DEFENSE THREAT REDUCTION AGENCY
8725 JOHN J. KINGMAN ROAD, STOP 6201
FORT BELVOIR, VA 22060-6201

February 17, 2022

Shannon Murray
U.S. Right to Know

Re: FOIA Case No.: 22-008

Dear Ms. Murray:

This is our final response to your Freedom of Information Act (FOIA) request perfected on October 6, 2021, and assigned FOIA case number 22-008 by the Defense Threat Reduction Agency (DTRA). You requested a copy of grant proposals, scientific and technical interim reports, reviewer response documents, policy-related documents, and email communications between DTRA staff and EcoHealth Alliance staff (email to or from the domain @ecohealthalliance.org, including attachments) about the following grants awarded by DTRA to EcoHealth Alliance, since January 2019: HDTRA12010026, HDTRA12010029, and HDTRA12110023.

Enclosed is a copy of the documents totaling 311 pages. These records are being released to you in part. Some information is being withheld under FOIA Exemption 6. Exemption 6 applies to information, which, if released, would constitute a clearly unwarranted invasion of the personal privacy of an individual. No fees are due as the assessable cost total $25.00 or less.

Determinations for this interim release were made by the Initial Denial Authority (IDA), Mr. Earl Washington, Chief, Records Management, FOIA, and Privacy Act Division / DTRA Records Officer, Information Management and Technology Directorate, on behalf of DTRA. If you consider this decision to be an adverse determination, you may file a written appeal that is postmarked no later than 90 calendar days after the date of this letter to the Deputy Director, Defense Threat Reduction Agency, Information Management and Technology Directorate, ATTN: FOIA/PA Office, 8725 John J. Kingman Road, MSC 6201, Fort Belvoir, Virginia 22060. The appeal should reference the FOIA/Privacy Act case number, contain a concise statement of the grounds upon which the appeal is brought, and a description of the relief sought. A copy of this letter should also accompany your appeal. Both the envelope and your letter should clearly identify that a Freedom of Information Act and/or a Privacy Act Appeal is being made.

Should you have additional questions or concerns regarding this case, you may seek dispute resolution services from the DTRA FOIA Public Liaison or the Office of Government Information Services (OGIS). The DTRA FOIA Public Liaison, Mr. Mario Vizcarra, may be contacted by phone at (703)767-1792 or by email at dtrafoiaprivacy@mail.mil. The contact information for OGIS can be found at www.archives.gov/ogis.

Sincerely,

Eugene McGirt

Eugene McGirt
FOIA/Privacy Act Specialist
Freedom of Information/Privacy Act Office

Enclosure(s):
As stated

From: Aleksei Chmura
To: (b)(6)
Cc: (b)(6) DTRA Ft Belvoir SI Mailbox SI-FMKA SPS Contracts; onr_boston@navy.mil; Joe Riccardi
Subject: [Non-DoD Source] Re: HDTRA1-20-1-0026 Award
Date: Friday, September 25, 2020 8:59:49 AM

All active links contained in this email were disabled. Please verify the identity of the sender, and confirm the authenticity of all links contained within the message prior to copying and pasting the address to a Web browser.

Dear(b)(6)

I confirm receipt.

Many thanks most,

Sincerely,

-Aleksei

Aleksei Chmura, PhD
Chief of Staff

EcoHealth Alliance
520 Eighth Avenue, Suite 1200
New York, NY 10018-4182

+1.212.380.4473 < tel:1.212.380.4469 > (office)
(b)(6) > (mobile)
Caution-www.ecohealthalliance.org < Caution-http://www.ecohealthalliance.org >

EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation.

On Sep 25, 2020, at 08:04, (b)(6)
Caution-mailt(b)(6) > wrote:

Attached you will find award documentation for grant HDTRA1-20-1-0026. Please confirm once you have received this email. Thank you!

V/r

(b)(6) Contractor
Contract Specialist • Broadleaf
Defense Threat Reduction Agency (DTRA)
Office Phone: (571) 616-4277

(b)(6)

<EHA India SOW.pdf><Terms and Conditions (DTRA-specific)_14Sep2020 FINAL.pdf><HDTRA1-20-1-0026 Award.pdf>

From: Aleksei Chmura
To: (b)(6)
Cc: Dr. Jon Epstein; Ava Sullivan; (b)(6) Joe Riccardi; (b)(6)
(b)(6) Alison Andre; (b)(6)
Subject: Re: [Non-DoD Source] FRBAA14-6-2-045
Date: Thursday, September 17, 2020 10:17:58 AM

All active links contained in this email were disabled. Please verify the identity of the sender, and confirm the authenticity of all links contained within the message prior to copying and pasting the address to a Web browser.

Dear (b)(6)

Apologies for missing your call just now.

I confirm that our India project budget is $4,956,064.36. This is less than our originally proposed budget. Our justified and verified budget costs were slightly reduced compared to what was originally submitted via Grants.gov < Caution-http://Grants.gov > .

Many thanks!

-Aleksei

Aleksei Chmura, PhD
Chief of Staff

EcoHealth Alliance
520 Eighth Avenue, Suite 1200
New York, NY 10018-4182

+1.212.380.4473 < tel:1.212.380.4469 > (office)
(b)(6) (mobile)
Caution-www.ecohealthalliance.org < Caution-http://www.ecohealthalliance.org >

EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation.

On Sep 16, 2020, at 10:04 (b)(6) < (b)(6)
Caution-mailto (b)(6) > wrote:

I do have a question, while reviewing your budget I see a total budget of $4,956,064.36 and S4,964,011.70, which has orignal. For clarification, what is the total proposed amount?

-----Original Message-----
From: Aleksei Chmura <chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > >
Sent: Wednesday, September 2, 2020 11:52 AM
To: Lyles, Latrice D CTR DTRA AL (USA) (b)(6)
Caution-mailto (b)(6)

Cc: Dr. Jon Epstein <epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > >; Ava Sullivan <sullivan@ecohealthalliance.org < Caution-mailto:sullivan@ecohealthalliance.org > >; (b)(6)
(b)(6)

Subject: Re: [Non-DoD Source] FRBAA14-6-2-0454

All active links contained in this email were disabled. Please verify the identity of the sender, and confirm the authenticity of all links contained within the message prior to copying and pasting the address to a Web browser.

Dear (b)(6)

Thank you for your continued patience with us and our partners as we gathered the requested documentation and clarifications.

Attached are the following files:

- DTRA India KVASU budget justification v01.docx
- DTRA India KVASU supporting docs.pdf

- DTRA India HMJF budget justification v01.docx
- DTRA India HMJF supporting docs.pdf
- DTRA India HMJF Supplies breakout with live links/URLs.xlsx

- DTRA India KGMU supporting docs.pdf
- DTRA India KGMU budget justification v01.docx

- DTRA India EHA supporting docs.pdf
- DTRA India EHA budget justification v01.docx
- DTRA India EHA budget v01.xlsx

- DTRA India EHA Clarifications v01.xlsx
- DTRA India EHA Questions and Responses v01.docx

Note that we have included (last file listed above) a word document version of our responses to the questions emailed previously, but these also are included in our Clarifications (xlsx) file.

Please call anytime, if you have questions, require additional details, or would like us to rapidly direct you to any specific documentation in our attached files.

Many thanks!

-Aleksei

Aleksei Chmura, PhD
Chief of Staff &
Authorized Organizational Representative

EcoHealth Alliance
520 Eighth Avenue, Suite 1200
New York, NY 10018-4182

+1.212.380.4473 < tel:1.212.380.4469 < tel:1.212.380.4469 > > (office)
(b)(6) > (mobile)
Caution-Caution-www.ecohealthalliance.org < Caution-http://Caution-Caution-www.ecohealthalliance.org > < Caution-Caution-http://www.ecohealthalliance.org/ < Caution-Caution-http://www.ecohealthalliance.org/ > >

EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation.

On Sep 1, 2020, at 14:52, Ava Sullivan <sullivan@ecohealthalliance.org < Caution-mailto:sullivan@ecohealthalliance.org > <Caution-mailto:sullivan@ecohealthalliance.org < Caution-mailto:sullivan@ecohealthalliance.org > > > wrote:

Thank you(b)(6)
We will submit the full clarification by OOB tomorrow. We apologize for the late submission, we have run into a few obstacles related to COVID, among other delays. Despite these delays, we will be able to submit very shortly and look forward to sharing the information with this group.

Thanks,

-
Ava Sullivan

On Sep 1, 2020, at 2:30 PM, Lyles, Latrice D CTR DTRA AL (USA) (b)(6)
Caution-mailto(b)(6)
Caution-mailto

Good Afternoon,

I will be picking up for Terrie.

I know it was mentioned that the clarification questions/documents would be submitted Friday August 28, 2020. I wanted to follow up on that and make sure we get the documents in so we can proceed with awarding this grant. I hope to hear back from you soon. Thanks!

-----Original Message-----
From: Ava Sullivan <sullivan@ecohealthalliance.org < Caution-mailto:sullivan@ecohealthalliance.org > <Caution-mailto:sullivan@ecohealthalliance.org < Caution-mailto:sullivan@ecohealthalliance.org > > >
Sent: Wednesday, August 26, 2020 9:15 AM
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Latrice
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(b)(6)

Aleksei MacDurian <chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > <Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > > >; Alison Andre <andre@ecohealthalliance.org < Caution-mailto:andre@ecohealthalliance.org > <Caution-mailto:andre@ecohealthalliance.org < Caution-mailto:andre@ecohealthalliance.org > > > (b)(6)

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Subject: Re: [Non-DoD Source] FRBAA14-6-2-0454

All active links contained in this email were disabled. Please verify the identity of the sender, and confirm the authenticity of all links contained within the message prior to copying and pasting the address to a Web browser.

Yes, I will do that.
Best wishes for the time ahead,

Ava Sullivan

Project Manager and Research Assistant

EcoHealth Alliance
520 Eighth Avenue – Suite 1200
New York, NY 10018
607-280-7669 < tel:607-280-7669 < tel:607-280-7669 > > (mobile) Caution-Caution-www.ecohealthalliance.org < Caution-http://Caution-Caution-www.ecohealthalliance.org > <Caution-http://Caution-Caution-www.ecohealthalliance.org < Caution-http://Caution-Caution-www.ecohealthalliance.org > > < Caution-Caution-http://www.ecohealthalliance.org < Caution-Caution-http://www.ecohealthalliance.org > >

EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation

On Aug 25, 2020, at 8:26 PM, Rodriguez, Terrie M CIV DTRA AL (USA) < (b)(6)
< Caution-mail (b)(6)
Caution-mailto
Caution-mailto

Good Evening,

Thank you very much for your e-mail and for the update. Kindly request that you please include all DTRA personnel contained on the "cc" line of this e-mail for all clarification responses, as I will be out on maternity leave beginning Monday 8/31.

Very Respectfully,

(b)(6)
Contract Specialist
Defense Threat Reduction Agency
(b)(6)
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-----Original Message-----

From: Ava Sullivan <sullivan@ecohealthalliance.org < Caution-mailto:sullivan@ecohealthalliance.org > <Caution-mailto:sullivan@ecohealthalliance.org < Caution-mailto:sullivan@ecohealthalliance.org > > < Caution-Caution-mailto:sullivan@ecohealthalliance.org < Caution-mailto:sullivan@ecohealthalliance.org > > >

Sent: Tuesday, August 25, 2020 8:21 PM

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Cc: Jon Epstein <epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > <Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > > < Caution-

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Caution(b)(6) > > >; Joe Riccardi <riccardi@ecohealthalliance.org < Caution-mailto:riccardi@ecohealthalliance.org > <Caution-mailto:riccardi@ecohealthalliance.org < Caution-mailto:riccardi@ecohealthalliance.org > > < Caution-Caution-mailto:riccardi@ecohealthalliance.org < Caution-mailto:riccardi@ecohealthalliance.org > > >; Nwani, Nkechiyere G CTR (USA)

(b)(6)

>; Aleksei MacDurian <chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > <Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > > < Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > > >; Alison Andre <andre@ecohealthalliance.org < Caution-mailto:andre@ecohealthalliance.org > <Caution-mailto:andre@ecohealthalliance.org < Caution-mailto:andre@ecohealthalliance.org > > < Caution-Caution-mailto:andre@ecohealthalliance.org < Caution-mailto:andre@ecohealthalliance.org > > >

Subject: Re: [Non-DoD Source] FRBAA14-6-2-0454

All active links contained in this email were disabled. Please verify the identity of the sender, and confirm the authenticity of all links contained within the message prior to copying and pasting the address to a Web browser.

Hell(b)(6)

Forgive the late response. We were expecting to submit our full packet of clarifications today. However, due to unforeseen circumstances including issues with COVID-19 in-country, we will require a few extra days. I hope it is acceptable that we submit this on Friday, the 28th.

Thank you for your understanding, and we look forward to providing all the requested materials, Ava

On Thu, Aug 20, 2020 at 1:38 PM(b)(6)

(b)(6) > < Caution-

Caution-mail (b)(6) [redacted] tion-
Caution-Caut <
Caution-Caut > >
> wrote:

Hi Ava,

Thanks so much for your e-mail. We look forward to receiving the responses. Have a great day!

Very Respectfully,

(b)(6) [redacted]
Contract Specialist
Defense Threat Reduction Agency

(b)(6) [redacted]
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-----Original Message-----
From: Ava Sullivan <sullivan@ecohealthalliance.org < Caution-mailto:sullivan@ecohealthalliance.org > <Caution-mailto:sullivan@ecohealthalliance.org < Caution-mailto:sullivan@ecohealthalliance.org > > < Caution-Caution-mailto:sullivan@ecohealthalliance.org < Caution-mailto:sullivan@ecohealthalliance.org > > < Caution-Caution-Caution-mailto:sullivan@ecohealthalliance.org < Caution-mailto:sullivan@ecohealthalliance.org > < Caution-Caution-mailto:sullivan@ecohealthalliance.org < Caution-mailto:sullivan@ecohealthalliance.org > > > >
Sent: Thursday, August 20, 2020 1:34 PM
To (b)(6) [redacted]
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Cc: Dr. Jon Epstein <epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > <Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > > < Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > > < Caution-Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > < Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > > > >;
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Alison Andre <andre@ecohealthalliance.org < Caution-mailto:andre@ecohealthalliance.org > <Caution-mailto:andre@ecohealthalliance.org < Caution-mailto:andre@ecohealthalliance.org > > < Caution-Caution-mailto:andre@ecohealthalliance.org < Caution-mailto:andre@ecohealthalliance.org > > < Caution-Caution-Caution-mailto:andre@ecohealthalliance.org < Caution-mailto:andre@ecohealthalliance.org > < Caution-Caution-mailto:andre@ecohealthalliance.org < Caution-mailto:andre@ecohealthalliance.org > > > >
Subject: Re: [Non-DoD Source] FRBAA14-6-2-0454

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A kind hello,

I am jumping on this thread on behalf of EcoHealth Alliance. We expect to submit the clarifications by Tuesday, August 25. I do hope this is agreeable.

Thank you,
Ava

Ava Sullivan

Project Manager and Research Assistant

EcoHealth Alliance
520 Eighth Avenue – Suite 1200
New York, NY 10018
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EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation

Begin forwarded message:

(b)(6)

Subject: RE: [Non-DoD Source] FRBAA14-6-2-0454

Date: August 18, 2020 at 08:50:01 EDT

To: Aleksei Chmura <chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > <Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > > < Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > > < Caution-Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > < Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > > > < Caution-Caution-Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > < Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > > < Caution-Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > < Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > > > > >

Cc: "Dr. Jon Epstein" <epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > <Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > > < Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > > < Caution-Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > < Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > > > < Caution-Caution-Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > < Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > > < Caution-Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > < Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > > > > >, (b)(6)

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(b)(6)

Greetings Dr. Chmura,

I just wanted to touch base to see if it was possible to receive a status update on the outstanding clarifications. We were hoping to reach resolution of these clarifications by mid-month in order to meet a prospective award date of 31 August however, we completely understand that EHA has its own competing priorities and that EHA may be waiting for responses from its own prospective subcontractors for this effort. Any update you might be able to share will help us shape expectations within our organization on a revised prospective award date.

Thank you very much and we look forward to continuing to work with you and your team! Have a wonderful day!

Very Respectfully,

(b)(6)
Contract Specialist
Defense Threat Reduction Agency

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-----Original Message-----
From: Aleksei Chmura <chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > <Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > > < Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > > < Caution-Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > < Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > > > < Caution-Caution-Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > < Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > > < Caution-Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > < Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > > > > >
Sent: Monday, August 10, 2020 9:23 AM

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Cc: Dr. Jon Epstein <epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > <Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > > < Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > > < Caution-Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > < Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > > > < Caution-Caution-Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > < Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > > < Caution-Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > < Caution-Caution-mailto:epstein@ecohealthalliance.org < Caution-mailto:epstein@ecohealthalliance.org > > > >
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Subject: Re: [Non-DoD Source] FRBAA14-6-2-0454

All active links contained in this email were disabled. Please verify the identity of the sender, and confirm the authenticity of all links contained within the message prior to copying and pasting the address to a Web browser.

Dear (b)(6)

I confirm receipt. Thank you for this notice and the additional clarification requests. We are working through the requested details and will get them back to as swiftly as possible.

Many thanks!

-Aleksei

Aleksei Chmura
Chief of Staff &
Authorized Organizational Representative

EcoHealth Alliance
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EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation.

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wrote:

Good Morning Dr. Chmura,

I just wanted to follow up to confirm that you did receive the below e-mail. I hope you had a nice weekend. Thanks in advance and have a wonderful day!

Very Respectfully,

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Contract Specialist
Defense Threat Reduction Agency
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-----Original Message-----
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Sent: Monday, August 3, 2020 3:15 PM
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Subject: RE: [Non-DoD Source] Re: FRBAA14-6-2-0454
Importance: High

Good Afternoon Dr. Chmura,

I hope that you enjoyed a nice weekend. We have some additional clarification question to add to our initial clarification request. Please let me know if you have any questions or concerns. Thank you in advance!

1. The proposal contains a 36.8% Indirect Rate for EHA however the latest NICRA for FY21 dated April 1, 2020 has 35.84% from 7/1/20 to 6/30/21. Please provide some additional information to support the use of 36.8% or update the proposal, if needed.

2. Please provide quotes, website link, or basis of estimate to substantiate cost proposed for Luminex machine in Y1 (EHA) and freezer in Y1 (KGMU)?

3. For all proposed travel which includes a conference registration cost, please provide the name of conference and the cost of registration.

4. For all proposed materials and supplies for which the budget justification refers to quotes or previous purchases, please provide any documentation you have available to support the proposed costs or to provide additional detail into the basis of estimates for the items.

5. If possible, request that KGMU and KVASU provide a copies of its institutional salary grades to support its proposed labor?

6. Please provide a breakout of all of HJF's proposed travel. (# of travelers, locations, per diem, dates, transportation, etc.)

7. Please provide documentation to support HJF's proposed cost for the AKTA service agreement.

8. If possible, request that HJF please provide directly to DTRA an updated copy of its provisional indirect cost and fringe benefit rates for FY20, if available?

9. Please provide documentation/basis of estimate to support KVASU's proposed cost $,1000 per year is to contribute to organizing the ongoing One Health stakeholder engagement meeting for venue and hosting costs. (ex. Breakout to support $1,000, what is included in the cost, etc.)

We are hoping to reach resolution of these clarifications (and those previously submitted) by mid-month, if possible, in order to meet a prospective award date of 31 August. Should your team run into any issues, please let us know. Thank you very much and we look forward to continuing to work with you and your team! Have a wonderful afternoon!

Very Respectfully,

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Contract Specialist
Defense Threat Reduction Agency
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-----Original Message-----
From: Aleksei Chmura <chmura@ecohealthalliance.org <
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Sent: Wednesday, July 22, 2020 12:47 PM
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Subject: [Non-DoD Source] Re: FRBAA14-6-2-0454
Importance: High

All active links contained in this email were disabled. Please verify the identity of the sender, and confirm the authenticity of all links contained within the message prior to copying and pasting the address to a Web browser.

Dear (b)(6)

Apologies for my slow reply. We are delighted to read your email!

I have cc'ed our Finance Manager Joe Riccardi on this email as well.

We will work through your requests this week and get responses back to you and Latrice as rapidly as possible.

I hope this email finds you and yours safe and healthy most,

Sincerely!

-Aleksei

Aleksei Chmura
Chief of Staff &
Authorized Organizational Representative

EcoHealth Alliance
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New York, NY 10018-4182

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EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation.

On Jul 16, 2020, at 11:12 (b)(6)

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wrote:

Greetings Dr. Epstein and Dr. Chmura,

CONGRATULATIONS! Your proposal, submitted under DTRA Broad Agency Announcement HDTRA1-14-24-FRCWMD, Proposal Number: FRBAA14-6-2-0454, has been selected as one that the Defense Threat Reduction Agency (DTRA) expects to award. PLEASE DO NOT BEGIN WORK as any award is subject to (1) successful negotiations between our contracting division and your organization and (2) the availability of funds. This notification must not be construed as an obligation on the part of the Government; only duly authorized procurement personnel may commit resources. Also, this notification must not be used as a basis for accruing costs to the Government prior to award.

Myself and (b)(6) will be your POCs until the award has been made. We will work directly with your office to discuss any clarifications required to support your proposal. Below are some initial clarifications for EHA's review and response.

1. Does EHA have its proposed budget available in MS Excel format and if so, would EHA be willing to share an executable file with DTRA for ease of review?
2. Does EHA have quotations available to support any of the proposed costs (ex. Proposed equipment or materials, sub-award)? If so, please provide that information to DTRA.
3. The proposal contains the procurement of a Luminex 200 Machine in Year 1 for use throughout the project. Please provide additional details as to how EHA proposes to mitigate the expected foreign tax burden for the local purchase, or importation of this piece of equipment.
4. The proposal contains the procurement of three laptops for this project, however it was noted in the budget justification that only one will be used to perform Luminex reads. Please provide additional justification to support the procurement of the additional two laptops.
5. The proposal contains a sub-award to HJF, which includes international travel. Please provide additional details which addresses the specific nature and frequency of international travel and how it relates to the requirements for project execution.
6. The proposal narrative states that Dr. Linfa Wang of Duke-NUS will serve as a Technical Advisor for this project, yet his role is not adequately characterized. There is no sub-award associated with Duke-NUS, nor are Dr. Wang's responsibilities, projected time, or salary for his role captured in the technical proposal, Statement of Work, or budget proposal. DTRA requests clarification on the role of Duke-NUS in the project, and subsequent submission of any relevant sub-award documentation, if appropriate.

Please let us know if you have any questions. Thank you and we look forward to working with you.

Very Respectfully,

(b)(6)
Contract Specialist
Defense Threat Reduction Agency
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Ava Sullivan
PREDICT-2 Operations Coordinator
Country Liaison, India

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EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation

Ava Sullivan

Project Manager and Research Assistant

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EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation

						ECOHEALTH ALLIANCE - DTRA INDIA BUDGET								
								01 Feb 2020 31 Jan 2021	1 Feb 2021 31 Jan 2022	1 Feb 2022 31 Jan 2023	1 Feb 2023 31 Jan 2024	1 Feb 2024 31 Jan 2025	Total	
MONTHS								Y1	Y2	Y3	OY1	OY2	3.5%	<---COLA increase
Y1	Y2	Y3	OY1	OY2	BASE	A. SENIOR KEY PERSONNEL								
3	3	3	3	3	$ 170,887.50	Epstein, Jon	Principal Investigator	$ 42,721.88	$ 44,217.14	$ 45,764.74	$ 47,366.51	$ 49,024.33	$ 229,094.60	
						Fringe, Epstein		$ 15,721.65	$ 16,271.91	$ 16,841.42	$ 17,430.87	$ 18,040.95	$ 84,306.81	
2	2	2	2	2	$ 91,730.03	Ross, Noam	Data Analyst	$ 15,288.34	$ 15,824.08	$ 16,378.86	$ 16,952.12	$ 17,545.44	$ 81,991.13	
						Fringe, Ross		$ 5,626.66	$ 5,823.59	$ 6,027.42	$ 6,238.38	$ 6,456.72	$ 30,172.77	
						TOTAL SENIOR KEY PERSONNEL		$ 79,360.02	$ 82,137.62	$ 85,012.44	$ 87,987.89	$ 91,067.45	$ 425,565.41	
						B. OTHER PERSONNEL								
12	12	12	12	12	$ 71,400.00	TBD	Post Doc Research Asst	$ 71,400.00	$ 73,899.00	$ 76,485.47	$ 79,162.46	$ 81,933.14	$ 382,880.06	
						Fringe, TBD		$ 26,275.20	$ 27,194.83	$ 28,146.65	$ 29,131.78	$ 30,151.40	$ 140,899.86	
12	12	12	12	12	$ 59,109.75	TBD	MSc Program Assistant	$ 59,109.75	$ 61,178.59	$ 63,319.84	$ 65,536.04	$ 67,829.80	$ 316,974.02	
						Fringe, TBD		$ 21,752.39	$ 22,513.72	$ 23,301.70	$ 24,117.26	$ 24,961.37	$ 116,646.44	
						TOTAL OTHER PERSONNEL		$ 178,537.34	$ 184,786.14	$ 191,253.66	$ 197,947.54	$ 204,875.71	$ 957,400.38	
						Total Salary		$ 188,521.46	$ 195,119.71	$ 201,948.90	$ 209,017.12	$ 216,332.71	$ 1,010,939.91	
					36.80%	Total Fringe		$ 69,375.90	$ 71,804.05	$ 74,317.20	$ 76,918.30	$ 79,610.44	$ 372,025.89	
						Total Salary + Fringe		$ 257,897.36	$ 266,923.77	$ 276,266.10	$ 285,935.41	$ 295,943.15	$ 1,382,965.80	
						C. EQUIPMENT								
						Luminex Bio-Plex 200 with wash etc		$ 55,719.50	$ -	$ -	$ -	$ -	$ 55,719.50	
						TOTAL EQUIPMENT		$ 55,719.50	$ -	$ -	$ -	$ -	$ 55,719.50	
						D. TRAVEL								
						1. Domestic		$ 11,581.90	$ 11,581.90	$ 11,581.90	$ 11,581.90	$ 11,581.90	$ 57,909.50	
						2. International		$ 34,515.40	$ 34,515.40	$ 34,515.40	$ 34,515.40	$ 34,515.40	$ 172,577.00	
						TOTAL TRAVEL		$ 46,097.30	$ 46,097.30	$ 46,097.30	$ 46,097.30	$ 46,097.30	$ 230,486.50	
						E. PARTICIPANT/TRAINEE SUPPORT COSTS								
						1. Tuition/Fees/Health Insurance		$ -	$ -	$ -	$ -	$ -	$ -	
						2. Stipends		$ -	$ -	$ -	$ -	$ -	$ -	
						3. Travel		$ -	$ -	$ -	$ -	$ -	$ -	
						4. Subsistence		$	$	$	$	$	$	
						5. Other		$	$	$	$	$	$	
						Total Participant/Trainee Support Costs		$ -	$ -	$ -	$ -	$ -	$ -	
						F. OTHER DIRECT COSTS								
						1. Materials and Supplies								
						Laptops for Luminex Reads & data anal	2	$ 4,798.00		$	$	$	$ 4,798.00	
						Harp Trap		$ 4,333.00					$ 4,333.00	
						Cryo-Boxes		$ 1,358.00	$ -	$ -	$ -	$ -	$ 1,358.00	
						Dry Shipper	2	$ 4,753.00	$ -	$ -	$ -	$ -	$ 4,753.00	
						Needles, Syringes, Tubes		$ 1,866.96	$ 1,866.96	$ 1,866.96	$ 1,866.96	$ 1,866.96	$ 9,334.80	
						Micro Centrifuge	2	$ 1,686.06			$ 1,686.06		$ 3,372.12	
						Total Materials and Supplies		$ 18,795.02	$ 1,866.96	$ 1,866.96	$ 3,553.02	$ 1,866.96	$ 27,948.92	
						2. Publication Costs		$ -	$ -	$ -	$ 10,760.00	$ 10,760.00	$ 21,520.00	
						3. Consultant Services								
5	5	6	6	6	$ 48,240.00	Bhatia, Rajesh	Consultant 1	$ 20,100.00	$ 20,100.00	$ 24,120.00	$ 24,120.00	$ 24,120.00	$ 112,560.00	
5	5	6	6	6	$ 48,240.00	Zachariah, Arun	Consultant 2	$ 20,100.00	$ 20,100.00	$ 24,120.00	$ 24,120.00	$ 24,120.00	$ 112,560.00	
						Total Consultant Services		$ 40,200.00	$ 40,200.00	$ 48,240.00	$ 48,240.00	$ 48,240.00	$ 225,120.00	
						4. ADP/Computer Services		$ -	$ -	$ -	$ -	$ -	$ -	
						5. Subawards/Consortium/Contractual Costs		$ 398,167.58	$ 509,772.13	$ 490,965.93	$ 459,623.57	$ 450,220.46	$ 2,308,749.67	
						6. Equipment or Facility Rental/User Fees		$	$	$	$	$	$	
						7. Alterations and Renovations		$	$	$	$	$	$	
						8. Other		$ -	$ -	$ -	$ -	$ -	$ -	
						Total Other Direct Costs		$ 457,162.60	$ 551,839.09	$ 541,072.89	$ 522,176.59	$ 511,087.42	$ 2,583,338.59	
						G. DIRECT & MODIFIED DIRECT COSTS								
						Direct Costs		$ 816,876.76	$ 864,860.16	$ 863,436.29	$ 854,209.30	$ 853,127.89	$ 4,252,510.39	
						Modified Direct Costs		$ 362,989.68	$ 355,088.03	$ 372,470.36	$ 394,585.73	$ 402,907.41	$ 1,888,041.22	
						H. INDIRECT COSTS								
					IDC Rate-->	35.84%		$ 130,095.50	$ 127,263.55	$ 133,493.38	$ 141,419.53	$ 144,402.02	$ 676,673.97	
					IDC Rate-->	35.84%		$ 21,842.70	$ 3,922.70	$ 1,114.61	$ -	$ -	$ 26,880.00	
						Total Indirect Costs		$ 151,938.20	$ 131,186.25	$ 134,607.99	$ 141,419.53	$ 144,402.02	$ 703,553.97	
						I. TOTAL DIRECT AND INDIRECT COSTS								
						Direct + Indirect		$ 968,814.96	$ 996,046.41	$ 998,044.27	$ 995,628.83	$ 997,529.89	$ 4,956,064.36	
						J. FEES								
						Fee								
						K. TOTAL COSTS AND FEES								
						Total Costs		$ 968,814.96	$ 996,046.41	$ 998,044.27	$ 995,628.83	$ 997,529.89	$ 4,956,064.36	
						Amount in Grants.gov		$ 970,366.84	$ 995,332.63	$ 999,666.56	$ 998,965.86	$ 998,985.95	$ 4,963,527.86	
						SUBAWARDS		2						
						KGMU		$ 211,608.16	$ 248,014.35	$ 229,208.15	$ 210,401.94	$ 200,998.84	$ 1,100,231.44	
						HMIF		$ 175,614.39	$ 250,812.76	$ 250,812.76	$ 238,276.60	$ 238,276.60	$ 1,153,793.12	
						KVASU		$ 10,945.02	$ 10,945.02	$ 10,945.02	$ 10,945.02	$ 10,945.02	$ 54,725.11	
						Total Subawards		$ 398,167.58	$ 509,772.13	$ 490,965.93	$ 459,623.57	$ 450,220.46	$ 2,308,749.67	
								Y1	Y2	Y3	OY1	OY2	TOTAL	
							Original	$ 971,376.59	$ 995,345.71	$ 999,610.36	$ 998,808.34	$ 998,970.72	$ 4,964,011.70	
							Variance	$2,561.63	$700.70	$1,566.09	$3,179.51	$1,440.81	$7,947.34	

CONSORTIUM MEMBER ALLOCATIONS ($)						
	Y1	Y2	Y3	OY1	OY2	TOTAL
EHA	$ 362,989.68	$ 355,088.03	$ 372,470.36	$ 394,585.73	$ 402,907.41	$ 1,888,041.22
HMIF	$ 175,614.39	$ 250,812.76	$ 250,812.76	$ 238,276.60	$ 238,276.60	$ 1,153,793.12
KGMU	$ 211,608.16	$ 248,014.35	$ 229,208.15	$ 210,401.94	$ 200,998.84	$ 1,100,231.44
KVASU	$ 10,945.02	$ 10,945.02	$ 10,945.02	$ 10,945.02	$ 10,945.02	$ 54,725.11
EHA in Country	$ 289,760.50	$ 221,026.14	$ 234,337.31	$ 251,618.03	$ 254,935.84	$ 1,252,277.82

COUNTRY ALLOCATIONS ($)						
	Y1	Y2	Y3	OY1	OY2	TOTAL
US	$ 248,674.77	$ 374,055.84	$ 378,727.01	$ 371,025.51	$ 376,229.48	$ 1,748,462.57
INDIA	$ 502,100.33	$ 428,222.36	$ 424,127.14	$ 430,601.63	$ 424,316.24	$ 2,836,819.52
TOTAL	$ 750,775.10	$ 802,278.20	$ 802,854.15	$ 801,627.14	$ 800,545.72	$ 4,585,282.09

COUNTRY ALLOCATIONS (%)						
	Y1	Y2	Y3	OY1	OY2	TOTAL
US	30%	41%	42%	42%	42%	42%
INDIA	70%	59%	58%	58%	58%	62%
TOTAL	1.00	1.00	1.00	1.00	1.00	1.00

INTERNATIONAL TRAVEL	Y1	Y2	Y3	OY1	OY2	TOTAL
NYC <-> INDIA (DEL->LKO) - Meetings						
Hotel Max Per Diem	$ 196.00	$ 196.00	$ 196.00	$ 196.00	$ 196.00	
Total Hotel	$ 2,548.00	$ 2,548.00	$ 2,548.00	$ 2,548.00	$ 2,548.00	
Meals and Incidental Expenses Per Diem	$ 74.00	$ 74.00	$ 74.00	$ 74.00	$ 74.00	
Total MIEs	$ 999.00	$ 999.00	$ 999.00	$ 999.00	$ 999.00	
Flight Estimate (NYC<->DEL<->LKO)	$ 1,414	$ 1,414	$ 1,414	$ 1,414	$ 1,414	
nsport to/from Airport ($73/NYC, $1.60 LKO)	$ 145.20	$ 145.20	$ 145.20	$ 145.20	$ 145.20	
Daily Transport in LKO ($1.50)	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	
No. Days	14	14	14	14	14	
No. Nights	13	13	13	13	13	
No. Trips per Year	3	3	3	3	3	
No. Travelers	2	2	2	2	2	
Total	$ 30,655.40	$ 30,655.40	$ 30,655.40	$ 30,655.40	$ 30,655.40	$153,277.00
International Conference						
Hotel Max Per Diem	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	
Total Hotel	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	
Meals and Incidental Expenses Per Diem	$ 173.00	$ 173.00	$ 173.00	$ 173.00	$ 173.00	
Total MIEs	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	
Flight Estimate	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	
ransport to/from Airport ($73/NYC, $75 GVA)	$ 292.00	$ 292.00	$ 292.00	$ 292.00	$ 292.00	
Daily Transport in GVA	N/A	N/A	N/A	N/A	N/A	
Registration	$ 500	$ 500	$ 500	$ 500	$ 500	
No. Days	4	4	4	4	4	
No. Nights	1	1	1	3	3	
No. Trips per Year	1	1	1	1	1	
No. Travelers	1	1	1	1	1	
Total	$ 3,860.00	$ 3,860.00	$ 3,860.00	$ 3,860.00	$ 3,860.00	$ 19,300.00
TOTAL INTERNATIONAL TRAVEL	$ 34,515.40	$ 34,515.40	$ 34,515.40	$34,515.40	$34,515.40	$172,577.00
NYC<->DEL (US carrier)	$1,570					
DEL<->LKO (non-US carrier)	$ 135					

DOMESTIC TRAVEL	Y1	Y2	Y3	OY1	OY2	TOTAL
NYC to DC Meetings						
Hotel Max Per Diem	$ 256	$ 256	$ 256	$ 256	$ 256	
Total Hotel	$ 512	$ 512	$ 512	$ 512	$ 512	
Meals and Incidental Expenses Per Diem	$ 71	$ 71	$ 71	$ 71	$ 71	
Total MIEs	$ 178	$ 178	$ 178	$ 178	$ 178	
Flight Transportation Estimate	$ 127	$ 127	$ 127	$ 127	$ 127	
Local Transport to/from Airport ($71.00/NYC, $68.90/WAS)	$ 280	$ 280	$ 280	$ 280	$ 280	
Daily Transport in DC ($24.65)	$ 98	$ 98	$ 98	$ 98	$ 98	
No. Days	3	3	3	3	3	
No. Nights	2	2	2	2	2	
No. Trips per Year	2	2	2	2	2	
No. Travellers	4	4	4	4	4	
Total	$ 9,473.60	$ 9,473.60	$ 9,473.60	$ 9,473.60	$ 9,473.60	$ 47,368
Annual Domestic Presentation/Conf. for PI or 1 Sr. Personnel						
Hotel Max Per Diem	$ 256	$ 256	$ 256	$ 256	$ 256	
Total Hotel	$ 1,024	$ 1,024	$ 1,024	$ 1,024	$ 1,024	
Meals and Incidental Expenses Per Diem	$ 71	$ 71	$ 71	$ 71	$ 71	
Total MIEs	$ 178	$ 178	$ 178	$ 178	$ 178	
Flight/Train Transportation Estimate	$ 127	$ 127	$ 127	$ 127	$ 127	
Local Transport to/from Airport ($71.00/NYC, $68.90/TBD)	$ 280	$ 280	$ 280	$ 280	$ 280	
Daily Transport in TBD ($24.65)	$ 147	$ 147	$ 147	$ 147	$ 147	
Registration	$ 500	$ 500	$ 500	$ 500	$ 500	
No. Days	5	5	5	5	5	
No. Nights	4	4	4	4	4	
No. Trips per Year	1	1	1	1	1	
No. Travellers	1	1	1	1	1	
Total	$ 2,108.30	$ 2,108.30	$ 2,108.30	$ 2,108.30	$ 2,108.30	$ 10,542
TOTAL DOMESTIC TRAVEL	$ 11,581.90	$ 11,581.90	$11,581.90	$11,581.90	$11,581.90	$ 57,909.50

KING GEORGE MU - OTRA INDIA BUDGET													
MONTHS								[illegible] 2019 30 Sep 2020 YEAR 1	1 Oct 2020 30 Sep 2021 YEAR 2	1 Oct 2021 30 Sep 2022 YEAR 3	1 Oct 2022 30 Sep 2023 OPTION YEAR 1	1 Oct 2023 30 Sep 2024 OPTION YEAR 2	Total
Y1	Y2	Y3	OY1	OY2	RATE	A. SENIOR/KEY PERSONNEL							
12	12	12	12	12	$ 9,077.00	[illegible]	Program Director/Co-Investigator (Res. Assoc. II)	$9,077.00	$9,077.00	$9,077.00	$9,077.00	$9,077.00	$45,385.00
						TOTAL SENIOR/KEY PERSONNEL		$9,077.00	$9,077.00	$9,077.00	$9,077.00	$9,077.00	$45,385.00
						B. OTHER PERSONNEL							
12	12	12	12	12	$ [illegible]	TBD	PhD Student (Sr. Res. Fellow)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	12	12	12	12	$ 9,077.00	[illegible]	Medical Faculty (Res. Assoc. II)	$9,077.00	$9,077.00	$9,077.00	$9,077.00	$9,077.00	$45,385.00
12	12	12	12	12	$ [illegible]	[illegible]	Medical Faculty (Res. Assoc. II)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	12	12	12	12	$ [illegible]	[illegible]	Medical Faculty (Res. Assoc. II)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	12	12	12	12	$ [illegible]	TBD	Animal Technician I (Jr. Res. Fellow)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	12	12	12	12	$ [illegible]	TBD	Animal Technician II (Jr. Res. Fellow)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	12	12	12	12	$ [illegible]	TBD	Animal Technician III (Jr. Res. Fellow)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	12	12	12	12	$ [illegible]	TBD	Wildlife Vet (Res. Assoc. I)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	12	12	12	12	$ [illegible]	TBD	Human Subject Coordinator (Res. Assoc. I)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	12	12	12	12	$ [illegible]	TBD	Laboratory Technician (Res. Assoc. I)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	12	12	12	12	$ [illegible]	TBD	Laboratory Technician (Res. Assoc. I)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	12	12	12	12	$ [illegible]	TBD	Laboratory Assistant (Jr. Res. Fellow)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	12	12	12	12	$ [illegible]		[illegible] (Res. Assoc. I)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	12	12	12	12	$ [illegible]	TBD	[illegible] (Res. Assoc. I)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						TOTAL OTHER PERSONNEL		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						TOTAL SALARY		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						C. EQUIPMENT							
						[illegible]		[illegible]	$0.00	$0.00	$0.00	$0.00	[illegible]
						TOTAL EQUIPMENT		[illegible]	$0.00	$0.00	$0.00	$0.00	[illegible]
						D. TRAVEL							
						1. Domestic		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						2. International		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						TOTAL TRAVEL		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						E. PARTICIPANT/TRAINEE SUPPORT COSTS							
						1. Tuition/Fees/Health Insurance		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						2. Stipend		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						3. Travel		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						4. Subsistence		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						5. Other		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						Total Participant/Trainee Support Costs		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						F. OTHER DIRECT COSTS							
						1. Materials and Supplies							
						[illegible]	2	[illegible]	$0.00	$0.00	$0.00	$0.00	[illegible]
						[illegible]	2	[illegible]	$0.00	$0.00	$0.00	$0.00	[illegible]
[illegible]	2.00	1.50	1.00	0.75		Supplies	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						[illegible]	5	[illegible]	$0.00	$0.00	$0.00	$0.00	[illegible]
						Total Materials and Supplies							$0.00
						2. Publication Costs		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						3. Consultant Services		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						4. ADP/Computer Services		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						5. Subawards/Consortium/Contractual Costs		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						6. Equipment or Facility Rental/User Fees		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						7. Alterations and Renovations		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						8. Other (NGS Testing and Sequencing)	10%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						Total Other Direct Costs		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						G. DIRECT & MODIFIED DIRECT COSTS							
						Direct Costs		$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
						Modified Direct Costs		$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
						H. INDIRECT COSTS							
					IDC Rate →	10%		$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
						Total Indirect Costs		$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
						TOTAL DIRECT AND INDIRECT COSTS							
						Direct + Indirect		$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
						I. FEES							
						Fee							
						K. TOTAL COSTS AND FEES							
						Total Cost		$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]

INR	[illegible]
USD	0.014

INR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Month (INR)	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
Annual	[illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]

	[illegible]	[illegible]
Lodging	$ [illegible]	$ [illegible]
Meals	$ [illegible]	$ [illegible]
Incidental	$ [illegible]	$ [illegible]

	Per Mile	[illegible]
Mileage Rate	$ [illegible]	$ [illegible]

[illegible]	[illegible]	$ [illegible]	[illegible]

Days Per Trip	20
Nights Per Trip	20
No. Trips	4
No. Persons Per Trip	[illegible]

Per Trip Costs	
Lodging	[illegible]
Meals	$ [illegible]
Incidentals	$ [illegible]
Mileage	$ [illegible]
Total Per Trip	[illegible]

No. Trips per Year	20	[illegible]

Total Per Year	[illegible]

DOMESTIC TRAVEL					TOTAL
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

INTERNATIONAL TRAVEL					TOTAL
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

KVASU - DTRA INDIA BUDGET													
								01 July 2019 - 30 June 2020	1 July 2020 - 30 June 2021	1 July 2021 - 30 June 2022	1 July 2022 - 30 June 2023	1 July 2023 - 30 June 2024	Total
MONTHS								YEAR 1	YEAR 2	YEAR 3	OPTION YEAR 1	OPTION YEAR 2	0%
Y1	Y2	Y3	OY1	OY2	BASE	A. SENIOR KEY PERSONNEL							
1	1	1	1	1	$ -	Nambiar, Prejit	Laboratory Lead	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						TOTAL SENIOR KEY PERSONNEL		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						B. OTHER PERSONNEL							
12	12	12	12	12	$ 5,000	TBD	Research Assistant 01	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$25,000.00
						TOTAL OTHER PERSONNEL		$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$25,000.00
						TOTAL SALARY		$5,000.00	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$25,000.00
						C. EQUIPMENT							
								$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						TOTAL EQUIPMENT		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						D. TRAVEL							
						1. Domestic		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						2. International		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						TOTAL TRAVEL		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						E. PARTICIPANT/TRAINEE SUPPORT COSTS							
						1. Tuition/Fees/Health Insurance		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						2. Stipends		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						3. Travel		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						4. Subsistence		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						5. Other		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						Total Participant/Trainee Support Costs		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						F. OTHER DIRECT COSTS							
						1. Materials and Supplies		$2,950.02	$2,950.02	$2,950.02	$2,950.02	$2,950.02	$14,750.10
						2. Publication Costs		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						3. Consultant Services		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						4. ADP/Computer Services		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						5. Subawards/Consortium/Contractual Costs		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						6. Equipment or Facility Rental/User Fees		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						7. Alterations and Renovations		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
						8. 2-Day Annual Meeting Costs		$2,000.00	$2,000.00	$2,000.00	$2,000.00	$2,000.00	$10,000.00
						Total Other Direct Costs		$4,950.02	$4,950.02	$4,950.02	$4,950.02	$4,950.02	$24,750.10
						G. DIRECT & MODIFIED DIRECT COSTS							
						Direct Costs		$ 9,950.02	$ 9,950.02	$ 9,950.02	$ 9,950.02	$ 9,950.02	$ 49,750.10
						Modified Direct Costs		$ 9,950.02	$ 9,950.02	$ 9,950.02	$ 9,950.02	$ 9,950.02	$ 49,750.10
						H. INDIRECT COSTS							
					IDC Rate-->	10.00%		$ 995.00	$ 995.00	$ 995.00	$ 995.00	$ 995.00	$ 4,975.01
						Total Indirect Costs		$ 995.00	$ 995.00	$ 995.00	$ 995.00	$ 995.00	$ 4,975.01
						I. TOTAL DIRECT AND INDIRECT COSTS							
						Direct + Indirect		$ 10,945.02	$ 10,945.02	$ 10,945.02	$ 10,945.02	$ 10,945.02	$ 54,725.11
						J. FEES							
						0.00%	G&A	$ -	$ -	$ -	$ -	$ -	$ -
						K. TOTAL COSTS AND FEES							
						Total Costs		$ 10,945.02	$ 10,945.02	$ 10,945.02	$ 10,945.02	$ 10,945.02	$ 54,725.11

HDTRA1-14-24-FRCWMD-BAA
CBEP = Thrust Area 6 – Cooperative Counter WMD Research with Global Partners

HDTRA1-14-24-FRCWMD-BAA
CTRP = Thrust Area 6 – Cooperative Counter WMD Research with Global Partners
Biosurveillance for Spillover of Zoonotic Viruses in Rural Communities in India

Abstract: Zoonotic viruses including certain henipaviruses, filoviruses, and coronaviruses constitute a significant threat to global health. Nipah virus (NiV), Ebola virus (EBOV), and SARS coronavirus are highly pathogenic viruses and select agents capable of causing public health emergencies of international concern. In 2018, the WHO listed these pathogens among the top ten threats to global health and security. In 2014, a single spillover event of Ebola Zaire from an animal host (presumed to be a bat) caused an epidemic in West Africa that infected more than 28,000 people, killing approximately 40%. In Bangladesh and India, Nipah virus causes outbreaks of acute encephalitis in people and has an associated mean mortality rate of 70%. Saudi Arabia and the Gulf states continue to have new cases of MERS CoV, a zoonotic coronavirus related to SARS CoV. Bats are reservoirs for these and related viruses, and zoonotic transmission from bats to humans either directly or via domestic animals has previously occurred in Southeast Asia. Despite their importance as threats to public health and security, the full diversity of these viruses in bats and their potential to infect livestock and people remains poorly understood. This project will test the hypothesis that henipaviruses, filoviruses, and coronaviruses are circulating in bats in India and have spilled over into animal and human populations undetected, which presents a threat to human health. In line with Thrust Area 6 – Cooperative Weapons of Mass Destruction Research with Global Partners, this project will reduce threat from these select agents and viruses of high concern by enhancing early detection and surveillance capacity in India by: 1) conducting biological surveillance in bats, macaques, livestock and people in rural communities in Uttar Pradesh; 2) transferring PCR protocols and a multiplexed serology platform that can detect RNA from and IgG antibodies against all known henipaviruses, filoviruses, and SARS & MERS coronaviruses, to Indian partner labs; and 3) training laboratory personnel to develop and safely utilize these assays to identify human and animal infection and exposure to these viruses. This project will contribute to the Global Health Security Agenda, India and we will share results with key Indian government partners. The proposed project is closely aligned with the aims of the Cooperative Threat Reduction Program in that it will support threat reduction through biosurveillance and capability building, engagement with partner-country scientists, and use of a One-Health approach.

Background: India has been identified as a hotspot for emerging infectious diseases (EIDs). The majority of EIDs are zoonotic and caused by pathogens that circulate in wild animal populations. People across South Asia, in both rural and urban settings, live in close association with domestic and wild animals, including bats, which have been identified as important reservoirs for zoonotic viruses. Zoonoses such as SARS CoV, Influenza and HIV, have already caused significant global pandemics, and there is potential for other zoonotic viruses (known and unknown) to cause widespread epidemics if given opportunities to jump into human populations (e.g. Ebola virus in West & Central Africa). The henipavirus, filovirus, and coronavirus viral groups include important zoonotic agents such as Nipah virus (NiV), Ebola virus (EBOV), and SARS CoV. Bats are natural reservoirs for all three viral groups. **Nipah virus and Ebola virus are listed as select agents by CDC and USDA, and the WHO has identified them and SARS coronavirus as three of the ten most important global infectious disease threats.** Enhancing surveillance for these significant zoonotic viruses in animal and human populations to improve detection and reporting in areas highly vulnerable to disease emergence is critical for reducing the risk of epidemics.

There is a need for enhanced surveillance for zoonotic viruses in India. Acute encephalitis syndrome (AES) accounts for more than 10,000 deaths each year in India. Uttar Pradesh (UP), in northern India, is a hot spot for AES, and more than 50% of encephalitides India-wide remain undiagnosed. Nipah virus is a zoonotic virus, carried by bats, that causes acute encephalitis in domestic animals and people. Since 2001, more than 20 NiV outbreaks have been reported in Bangladesh and India, with a mean mortality rate of 70% (100% in some outbreaks). Repeated spillover from bats; high mortality; and human-to-human transmission signifies NiV's importance as an emerging zoonotic pathogen with pandemic potential. Kerala, India reported its first outbreak of Nipah virus encephalitis in May 2018, which infected 23 people (case fatality rate = 91%). *Pteropus medius* bats are a reservoir for henipaviruses in Bangladesh and India. Our group has shown that Nipah virus incidence in pteropid bats in Bangladesh is low (~1%-4%). Viral infections are transient and periodic and spillover depends on coincident active infection within a local bat population and a route of transmission. In Bangladesh, spillover happens seasonally when people consume date palm sap that has been contaminated by bat excreta. The mechanism of spillover in Kerala remains unknown, and despite evidence of NiV in bats in northern and southern India, there is a lack of surveillance in people and livestock. As a result, the extent to which NiV contributes to AES in India is unknown.

Bats also carry filoviruses, which cause viral hemorrhagic fever. Several species of bats have been associated with Ebola and Marburg viruses in Africa. The 2014 Ebola outbreak in West Africa was hypothesized to have begun with a single spillover event from a bat, though which bat species remains unknown. In Asia, outbreaks of viral hemorrhagic fever have not been associated with filoviruses; however, antibodies against Reston ebolavirus, a non-pathogenic filovirus, were detected in pigs and people in the Philippines in 2008. Our group identified Reston ebolavirus RNA and antibodies in local *Mineopterus schreibersii,* a common insectivorous bat, suggesting that pig and human cases were due to spillover from bats. There is now more evidence that various bats in Asia carry filoviruses, though the diversity of those viruses and their threat to human health is unknown. Mengla virus is a new species of filovirus discovered in *Rousettus* bats in China. It is different from Ebola and Marburg, but shares structural and functional traits with them, suggesting that it can infect people. Prior to this discovery, we found antibodies against unknown Ebola-like viruses in *Rousettus leschenaultii* and *Pteropus medius* (the Nipah reservoir) in Bangladesh – both of which are also common in India, suggesting that related filoviruses also circulate in South Asia. Despite this, there is currently no surveillance for filoviruses in India.

SARS CoV emerged in live animal markets in southern China in 2002 and caused a severe respiratory and gastrointestinal disease in people. It spread to 26 countries and infected more than 8,000 people, with 9% mortality. Middle East respiratory syndrome (MERS) CoV, related to SARS CoV, was first identified in a person who died from severe respiratory disease in Saudi Arabia in 2012. Our group identified Chinese horseshoe bats as the natural reservoir for SARS and SARS-like CoVs. Horseshoe bats are also common in India and it is unknown whether SARS-like CoVs have contributed to human respiratory disease in India.

Scientific & threat reduction impact: ***The possible presence of bat reservoirs for zoonotic viruses and lack of surveillance presents a situation where high consequence viral pathogens may emerge in human populations undetected. This project will establish a surveillance platform that will help mitigate the threat of zoonotic viral outbreaks in animals and people in India.*** The proposed project closely aligns with the goals of the Cooperative Biological Threat Reduction Program. Improving coordination among public health and animal health agencies; increasing capacity to detect viral zoonotic agents in animals and people; and identifying high risk behaviors for spillover in communities where there is contact among these groups, is necessary to adequately respond to outbreaks and reduce the threat to people's health and well-being. This project will provide important information about the risk of spillover of high consequence zoonotic viruses to livestock and people where people and animals live in very close association. This project will implement biosurveillance using a One Health framework, and capability building through engagement with local and federal institutions. It will also support and complement

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India's ability to meet IHR and OIE obligations and achieve Global Health Security Agenda (GHSA) objectives by enhancing local capacity to identify natural spillover or deliberate release of known and novel zoonotic agents. Early detection and prevention of spillover of high-risk viral pathogens in India, one of the most populous and globally connected regions of the world, will be critical to preventing local outbreaks and global pandemics.

Scientific approach & methods. We propose to test the following overarching hypothesis: Henipaviruses, filoviruses and coronaviruses are circulating in bats in rural India where people, bats and livestock live in close proximity, and spillover has occurred undetected. *This study will answer the following questions: 1) Which bat species carry henipaviruses, filoviruses and high consequence coronaviruses in India; 2) are there seasonal patterns to viral infections in bat reservoirs in rural communities; 3) have other wildlife species (e.g. macaques) and livestock been exposed to these viruses; and 4) does having livestock increase risk of exposure?* Building on our work from PREDICT in Uttar Pradesh, we will expand our human and animal surveillance where bat, human, and livestock populations live in close association. We will work with local university, state, and federal institutions using established and Indian Medical Research Council (ICMR)-approved sampling protocols developed under PREDICT. We have already established relationships with communities in Gorakhpur, a region with high rates of undiagnosed encephalitis and other illnesses. We will add additional communities in other parts of UP to total six field sites: three communities that rear livestock (e.g. pigs, goats, cattle) and three that do not. We will conduct quarterly sampling of wildlife (bats and macaques), livestock, and people at each location over 30 months (or 48 months including option years), and use questionnaires to collect data about how people interact with animals. We will collect ecological data such as bat species diversity and abundance, terrain and vegetation, food cultivation and dietary practices, and potential sources of environmental exposure to animals. Samples will be screened for henipavirus, filovirus, and SARS & MERS coronavirus viral RNA (PCR) or antibodies (Luminex) at King George's Medical University. PCR protocols for viral families developed under PREDICT will be established at KGMU. A validated, multiplexed serology assay (Luminex) that uses soluble glycoproteins from all known henipaviruses and filoviruses, as well as spike proteins from SARS and MERS CoV has been developed by the Broder lab at Uniformed Services University and we have used them in several previous and current research projects, including one funded by DTRA in Malaysia. We will also transfer these assays to other Indian lab partners (e.g. NIV, Pune) to enhance their ability detect novel and known members of these viral groups. We will compare viral detection rates and seroprevalence in humans and animals among study sites and measure changes over time. Serosurveillance will be especially informative to help identify bat reservoirs as these viruses cause acute, transient infections in bats making viral detection more difficult than antibody detection. Using a One Health approach to biosurveillance that includes people and livestock will also allow us to characterize virus and host diversity within these viral groups and identify past spillover events and high-risk behaviors that may have contributed to exposure.

We will report results from this project to relevant government stakeholders in human and animal health sectors, which will help them fulfill their reporting requirements for IHR and OIE. This project also supports the aims of the GHSA and we will present results at India GHSA meetings. This will also facilitate coordination with the US CDC, as they also conduct human disease surveillance in UP. We will publish findings from this study in high-impact, peer-reviewed journals and present at scientific meetings. We have included an optional 4th and 5th year in which we will continue targeted surveillance in UP, and also expand this project to Kerala state where a recent outbreak of Nipah virus occurred and where our group has already established partnerships with state wildlife, livestock and human health agencies through the state One Health platform.

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Capacity Building. This project will build capacity by: 1) developing and training local field teams; 2) transferring diagnostic technologies to partner (including GoI) laboratories and training staff to develop reagents & analyze data; 3) facilitating exchange of research personnel between US partners (EHA, USU) and partner labs in India; 4) providing postdoctoral research opportunities for Indian students interested in One Health, epidemiology, and laboratory diagnostic development; 5) holding One Health meetings to bring together stakeholders from human, domestic animal, and environmental (wildlife) sectors to strengthen cooperation and communication around viral disease surveillance; and 6) supporting the development of the new ICMR National One Health Institute (**an MOU between EHA and ICMR is in process**). These activities align with CTRP's mission to enhance India's ability to detect and respond to biological threats posed by zoonotic viruses. The increased capacity at both the field and laboratory level in human and animal health sectors, including wildlife, will directly improve livelihoods, reduce the threat from deliberately released agents, and limit the opportunity for zoonotic viruses to emerge undetected.

Partner Institutions and roles: EcoHealth Alliance (EHA): Design and coordinate the study with project partners; supervise local post-doctoral candidate; ensure coordination between field and lab studies and communication to Indian government agencies; and collaboratively analyze and publish data. EHA will be responsible for all contractual obligations with DTRA. **King George's Medical University (KGMU)**, Lucknow: Local implementing partner. KGMU will coordinate & conduct field surveillance activities, sample testing, data analysis and reporting. **National Institute of Virology, Pune:** The national reference laboratory for new and emerging viruses, as well as BSL 4 agents. NIV Pune will assist with further genetic characterization of viruses. **Uniformed Services University, Maryland.** Study development. Development and transfer of Luminex reagents to partner labs. Training, data analysis, and reporting.

5-year staged plan: <u>Year One:</u> Formalize local partnerships & update protocols; apply for research approvals through ICMR/HMSC; transfer PCR protocols, Luminex and reagents to partner labs and conduct trainings; hire & train local animal field team; develop database for project; community outreach and begin human & animal sampling. <u>Years 2-3:</u> Continue sampling; coordinate stakeholder meetings to share results and develop surveillance and intervention strategies; publish/present findings (conference & journal). Coordinate with Govt. of India, regional One Health networks (e.g. Bat One Health Research Network) and US CDC India office to disseminate information from project and help develop regional strategies for risk mitigation of bat borne zoonoses. <u>Optional Years 4 & 5:</u> Continue longitudinal surveillance in animals and people in UP; initiate activities in Kerala with established state One Health partners (e.g. Kerala Forest Dept., Kerala Veterinary and Animal Sciences University).

Major Goals and Milestones: 1) Identify bat reservoirs for henipaviruses, coronaviruses and filoviruses: Establish study protocols; train field teams; implement field studies; transfer diagnostic technologies to lab partners; **2) Test the hypothesis that spillover has occurred previously in Uttar Pradesh**: Establish community surveillance; integrate questionnaire about animal exposure; screen human and animal samples. **3) Strengthen One Health systems by improving knowledge and capacity**: Support the development of a One Health platform in India via ICMR's new One Health Institute. Establish inter-departmental collaborations; conduct integrated training of local technical personnel & graduate students. Report findings to local & federal authorities publish and share project findings via GHSA India meetings & scientific conferences.

Estimated Budget: Y1: $850,000 Y2: $950,000 Y3: $950,000 **Y1-3 Total: $2,750,000**
OY 4 $850,000 OY 5 $750,000. **OY4-5 total: $1,600,000**

Cooperative Biological Engagement Program (CBEP) = Thrust Area 6 – Cooperative Counter WMD Research with Global Partners

Biosurveillance for Spillover of Henipaviruses and Filoviruses in Rural India

Abstract: The henipaviruses and filoviruses include Hendra virus (HeV) and Nipah virus (NiV), and several species of Ebola (EBOV) and Marburg virus (MARV), respectively, which are highly pathogenic viruses and select agents capable of causing public health emergencies of international concern. In 2018 the WHO listed Nipah virus as one of the top ten threats to global health and security. In Africa, Ebola viruses have caused significant morbidity and mortality in people and wildlife. In 2014, Ebola Zaire caused an epidemic in West Africa that infected more than 28,000 people, killing approximately 40%. The outbreak began with a single spillover event, presumably from contact with an infected bat. *Pteropus medius* is a reservoir for Nipah virus and occurs throughout India and Bangladesh. In Bangladesh and India, including a recent outbreak in May 2018 in Kerala, India, Nipah virus has caused recurrent, seasonal outbreaks of acute encephalitis in people and has an associated mean mortality rate of 70%. Hemorrhagic fever has also recently been reported in India, but surveillance is limited and to date, no Ebola-related cases have been identified. Bats are reservoirs for both henipa- and filoviruses, and zoonotic transmission of these viruses from bats to humans either directly or via domestic animals has previously occurred in Southeast Asia. Despite their importance as threats to public health and security, the full range of henipa- and filoviruses in bats and their potential to infect livestock and people remains poorly understood. The recent outbreak in Kerala illustrates that Nipah virus circulates in bats throughout the country and spillover is possible wherever bats and people interact. In India, reducing spillover risk is particularly important due to the high population density in the region and high global connectivity via international airports, creating opportunity for local outbreaks to become pandemics. In line with Thrust Area 6 – Cooperative Weapons of Mass Destruction Research with Global Partners, this project will reduce threat from these select agents through enhancing early detection and surveillance capacity in India by: 1) transferring Luminex technology with validated reagents to detect IgG antibodies against all henipaviruses and filoviruses to key partner labs in animal and human health sectors; 2) training laboratory personnel to develop and utilize Luminex assays to identify exposure to henipa-and filoviruses; 3) conduct biological surveillance in bats, nonhuman primates, livestock and people in rural communities in Kerala where there are high levels of contact among people and animals, and with optional expansion into high risk zones in Uttar Pradesh and West Bengal. This project will test the hypothesis that both henipaviruses and filoviruses are circulating in fruit bats in India and have spilled over into animal and human populations, which presents a threat to human health. Activities will be coordinated with the Global Health Security Agenda, and surveillance data will be shared with the government partners at local, provincial and national levels. The proposed project is closely aligned with the aims of the Cooperative Biological Engagement Program in that it will support threat reduction through biosurveillance and capability building, engagement with partner-country scientists, will engage with the CBEP Bat One Health threat reduction network (BOHRN) and promotes a One-Health approach.

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Cooperative Biological Engagement Program (CBEP) = Thrust Area 6 – Cooperative Counter WMD Research with Global Partners

Biosurveillance for Spillover of Henipaviruses, Filoviruses, and Coronaviruses in Rural India

Abstract: The henipaviruses and filoviruses include Hendra virus (HeV) and Nipah virus (NiV), and several species of Ebola (EBOV) and Marburg virus (MARV), respectively, which are highly pathogenic viruses and select agents capable of causing public health emergencies of international concern. Severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) are zoonotic coronaviruses associated with global spread. In 2018, the WHO listed these pathogens among the top ten threats to global health and security. In Africa, Ebola viruses have caused significant morbidity and mortality in people and wildlife, and Saudi Arabia and the Gulf states continue to have new cases of MERS CoV, some of which are associated with dromedary camels. In 2014, a single spillover event of Ebola Zaire from an animal host (presumed to be a bat) caused an epidemic in West Africa that infected more than 28,000 people, killing approximately 40%. Currently, there is an Ebola outbreak in an insecure region of DRC which threatens to spread to Uganda. In Bangladesh and India, Nipah virus has caused recurrent, seasonal outbreaks of acute encephalitis in people and has an associated mean mortality rate of 70%, including the recent outbreak in May 2018 in Kerala, India. *Hemorrhagic fever and acute encephalitis both occur in India, but surveillance is limited and most cases remain undiagnosed.* Bats are reservoirs for henipa- corona-, and filoviruses and zoonotic transmission of these viruses from bats to humans either directly or via domestic animals has previously occurred in Southeast Asia. Despite their importance as threats to public health and security, the full diversity of these viruses in bats and their potential to infect livestock and people remains poorly understood. The recent Nipah virus outbreak in southern India and previous findings of Nipah in bats in northern India illustrates that Nipah virus circulates in bats throughout the country and spillover is possible where bats and people interact. In line with Thrust Area 6 – Cooperative Weapons of Mass Destruction Research with Global Partners, this project will reduce threat from these select agents and viruses of high concern by enhancing early detection and surveillance capacity in India by: 1) transferring Luminex technology with validated reagents to detect IgG antibodies against all henipaviruses, filoviruses, and MERS and SARS CoVs to key Kerala state and government of India partner labs in animal and human health sectors; 2) training laboratory personnel to develop and utilize Luminex assays to identify human and animal exposure to henipa- filo- and CoVs; 3) conduct biological surveillance in bats, nonhuman primates, livestock and people in rural communities in Kerala and UP, where there are high levels of contact among people and animals. This project will test the hypothesis that henipaviruses filoviruses, and coronaviruses are circulating in bats in southern India and have spilled over into animal and human populations undetected, which presents a threat to human health. Activities will be coordinated with the Global Health Security Agenda and surveillance data will be shared with the government partners in Kerala and the Government of India (GoI). The proposed project is closely aligned with the aims of the Cooperative Biological Engagement Program in that it will support threat reduction through biosurveillance and capacity building, engagement with and implementation by partner-country scientists, and use of a One-Health approach.

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Grant Training DCP Matrix

	DOMAINS											
	Domain 1		Domain 2			Domain 3				Domain 4		
	COMPETENCIES											
Training Task	1.1.1	1.1.2	2.1.1	2.1.2	2.1.3	3.1.1	3.1.2	3.1.3	3.1.4	4.1.1	4.1.2	4.1.3
Ex. Task 1.3.2: Conduct laboratory-based diagnostic trainings				X			X					
1.2.2. hire and train field and lab teams	x	x	x	x	x	x	x	x			x	x
1.2.5-OY5.2.5. Train students & team through field & lab activities.	x	x	x	x	x	x	x	x			x	x
1.3.3-2.3.3. Train technicians from KGMU to develop reagents & run pseudovirus neutralization assay.	x	x	x	x	x	x	x	x				
1.6.1-OY4.6.1 Hospital staff identified and trained on study protocols	x	x	x			x						

Grant Training DCP Matrix

	DOMAINS													
	Domain 5					Domain 6			Domain 7			Domain 8		
	COMPETENCIES													
Training Task	5.1.1	5.1.2	5.1.3	5.1.4	5.1.5	6.1.1	6.1.2	6.1.3	7.1.1	7.1.2	7.1.3	8.1.1	8.1.2	8.1.3
Ex. Task 1.3.2: Conduct laboratory-based diagnostic trainings					X									
1.2.2. hire and train field and lab teams	x	x	x	x	x	x	x	x	x	x	x	x	x	x
1.2.5-OY5.2.5. Train students & team through field & lab activities.	x	x	x	x	x	x	x	x	x	x	x	x		
1.3.3-2.3.3. Train technicians from KGMU to develop reagents & run pseudovirus neutralization assay.	x	x	x	x	x				x	x	x	x	x	x

Grant Training DCP Matrix

1.6.1-OY4.6.1 Hospital staff identified and trained on study protocols									x	x	x	x	x	x

Instructions: *this matrix will help track and capture the alignment of BAA research training and professional development activities to BTRP's Domains, Competencies, and Proficiencies Framework. Please note: alignment is only required to the* ***competency level definitions shown below***.

1. *in the left-hand column of the above chart, list every training activity to be performed on a separate line, using their task or sub-task number (ex. Task 2; subtask 2.1; subtask 2.1.1)*
2. *place an x or tally against the competencies that align to the training activity. Competency decisions can be made by determining using the definitions listed below and determining if a) the training subject matter corresponds to the defined competency or b) if the training outcome corresponds to the defined competency. Please note: training activities can align to multiple competencies across the 8 domains. (Note: if completing an annual report, stop at step 2; if drafting a Full Proposal, continue to step 3)*
3. *once completed, list the aligned competencies under its corresponding training activities in the grant proposal.*

Domain	**Domain Definition**	**Competency**	**Competency Definition**
1. Disease recognition and prevention of spread	**1.1** Understanding of emerging and high-consequence pathogens (EHCP) in the following realms: morbidity, mortality, transmission,	**1.1.1** Disease characteristics and impact	Disease characteristics and epidemiology of especially high consequence pathogens (EHCPs) and the diseases they cause, including etiology, signs and symptoms, morbidity, mortality, risk factors, incubation period, period of communicability, mode of

	control, disease presentation and distribution, and impact.		transmission, clinical presentation, mechanisms of spillover, reservoir species, spatiotemporal and geographic distributions of affected populations, and demographic characteristics of affected populations (species/age/sex/occupational status/ etc.), including outcomes on population health.
		1.1.2 Clinical Infection control and animal health biosecurity	Understanding of basic infection prevention and control procedures related to especially high consequence pathogens (EHCPs) for human and animal clinical settings in line with GHSA and IHR milestones (when applicable), including standard precautions (PPE use; disinfection; sterilization); environmental infection control; laboratory testing; nosocomial infections, including AMR; and animal health biosecurity principles, procedures.)
2. Disease identification, detection, confirmation, and reporting	**2.1** Positive identification of emerging and high consequence pathogens (EHCP) and reporting to appropriate authorities.	**2.1.1** Sample collection	Knowledge, understanding and proficiency with procedures for safely and securely collecting appropriate specimens/samples for testing of pathogens (human; animal; environmental), especially EHCPs, and handling and packaging of samples for transport to diagnostic testing laboratories, based on national and international guidelines and best practices, while ensuring specimens will are maintained in condition required for testing (cold chain and or fixation, etc.)
		2.1.2 Test procedures (presumptive/confirmatory)	Knowledge, understanding and proficiency with procedures for conducting screening, diagnostic, and confirmatory testing and interpreting test results for ECHPs from

			different types of samples using different types of tests (ELISA, PCR, etc.) for high consequence pathogens, including test accuracy, reliability, specificity, and sensitivity and quality control/quality assurance (QA/QC) measures needed to validate testing results.
		2.1.3 Reporting	Knowledge, understanding and proficiency in policies and procedures for disease notification and/or bi-directional reporting of surveillance and laboratory data through national information-sharing systems, or to notify regional/international authorities such as WHO/OIE/FAO of a disease, other significant epidemiological event, or potential public health emergency of international concern (as appropriate to roles and responsibilities at each operational level).
3. Analytics, assessment, and research	**3.1** Appropriate study design, data analysis, and implementation of processes, as applies to each discipline.	**3.1.1** Study design and ethics	Knowledge and understanding of scientific methodologies and study design principles (hypothesis development, research plan development, sampling design, strategy for data collection and analysis) and application of research ethics to responsibly address safety, security, and ethical issues related to the research aims and hypotheses, including understanding of issues around dual-use research of concern.
		3.1.2 Methodologies and analysis	Knowledge, understanding and proficiency in the use of statistical and other relevant methodologies for scientific research analyses including practices and approaches for data collection, use and interpretation of statistical data analyses, data visualization, and use of

			statistical data software tools.
		3.1.3 Dissemination of findings and outreach to stakeholders	Knowledge, understanding and proficiency in the dissemination of research findings through peer-reviewed scientific journal publications, conference presentations and public outreach activities, including engagement with appropriate stakeholders and partners at national, regional, and international levels.
		3.1.4 Resource mobilization and management	Knowledge, understanding and proficiency in the planning, acquisition, mobilization, allocation, management and tracking of financial and non-financial resources for research projects, including proposal development and grant writing.
4. Management, leadership, and advocacy	**4.1** Critical skills, knowledge and behaviors necessary to effectively manage projects and programs, lead teams, champion solutions, inspire action, and sustain programs.	**4.1.1** Plan, implements, and evaluates a project or program	Knowledge, understanding and proficiency in program planning, implementation, monitoring and evaluation, including development and measurement of appropriate indicators, and advocacy, or management/oversight of the process.
		4.1.2 Apply program management techniques throughout the project or program	Knowledge, understanding and proficiency in program management, including timeline and deliverables management, team building, and generating high-level stakeholder support.

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		4.1.3 Lead culturally diverse teams to complete a project or program	Knowledge, understanding and proficiency in developing and leading culturally diverse teams, ensuring collaboration among team members, and mentorship of future team leaders.
5. Quality management systems	**5.1** Knowledge, skills, and abilities required for developing a culture of quality. Operations, services, and infrastructure integrated in a system that meets applicable standards, professional guidelines, and customer requirements for ensuring and maintaining quality and continually improving services.	**5.1.1** Physical environment and equipment	Knowledge, understanding and proficiency with facility and equipment operations and maintenance, and facility management policies and procedures, in support of establishing a culture regarding physical environment and equipment necessary for EHCP detection, management, and control, or management/oversight of these operations, in a system that meets applicable standards, professional guidelines, and customer requirements for ensuring and maintaining quality and continually improving services.
		5.1.2 Qualified, well-trained, and competent workforce	Knowledge, understanding and proficiency with the principles, processes, and methodologies for workforce development and sustainment in relation to EHCP detection, management, and control, including workforce planning, training, refresher training, continuing education, and/or professional development, in a system that meets applicable standards, professional guidelines, and national licensing requirements where applicable.
		5.1.3 Materiel resource management	Knowledge, understanding and proficiency with procedures and policies for procurement

			and inventory management of materiel resources, including supply chain systems, operations, and infrastructure, or management/oversight of these processes.
		5.1.4 Quality review practices and procedures	Knowledge, understanding and proficiency with quality assurance, quality control, and/or quality management review practices and procedures, based on national or international best practices.
		5.1.5 Document management	Knowledge, understanding and proficiency with document and information management policies and procedures, and program documentation and records/archival management processes.
6. Outbreak preparedness and surveillance	**6.1** Use of operational guidelines, identification and analysis of outbreak situations, and effective communication with stakeholders.	**6.1.1** Operational guidelines	Knowledge, understanding and proficiency with development and implementation of outbreak preparedness, surveillance, investigation, laboratory practices, and response planning and operations guidelines, including case definitions, and demonstrated ability to use related operational tools such as emergency preparedness and response plans, contingency plans, SOPs, and job aids when available. Special note and care should be

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			given to documents designed for health care workers directly combatting an outbreak.
		6.1.2 Identification and analysis	Knowledge and proficiency with principles and processes for developing and maintaining disease outbreak situational awareness capabilities, including coordination and communication or reporting across surveillance, laboratory, and other data sources, epidemic intelligence, data analysis, and field epidemiological and outbreak investigation techniques, such as contact tracing, and decision-making in support of these activities.
		6.1.3 Communication systems	Knowledge and proficiency with development, implementation, and sustainment of communications systems for outbreak situational awareness and response, including multisectoral and intrasectoral coordination (including via emergency operations centers or equivalent assets), operational risk communication, and public risk communication.
7. Biosafety	**7.1** The application of knowledge, techniques, and equipment to prevent accidental exposure to and release of emerging and high consequence pathogens (EHCP).	**7.1.1** Biohazard Identification and classification	Knowledge, understanding and proficiency with identification and classification of biohazards associated with EHCPs, for laboratories, hospitals, other biomedical and clinical facilities, and the community, including biohazard risk assessment and characterization, and biohazard identification policies and compliance procedures.
		7.1.2 Biohazard Control Measures	Knowledge, understanding and proficiency

Grant Training DCP Matrix

		(e.g., personal protective equipment, safety practices and equipment, facility design, and administrative controls).	with development and implementation of international best practices and procedures for EHCP biosafety and biohazard control measures (substitution, elimination, mitigation) for personnel, equipment, facilities (laboratories, hospitals, and other biomedical and clinical facilities) and the community.
		7.1.3 Biohazard Incident Management	Knowledge, understanding and proficiency with development and implementation of policies, procedures, and operational guidelines, including emergency operation communications systems, for Biohazard Incident Management for EHCP outbreaks, releases or exposures.
8. Laboratory biosecurity	**8.1** Prevent theft, misuse, loss, or deliberate release of emerging and high consequence pathogens (EHCP).	**8.1.1** Biosecurity Risk Identification	Knowledge, understanding and proficiency with principles and procedures for Biosecurity Risk identification, risk assessments, characterization and compliance with recommended international standards and best practices to prevent the loss, theft, or misuse of biological organisms and laboratory/research technologies.
		8.1.2 Biosecurity Risk Mitigation	Knowledge, understanding and proficiency with international best practices for Biosecurity Risk Mitigation, and related risk reduction approaches to enhance physical security, personnel reliability, material control and accountability, transport security, and information security/cybersecurity, and the development and implementation of Biosecurity Risk Mitigation strategies for laboratories, facilities, and personnel to

			prevent the loss, theft, or misuse of biological organisms, especially EHCPs, and laboratory/research technologies.
		8.1.3 Biosecurity Incident Management	Knowledge, understanding and proficiency with international best practices for Biosecurity Incident Management, and development and implementation of Biosecurity incident management policies and procedures for suspected or confirmed illicit access to pathogens, intruder alerts, and other biosecurity incidents.

Please fill out the requested information on all tabs (click on each bottom colored tab or sheet) labeled Cover Page, Personnel, Publications, Presentations, Impacts, Intellectual Property, and Transitions. For annual reports, please only describe DTRA funded work for the reporting period (July 1, 2019 - June 30, 2020).

Tab	Description
Cover Page	
	Providing information about the project participants and collaborating organizations allows an assessment of performance in promoting partnerships and collaborations.
Publications	The products from an effort demonstrate the excellence of the research and efficacy with which the results are being communicated to colleagues, potential users, and the public. Publications are the characteristic product of research. If there is nothing to report during this reporting period, the awardee shall state "Nothing to Report".
Presentations	The products from an effort demonstrate the excellence of the research and efficacy with which the results are being communicated to colleagues, potential users, and the public. Many projects (thought not all) may develop products other than publications. In all cases, if there is nothing to report during this reporting period, the awardee shall state "Nothing to Report".
Impacts	knowledge, enlarges the pool of people trained to develop that knowledge and techniques or put it to use, and improves the physical, institutional, and information resources that enable those people to get their training and perform their functions. In all cases, if there is nothing significant to report during this reporting period, the awardee shall state "Nothing to Report".
Intellectual Property	Information on any intellectual property demonstrates the value of protectable innovative ideas resulting from sponsored research and includes patents, inventions, and licenses. Submission of this information is not a substitute for other invention reporting requirements under the awards terms and conditions. In all cases, if there is nothing significant to report during this reporting period, the awardee shall state "Nothing to Report".
Transitions	Refers to cases where knowledge resulting from your DTRA sponsored effort will be further developed for, or will be used in, a technology application. Transition sponsors can be entities in DoD, other federal agencies, or industry.

SHADED FIELDS ARE REQUIRED

Report Submitted to	**Defense Threat Reduction Agency**	
Grant/Award #	HDTRA1-20-1-0026	
Organization/Institution	EcoHealth Alliance	
Project Title	Biosurveillance for Spillover of Henipaviruses and Filoviruses in Rural India	
Name of Submitting Official	Dr. Jonathan Epstein	
Title of Submitting Official	Principal Investigator	
Email Address	epstein@ecohealthalliance.org	
Phone Number	1.212.380.4471	
Submission Date		7/1/2021
Reporting Period End Date	**June 30th, 2021**	
Reporting Period	**Annual**	
	Foreign Spending Country	**Foreign Spending ($)**
		55891.3
Country 1	India	
Country 2		
Country 3		

Proceed to Personnel

Enter the principle investigator (PI) and all other personnel that have worked at least one person month (~160 hours) on this DTRA project during the reporting period, regardless of the source of compensation.

Instructions	Select the appropriate personnel type from the drop down list.			Enter Suffix (e.g. Jr., Sr., III)	Enter the number of months worked rounded to the nearest month	Enter the FULL name of the university, organization, or institution.	Enter the Hirsch index for PI and Co-PI(s). Single whole number only.	Select whether a student has graduated or not.	Enter a graduation or anticipated graduation date for student in Month Year format.
Award #	**Personnel Type**	**Last name**	**First name**	**Suffix**	**Person Months Worked**	**Organization/Institution**	**Hirsh Index**	**Graduated**	**Graduation date (students)**
Example	*Post-Doc*	*Smith*	*John*	*Jr.*	3	*State University*			
HDTRA1-20-1-0026	Co-PI	Epstein	Jonathan		3	EcoHealth Alliance	44		
HDTRA1-20-1-0026	Co-PI	Jain	Amita		2	King George Medical Unviersity	43		
HDTRA1-20-1-0026	Research Associate/Scientist	Nambiar	Prejit		1	Kerala Veterinarian and Agricultural Sciences University			
HDTRA1-20-1-0026	Research Associate/Scientist	Sullivan	Ava		7	EcoHealth Alliance			
HDTRA1-20-1-0026	Research Associate/Scientist	Zacariah	Arun		1	Department of Forests and Wildlife, Government of Kerala			
HDTRA1-20-1-0026	Research Associate/Scientist	Sterling	Spencer		7	Uniformed Services University			
HDTRA1-20-1-0026	Co-PI	Bhatia	Rajesh		1	formerly WHO SEARO			
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Proceed to Publications

Enter all publications (Journal Articles, Books, Book Chapters, Conference Papers, and Theses/Dissertations) resulting from this DTRA project during this reporting period.
DO NOT include publications that have not yet been submitted.

Award #	Publication Type	Author	Journal (Book Title)	Article Title (Chapter Title)	Volume	Issue	Publication Year	Page	Status	Publication Identifier Type	Publication Identifier	Acknowledgement of DTRA Support	Peer Reviewed	Editors (Book)	Collection (Book)	Publisher (Book)	Publication Location (book)	Media Type (Book)	Edition (Book)
Instructions	Select the appropriate publication type from the drop down list. Select "Nothing to Report" if there were no publications.	Enter the full name of all authors	Select the Journal from the drop down list or enter the FULL name of the journal (book)	Enter the FULL name of the article title (chapter title of book)				Enter the first page number of the article or chapter	Select the publication status from the drop down list (e.g. Published, Submitted)	Select the publication identifier type (i.e. DOI, ISBN, ISSN)	Enter the publication identifier number for the type selected in the previous column	Select whether or not an acknowledgement of DTRA support was provided to the publisher	Select whether or not a journal article or conference paper has gone through the peer review process						
Example	*Journal Article*	*John Smith and Jane Doe*	*Journal of Applied Physics*	*Trace chemical analysis using Coherent Anti-Stokes Raman Spectroscopy*	*1*	*1*	*2019*	*112*	*Published*	*DOI*	*10.1021/jn123456x*	*Yes*	*Yes*						
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Proceed to Presentations

Enter all presentations (poster or oral) given during the reporting period that resulted from this DTRA project or contained significant results from this DTRA project.

Award #	Presentation Type	Presentation (Paper) Title	Conference Date	Conference Name	Conference Location City, State	Author(s)	Personnel Type	Acknowledgement of DTRA Support
Instructions	Select the presentation type from the drop down list. Select "Nothing to Report" if there were no presentations.	Enter the FULL title of the presentation.	Enter the date of the presentation in month/day/year format.	Enter the FULL name of the presentation sponsor (e.g. conference, professional society, or university).	Enter the location of the presentation (conference) as City, State for domestic meetings or City, Country for international meetings.		Select from the drop down list the personnel type for the presenter.	Select whether or not an acknowledgement of DTRA support was included in the presentation.
Example	*Oral Keynote*	*Infrared Spectroscopy of Metal Carbonyls*	*8/1/2019*	*Materials Research Society Fall Meeting*	*Boston, MA*	*John Smith*	*Graduate Student*	*yes*
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Proceed to Impacts

Enter awards, honors, promotions, or graduations that occurred during the reporting period for the personnel contributing to this DTRA project.

Instructions	Select the impact (honor) type from the drop down list. Select "Nothing to Report" if there were no impacts.		Select the personnel type for the individual who received the award or honor.	Enter the FULL name of the individual who received the award.	Enter the date the award or honor was received in month/day/year format.	
Award #	**Impact Type**	**Impact Description**	**Personnel Type**	**Awardee Name**	**Impact Date**	**Impact Details/Website**
Example	*Best Poster*	*Best Graduate Student Poster at the American Physical Society winter conference*	*Graduate Student*	*John Smith*	*9/20/2019*	
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Proceed to Intellectual Property

Enter all patents, invention disclosures, and licenses resulting from this DTRA award that were awarded or applied for during the reporting period.
Reporting here does NOT replace the reporting requirements for patents and invention disclosures in the terms and conditions of the award.

Instructions	Select the intellectual property type from the drop down list (i.e. patent, license, or invention). Select "Nothing to Report" if there was no intellectual property.	Enter the FULL title of the intellectual property.	Enter the relevant number for the patent, application, etc.	Enter the country or region in which the patent, invention, or license resides.	Enter the application date in month/day/year format.	Enter the issue date in month/day/year format.		Enter the name(s) of the inventor(s).	Select the status of the patent or application from the drop down list.
Award #	**Intellectual Property Type**	**Title**	**Number**	**Country**	**Application Date**	**Date Issued**	**Abstract or Description**	**Inventors**	**Status**
Example	*Invention*	*Accelerator Device to Detect WMDs*	*123456*	*USA*		*8/3/2019*	*Invention report submitted to State University for an accelerator to detect heavily shielded WMDs*	*John Smith and Jane Anybody*	*Submitted*
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Proceed to Transitions

Enter transitions of the research or technology from this DTRA project.

Instructions	Enter a text description of the transitioned research or technology. Enter "nothing to report" if there were no transitions.	Enter the year that the transition started.	Enter the organization, company, or government agency to the which this work has (is) transitioning.
Award #	**Transition Description**	**Year**	**Transitioned to**
Example	*The accelerator technology for detection of WMDs transitioned to funding from other US government agency for further development*	*2020*	*USGOV Contract # 12-34-5678*
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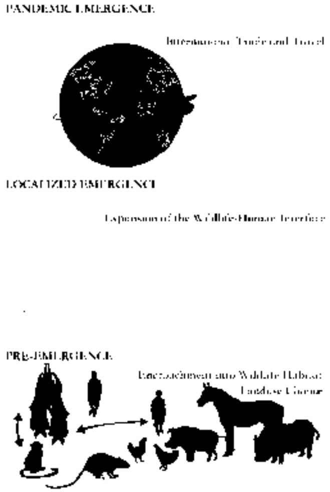
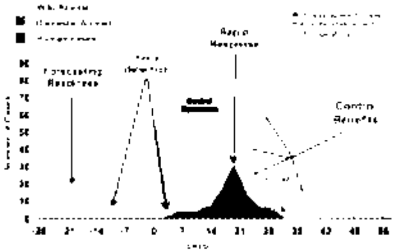
Biosurveillance for Spillover of *Henipaviruses* and *Filoviruses* in Rural India,
Dr. Jonathan Epstein
EcoHealth Alliance
HDTRA1-20-1-0026

Objective: To enhance capacity for surveillance for high priority zoonoses in animals and people in Uttar Pradesh and Kerala. To identify wildlife hosts for henipaviruses and filoviruses and characterize their distribution near at-risk human populations, and to conduct targeted biosurveillance in wildlife, livestock and humans to detect exposure to or infection with high consequence viruses. Threat Reduction Impact: 1) enhancing field and laboratory capacity to safely conduct biosurveillance in animals and people for henipaviruses and filoviruses; and 2) conducting targeted biological surveillance in wildlife (esp. bats), livestock and people in rural communities in Uttar Pradesh and Kerala to determine reservoir hosts for and detect spillover of these viruses; and 3) assess the role of livestock and geography in exposure rates of henipa- and filoviruses in rural communities. Capacity/Capability Building: Through the development of lab capacity, joint multi-sectoral field surveillance activities, and graduate student training, India's capacity to detect and respond to emerging zoonoses and identify additional causes of AES and VHF will be significantly strengthened





Surveillance in animals and people at high risk to detect & respond to spillover earlier

Status of effort: Current collaboration with public health and vet partners in UP & Kerala; laboratory team hired, Luminex and lab supplies procurement underway, local permissions submitted, archived human samples from study sites currently available; 25 reagents for filo and henipavirus antibody detection produced and validated.Personnel Supported: 4 Researchers, 4 University Faculty, 2 Field Veterinarians, 2 Graduate Students, 1 Post-Doctoral Fellow, 2 Scientific Advisors; 6 Lab Research Assistants/Techs; 6 Field Scientists, 1 Program Assistant. Publications & Meetings: Stakeholders Meeting planned July 2021

- Enhance capacity within India to conduct surveillance fo henipa- and filoviruses Years 1-5Produce & validate reagents to detect henipa- and filovirus antibodies Year 5.Conduct wildlife, livestock, and human biosurveillance rural communities Years 1-5.Carry out hospital-based a encephalitis and viral hemorrhagic fever studies in clinic settings Years 1-5Funding Profile: Y1 $970,566.84 Y $995,322.63 Y3 $999,666.56 OY4 $998,965.88 OY5 $998,985.95 TOTAL Y1-Y5 $4,963,517.86 Contact information: PI: Jonathan H. Epstein 21238-4467 Epstein@ecohealthalliance.orgCo-PI: Amita Jain

(b)(6)

DTRA Basic Research Annual Report

Please answer all sections of the document. You are welcome to use figures and tables to complement or enhance the text. For annual reports, please only describe work for the period of performance (July 1, 2020 - June 30, 2021). (Project awarded September 24, 2020)

Grant/Award #: HDTRA1-20-1-0026
PI Name: Dr. Jonathan Epstein
Organization/Institution: EcoHealth Alliance
Project Title: Biosurveillance for Spillover of Henipaviruses and Filoviruses in Rural India

What are the major goals of the project?
List the major goals of the project as stated in the approved application or as approved by the agency. If the application lists milestones/target dates for important activities or phases of the project, identify these dates and show actual completion dates or the percentage of completion. Generally, the goals will not change from one reporting period to the next. However, if the awarding agency approved changes to the goals during the reporting period, list the revised goals and objectives. Also, explain any significant changes in approach or methods from the agency approved application or plan.

Our overall goal is to characterize the distribution of henipaviruses and filoviruses in bats and determine whether undetected spillover into livestock or people has occurred in rural communities in Uttar Pradesh and Kerala, India. By enhancing capacity at partner institutions to conduct targeted surveillance for filoviruses and henipaviruses in wildlife, domestic animals, and high-risk rural human populations, using a One Health approach, we will reduce threat of future outbreaks. The proposed interdisciplinary research effort has three objectives: 1) enhance capacity for surveillance for henipaviruses and filoviruses in animals and people in UP and Kerala; 2) identify wildlife hosts for henipaviruses and filoviruses and characterize prevalence within these hosts; and 3) conduct targeted biosurveillance in wildlife, livestock, and humans to determine exposure rates and detect spillover of these high consequence viruses.

What was accomplished under these goals? *For this reporting period describe: 1) major activities; 2) specific objectives; 3) significant results, including major findings, developments, or conclusions (both positive and negative); and 4) key outcomes or other achievements. Include a discussion of stated goals not met. As the project progresses, the emphasis in reporting in this section should shift from reporting activities to reporting accomplishments.*

Task 1.

1) Major activities: Apply for permits and ethical approvals.

2) Specific objectives: To gain approval across One Health research and project areas, including human sampling permissions, animal sampling permissions, livestock sampling permissions, ethical approvals, for compliant work to occur across both geographical states (UP and Kerala) through both local and US-based approving bodies. This includes HMSC research permits/ethical approval via the Indian Medical Research Council, local IACUC permissions, wildlife permits will be obtained via the Forest Department, US IRB and US-based IACUC through Tufts Vet School.
1.1.1. Apply for HMSC research approvals & local ethical approvals;
1.1.2. Apply for IRB, IACUC, HRPO, ACURO approval in US;
1.1.3-2.1.3. Apply for wildlife permits in UP and Kerala.

3) Significant results: All local permissions and approvals have been generated and submitted for local clearance. Significant efforts related to this objective include the submission of the human-sampling ethics clearance through King George Medical University (KGMU), Kerala State and UP State Forest Department permissions, livestock sampling permissions through Indian Council of Agricultural

Research (ICAR), and Institutional Biosafety Committee clearance through Kerala Veterinarian and Agricultural Sciences University (KVASU), all of which have been submitted and are pending approval. US-based IACUC and IRB have been generated and submission is imminent.

4) Key outcomes: All major local permissions have been submitted, and permission is expected upon committee hearings. Individual meetings, including those with the State Surveillance Officer in Uttar Pradesh, were held to discuss and prime stakeholders on project activities in order to facilitate permissions and approvals. Once all local and US-based permissions are gained the full project activities will be able to commence. Permission and approvals further represent a key opportunity and outlet for stakeholder sensitization and have provided the project with a platform to introduce the objectives of the research, build local relationships with stakeholders, and build interest and buy-in from community and institutional gate-keepers.

Task 2.

1) Major activities: Enhance capacity within India to conduct biosurveillance for henipaviruses and filoviruses

2) Specific objectives:

1.2.1. Transfer BioRad Bio-Plex 200 machine & reagents and PCR protocols to KGMU;
1.2.2. Hire and train field and lab teams, including a 7-day Luminex training
1.2.3 Select 1 PhD student at KGMU and USU and hire a postdoc at EHA
1.2.4-2.2.4 Create sample repository with tracking system at KGMU.

3) Significant results

The transfer of a Luminex machine has been initiated with Luminex US for shipment of KGMU in Lucknow, UP, India. The shipment of supplies including reagents is underway between partners from Uniform Services University (USU) to King George Medical University, for use with Luminex machine. A Luminex training has been planned to occur once the machine arrives at KGMU. The lab team at KGMU has been hired, including a doctoral research associate, research assistants, laboratory technicians, and a data entry operator. Laboratory SOPs have been shared, and training sessions are being planned to commence once supplies and equipment are received.

4) Key outcomes: 7 hospital collaborators have been identified and 6 laboratory and hospital staff have been hired for this study. The purchase and shipment of a Luminex machine, as well as a shipment of necessary laboratory supplies, has been initiated. Implementing serological surveillance for groups of viruses known to cause encephalitis and hemorrhagic disease will greatly enhance the capacity of local health systems to detect exposure to or past infection in wildlife, domestic animals and human populations. To establish this capacity, EHA and KGMU will establish a joint human and animal surveillance team and train members to safely sample animals and people, using appropriate personal protective equipment and other biosafety techniques. We will provide a BioRad Bio-Plex 200 machine with computer console to KGMU and coordinate training activities for serological surveillance and pan-henipavirus and pan-filovirus consensus PCR assays for molecular analysis using existing PCR capabilities at KGMU's virology lab. The hiring of the research team allows for targeted and novel capacity building efforts in at KGMU, a highly skilled and respected diagnostic laboratory, in disease detection methods and One Health approaches to surveillance.

Task 3.

1) Major activities: Produce & validate reagents to detect henipa- and filovirus antibodies:

2) Specific objectives:

1.3.1.-OY5.3.1 Provide reagents to partner labs;
1.3.2-OY5.3.2 Produce reagents for newly discovered viruses;
1.3.3-2.3.3 Train technicians from KGMU to develop reagents & run pseudovirus neutralization assay.

3) Significant results: Protein production and assay validation is part of the ongoing collaboration between EcoHealth Alliance, the Uniformed Services University, and the King George Medical University in Lucknow, India. Throughout Year 1, our team has produced and validated reagents recombinant henipavirus attachment glycoprotein (G) for antigen-based serology. These G protein antigens will be used for the planned retrospective human sera screening of banked samples stored at KGMU. Reagents are prepared to ship and are planned to be sent as choreographed with the arrival of the Luminex machine.

4) Key outcomes: These assays will be used to screen bat samples and hospitalized patient sputum and CSF for viral RNA. Testing bat samples and acutely ill hospital patients by PCR may allow us to detect viral RNA during active infection, providing important information about the diversity of viral strains circulating within bat species that may account for human infection and observed immune responses seen on Luminex.

Task 4.

1) Major activities: Develop/maintain project database

2) Specific objectives: Develop a functional database that allows for the secure storage, sharing, and analysis of field and lab data and metadata, that will also connect to sample tracking software so that data is linked to sample IDs in repository. Database will be adaptable to new types of data that may arise during project.

3) Significant results: We have created a functional project database which is bespoke to the current project's data needs which are complex and interdisciplinary in nature. The project database uses an Airtable platform which is relational in structure and links data records across tables. Our project database in Airtable allows for collaborative data entry efforts across sampling and lab efforts, as well as secure remote storage, tiered access, and the capacity to hold multitudinous data points. The online database is able to contain all information related to field work and field sites, bat, livestock and human samples, and results of molecular assays. We have also created a SOP for the database which includes clear guidance on use, data quality/data assurance measure, and a data dictionary.

4) Key outcomes: An online database tailored to the specific project needs has been created. This database allows for the secure, organized and comprehensive storage of data across multiple sampling and lab efforts. The database allows for report generation, data cleaning measures, and analysis tools. The database works across data collection platforms and allows multiple data types to be stored together in a secure, central system.

Task 5.

1) Major Activities: Screen archived human VHF and AES samples from KGMU

2) Specific Objectives:

1.5.1-2.5.1. Archived specimens identified/logged/tested

1.5.2.-3.5.2 Results entered into database.

3) Significant results: The partnership between EHA and KGMU has been formed through a signed sub awardee agreement, representing the ability for KGMU to use their robust biobank to screen archived samples. While the project awaits the impending shipment of supplies and the Luminex equipment, the KGMU laboratory team has been formed and primed to receive training on the Luminex platform.

4) Major Outcomes: The KGMU subaward has been established, and 6 hospital and laboratory staff have been hired, in anticipation of the screening of archived samples. King George's Medical University hospital is a referral hospital that serves patients from all over Uttar Pradesh. Annually, KGMU sees more than 300 BHF cases and 1000 AES cases, many of which are negative to known agents such as Dengue or JEV. Professor Jain has led studies of AES and VHF, and by screening archived serum and CSF from patients who have previously volunteered and consented to use of their samples for this aim, we will be able to assess the baseline prevalence and geographic distribution of henipaviruses and filoviruses in this population of acutely ill patients, which will inform our sampling strategy for the village cross sectional studies as well as deepen our understanding of whether these agents play a significant role in causing severe VHF or AES in UP. We will screen 600 archived sera from VHF patients and from 900 AES patients using the Bioplex assay. Up to 300 CSF samples will be screened using PCR.

Task 6.

1) Major Activities: Hospital-based AES and VHF studies

2) Specific Objectives: 1.6.1-OY4.6.1 Hospital staff identified and trained on study protocols

3) Significant results: The KGMU hospital staff team has been identified, including collaborators in the KGMU Department of Pediatrics, Medicine, Neurology, Microbiology, as well as research and laboratory associates and assistants. The team awaits the materials and supplies required for a full training on study protocols and methodologies. The human clinical survey has been created as a standardized qualitative and quantitative data collection tool.

4) Major Outcomes: 7 hospital collaborators have been identified and 6 laboratory and hospital staff have been hired for this study. The hiring and training of the hospital-based team will allow for samples to be taken from a clinical setting in an ethical, efficient, and scientifically sound manner. Data from this study will generate new hypotheses about the prevalence of NiV and EBOV related viruses in India, as well as support the human behavioral risk underpinning these diseases of interest.

Task 7.

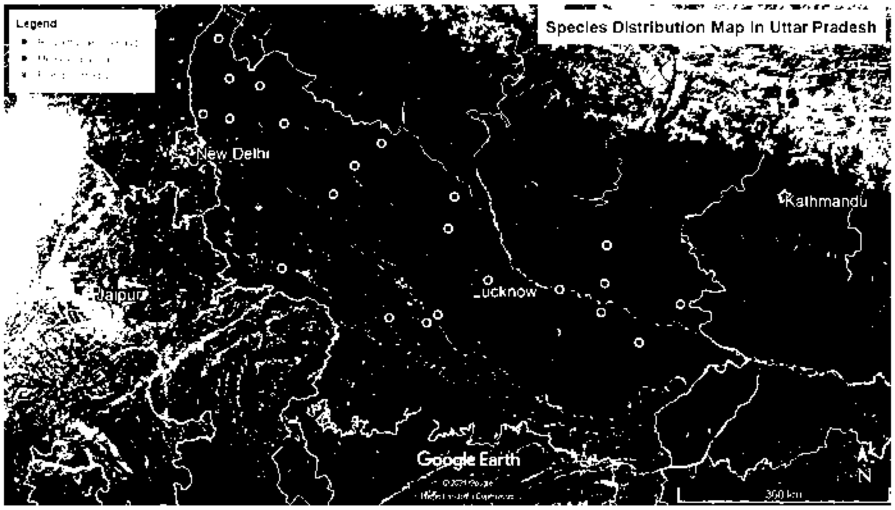
1) Major Activities: Wildlife, livestock, and human biosurveillance in rural communities

2) Specific Objectives:

1.7.1.-OY4.7.1. study sites selected

1.7.2-OY5.7.2 human, wildlife, and domestic animal samples collected and tested

3) Significant results: While the Indian subcontinent has been experiencing the extremely disruptive effects of the COVID-19 pandemic, the project has thus far been able to address the matter of site selection using a literature review, expert knowledge, and species mapping. Experts in bat biology have been utilized to map bat species distribution in UP and Kerala, and expect use these tools to inform further efforts in site selection when travel is safe. Areas in UP and Kerala where key bat species are found will be considered in conjunction with overlapping areas of livestock farming, as well as human settlements.



4) Major Outcomes: Bat distribution mapping efforts have been undertaken by members of the Animal Health team across UP and Kerala. A literature review of relevant bat species has been performed as a foundational source of information relevant to site selection, which will inform the mapping exercise and in-person field visits and reconnaissance once is reasonably safe. A standardized data collection survey tool has been developed to be used in human community sampling efforts.

Task 8.

1) Major Activities: Analyze data

2) Specific Objectives: Analyze field epi and lab results.

3) Significant results: None to report.

4) Major Outcomes: While no major data collection efforts have been undertaken at the point in the project, the project database has been created with this major activity and specific objective in mind. The project database has been designed in order to facilitate rapid analysis and generate, present and publish epidemiological and other project data.

Task 9.

1) Major Activities: Disseminate results to relevant stakeholders

2) Specific Objectives:

1.9.1-5.9.1 Submit annual reports to DTRA.

1.9.2-OY5.9.2 Provide results to local stakeholders.

3) Significant results: None to report.

4) Major Outcomes: Annual report generated for DTRA, July 2021. A local stakeholders meeting is planned to occur July 2021 with leadership from Co-PI's Dr. Amita Jain of KGMU, Dr. Prejit Nambiar of KVASU, Dr. Arun Zacariah of Kerala Wildlife Department, and Dr. Rajesh Bhatia, formerly of WHO SEARO. This planned stakeholder's meeting represents a major point of relationship building and stakeholder engagement for the project, and is expected to inform project ability to gain rapid approvals, disseminate project results, and further implement the project successfully.

What samples has the project collected and what methodologies has the project implemented?

For this reporting period, use the impact questions below to guide your discussion of: 1) sample collection; 2) sample storage; 3) laboratory techniques; and 4) sustainment of skills. You should provide an annual sample repository list to include all samples collected from this research effort. Discuss how you plan to maintain samples collected during the proposed research effort, along with relevant metadata, for at least 12 months after the project end date. If nearing the end of the project, you should state a plan and schedule for final disposition of EDP samples collected in support of the research effort.

Samples

- What are the roles and responsibilities of each partner in sample collection for pathogen identification?

- How will the sample collection, field or clinical, methodologies practiced during this research project have long-term impact on sustained and durable capabilities?

Laboratory or Clinical Techniques

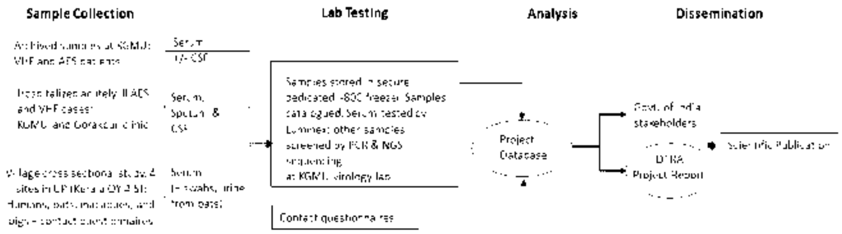
- What are the laboratory techniques built or reinforced during the duration of the research project?

- How will the techniques and practices taught through the duration of the research project support long-term sustainment and durability of skills in partner country(ies)?

At this point in the project, approvals, permissions, and permits are underway to allow for sample collection to occur. Due to the hardship imposed by the ongoing COVID-19 pandemic in India, this already involved process has an elongated timeline. As such, no samples have been collected for the project thus far. Despite this, progress has been made in terms of the creation of methodologies for future use.

All biological samples will be collected in duplicate and stored in our partner lab at KGMU in secure ultra-cold freezers. Samples will be tracked using specialized lab software and linked to a database with all metadata collected at the time of sampling. Samples will be tracked using specialized lab software and linked to our project database with all metadata collected at the time of sampling.

Project Sample Collection and Testing Workflow



We will provide protocols and training for sample collection, handling, and storage in the field and lab, using established biosafety and biosecurity protocols, including those developed under PREDICT. We will provide a BioRad Bio-Plex 200 machine with computer console to KGMU and coordinate training activities for serological surveillance and pan-henipavirus and pan-filovirus consensus PCR assays for molecular analysis using existing PCR capabilities at KGMU's virology lab. Co-PI Broder and Co-I Laing (USU) will provide Bioplex / ELISA reagents for all henipa- and filovirus assays to KGMU. Epstein (EHA) will provide the Bioplex machine and PCR protocols. Drs. Broder and Dr. Laing will run a 7-day training course for KGMU lab technicians and invite technicians from UP state medical and veterinary diagnostic labs which currently have ELISA capabilities. To manage and reduce biothreat, a secure, dedicated -80C freezer will be installed at KGMU for project samples. Commercial software will be used to log and curate samples in the lab, creating a sample repository at KGMU.

What opportunities for training and professional development has the project provided?
If the research is not intended to provide training and professional development opportunities or there is nothing significant to report during this reporting period, state "Nothing to Report."
Use the impact questions below to guide your discussion of opportunities for training and professional development provided to anyone who worked on the project or anyone who was involved in the activities supported by the project. Please indicate for each training: participants, objectives, duration, subject matter, outcomes, and assessment results. For trainings aligned to BTRP Training Domains, Competencies, and Proficiencies Framework (DCPs), please indicate the competencies associated with the training according to the matrix. "Training" activities are those in which individuals with advanced professional skills and experience assist others in attaining greater proficiency. Training activities may include, for example, courses or one-on-one work with a mentor. "Professional development" activities result in increased knowledge or skill in one's area of expertise and may include workshops, conferences, seminars, study groups, and individual study. Include participation in conferences, workshops, and seminars not listed under major activities.

Training
- How will the trainings completed through this project contribute to long-term durability of the capabilities this project reinforces?
- What are the capabilities built, reinforced, and/or improved upon in the partner country through the efforts of this research project?
- What are the areas of challenge in terms of transitioning all research capabilities to partner countries and sustaining these efforts?

Conference Attendance/Knowledge Sharing (Network Building)
- How did you leverage conferences, seminars, and stakeholder meetings to support and engage partner country scientists affiliated with the research?

- How has this research leveraged local and regional threat reduction networks to strategically address current or future biological threats?
- How has this research strengthened the capabilities of partner country scientists to identify and secure competitive research funding through networking and scientific collaboration activities?

Nothing to Report

How have the results been disseminated to communities of interest?
If there is nothing significant to report during this reporting period, state "Nothing to Report."
Use the impact questions below to guide your discussion of how the results have been disseminated to communities of interest. Include any outreach activities that have been undertaken to reach members of communities who are not usually aware of these research activities, for the purpose of enhancing public understanding and increasing interest in learning or careers in science, technology, and the humanities.

Transparency
- How has this research endorsed a culture of transparency within, and between local, regional, and international stakeholders associated with this effort?
- How has this research supported public awareness and prevention strategies in the local and regional communities of partner country(ies)?

Intellectual Property/Publications
- How have the protocols and information learned during the research project informed disease detection and surveillance knowledge (protocols, SOPs, training) in the long-term?
- How will the information garnered from the research affect standard guidance on disease detection for clinical health professionals? This impact can be in the form of guidance updates, clinical guidelines, or supporting evidence for policy changes at the country-level.

Evidence Based Data Communication to Stakeholders
- How has this research enhanced or supported mechanisms (SOPs, committees, outreach, etc.) to share resources, expertise, and data between local, regional, and international stakeholders?
- How has this research supported a communication plan to national and international public health stakeholders in the event of a public health emergency of international concern?

Nothing to report

What do you plan to do during the next reporting period to accomplish the goals?
If there are no changes to the agency-approved application or plan for this effort, state "No Change."
Describe briefly, what you plan to do during the next reporting period to accomplish the goals and objectives.

At the time of this report, there are no major changes to the agency-approved plan for this effort, and we expect that all tasks and subtasks will be achieved despite the increased difficulties as a result of the COVID-19 pandemic in India. However, an adjustment has been made in order to best achieve the goals of the project. In the approved proposal, the earliest surveillance efforts for human hospital sampling, human community sampling, wildlife sampling, and livestock sampling were slated to occur in firstly Uttar Pradesh, while our efforts in Kerala were staggered to begin later in Y2, and increase in subsequent years. During the period in which we are seeking permissions, approvals and permits, we have been seeking permissions to work in both states. Based on leadership and identified capacity in Kerala for performing wildlife training, especially through our partners at Kerala Wildlife Department, and KVASU, we have decided to assemble and train the animal team in Kerala. In doing so, we have identified pragmatic reasons for developing plans to work in both states at the earliest point of approval. This will allow us to commence field work as soon as permissions are granted fully. This shift will give us increased flexibility should there be unavoidable delays in one state or another, based on the pandemic, natural/climate conditions, political conditions, or otherwise. It also allows the project to best utilize the capacity and leadership of the emerging Animal Health team in Kerala, working in concert with team in Uttar Pradesh.

From: Aleksei Chmura
To: (b)(6)
Cc: (b)(6); Whitney Bagge; Joe Riccardi; Billy Karesh
Subject: Re: [Non-DoD Source] FRBA14-6-2-0471 Clarifications
Date: Thursday, September 17, 2020 11:38:05 AM
Attachments: DTRA Jordan Budget 28 Aug 2020.xlsx

All active links contained in this email were disabled. Please verify the identity of the sender, and confirm the authenticity of all links contained within the message prior to copying and pasting the address to a Web browser.

Dear (b)(6)

Please find our excel file with a breakdown of EcoHealth Alliance costs and with separate tabs for our subcontracts.

Call me anytime, if you have additional questions or need other documents.

Many thanks!

-Aleksei

Aleksei Chmura, PhD
Chief of Staff &
Authorized Organizational Representative

EcoHealth Alliance
520 Eighth Avenue, Suite 1200
New York, NY 10018-4182

+1.212.380.4473 < tel:1.212.380.4469 > (office)
(b)(6) (mobile)
Caution-www.ecohealthalliance.org < Caution-http://www.ecohealthalliance.org/ >

EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation.

On Sep 14, 2020, at 11:23, (b)(6)
(b)(6) > wrote:

Good morning,

Thank you for documents as they will come in handy. Would you be able to provide an excel breakdown of EHA and subs?

-----Original Message-----
From: Aleksei Chmura <chmura@ecohealthalliance.org <mailto:chmura@ecohealthalliance.org> >
Sent: Wednesday, September 2, 2020 12:34 PM
To: (b)(6)

Y1	Y2	Y3	OY1	OY2	Base	**PRIME Budget**	Y1	Y2	Y3	OY1	OY2	Total
						A. Senior Key Personnel						
2	2	2	2	2	$ 201,[illegible]	[illegible] Kasash, PI	$ 46,556.20	$ 50,[illegible].06	$ 53,510.[illegible]	$ 55,165.66	$ 56,[illegible].84	$ 262,[illegible].62
						[illegible] Kasash Fringe	$ 17,[illegible].95	$ 18,[illegible]	$ 19,[illegible]	$ 20,[illegible]	$ 21,[illegible]	$ [illegible].04
3	3	3	3	3	$ 62,747.18	Emily Hogan, Behavioral Risk Scientist	$ 16,[illegible].80	$ 17,[illegible]	$ 18,[illegible]	$ [illegible].46	$ [illegible].78	$ [illegible].46
						Emily Hogan Fringe	$ 6,232.74	$ 6,544.36	$ 6,871.50	$ 7,215.18	$ 7,573.94	$ 34,436.83
4	4	4	4	3	$ 85,884.88	Catherine [illegible], Co-Investigator	$ 28,628.29	$ 30,030.71	$ 31,302.86	$ 33,140.83	$ 43,497.04	$ 166,558.85
						Catherine [illegible] Fringe	$ 10,533.21	$ 11,061.07	$ 11,615.07	$ 12,195.82	$ 16,007.02	$ 61,413.10
2	2	2	2	2	$ 93,100.00	Whitney Bagge, Modeler	$ 14,050.11	$ 15,007.02	$ 15,321.00	$ 16,012.07	$ 17,442.05	$ 79,203.40
						Whitney Bagge Fringe	$ 5,250.94	$ 5,544.95	$ 5,822.13	$ 6,113.20	$ 6,418.90	$ 29,179.99
		Fringe Rate %			36.80%	Total Senior Key Personnel	$ 143,350.15	$ 155,779.10	$ 163,267.00	$ 171,745.42	$ 182,232.90	$ 831,054.05
						B. Other Personnel						
1	1	1	1	1	$ 59,[illegible]	Amanda Andre, Program Coordinator	$ 14,[illegible].05	$ 15,577.[illegible]	$ 16,481.[illegible]	$ 17,264.[illegible]	$ 18,[illegible].54	$ [illegible].04
						Amanda Andre Fringe	$ [illegible].55	$ 5,[illegible].25	$ 6,[illegible]	$ [illegible]	$ [illegible].88	$ [illegible].06
12	12	12	12	12	$ 61,[illegible]	Research Assistant	$ [illegible]	$ [illegible]	$ 67,252.[illegible]	$ [illegible].10	$ [illegible].06	$ [illegible].51
						RA Fringe	$ 22,442.00	$ 23,570.[illegible]	$ 24,748.[illegible]	$ 25,985.07	$ 27,2[illegible].68	$ [illegible].07
		Fringe Rate %			36.[illegible]%	Total Other Personnel	$ [illegible].41	$ [illegible]	$ 114,820.40	$ [illegible].45	$ [illegible]	$ [illegible]
						C. Equipment						
						Total Equipment	$ -	$ -	$ -	$ -	$ -	$ -
						D. Travel						
						1. Domestic Travel	$ 4,607.80	$ 7,321.80	$ 7,942.80	$ 7,942.80	$ 7,942.80	$ 35,858.00
						2. Foreign Travel	$ 31,610.00	$ 33,532.50	$ 36,209.50	$ 35,909.00	$ 34,273.90	$ 173,101.00
						Total Travel	$ 36,[illegible]	$ 40,[illegible]	$ 44,[illegible]	$ 43,[illegible]	$ 42,216.70	$ 208,959.00
						E. Participant/Trainee Support Costs						
						1. Tuition/Fees/Health Insurance						$
						2. Stipends						$ -
						3. Travel						$ -
						4. Subsistence						$ -
						5. Other						$ -
						Total Participant Trainee Support Costs	$ -	$ -	$ -	$ -	$ -	$ -
						F. Other Direct Costs						
						1. Materials and Supplies	$ 8,240.45	$ 2,512.50	$ 2,312.50	$ 2,312.50	$ 2,312.50	$ 17,[illegible].45
						2. Publication Costs	$ -	$ 5,205.00	$ 5,205.00	$ -	$ -	$ 10,410.00
						3. Consultant Services	$ 5,500.00	$ 500.00	$ 500.00	$ 500.00	$ 500.00	$ 7,500.00
						4. ADP/Computer Services						$ -
						5. Subawards/Consortium/Contractual Costs						$
						[illegible]	$ 553,244.09	$ 536,319.70	$ 528,047.00	$ 524,904.92	$ 434,909.06	$ 2,572,950.72
						[illegible] Link	$ 3,479.17	$ 14,140.97	$ 14,140.57	$ 14,140.37	$ 14,140.97	$ 60,042.05
						6. Equipment or Facility Rental/User Fees						$ -
						7. Alterations and Renovations						$ -
						8. Other						$ -
						9. Other						$ -
						Total Other Direct Costs	$ 13,740.45	$ 8,217.50	$ 8,017.50	$ 2,812.50	$ 2,812.50	$ 36,[illegible].45
						G. Direct Costs and Modified Direct Costs						
						Direct Costs	$ 3[illegible],257.81	$ 3[illegible]	$ 330,287.[illegible]	$ 33[illegible]	$ 350,571.13	$ 1,65[illegible].94
						Modified Direct Costs						$ -
						H. Indirect Costs						
		IDC Rate %			36.54%	1. Indirect Cost Type	$ 108,339.95	$ 112,439.77	$ 118,390.01	$ 121,707.80	$ 130,253.97	$ 591,353.66
		IDC Rate %			36.54%	2. Indirect Cost Type	$ 11,595.90	$ 5,009.00	$ 392.90	$		$ 17,020.00
						I. Total Direct and Indirect Costs						
						Direct + Indirect	$ 422,020.09	$ 421,234.90	$ 450,330.23	$ 461,294.10	$ 480,807.11	$ 2,236,290.90
						J. Fee						
						Fee						
						K. Total Costs and Fee						
						Total Costs	$ 422,[illegible]	$ 4[illegible]	$ 450,[illegible]	$ 461,294.[illegible]	$ [illegible]	$ 2,236,[illegible]
						OVERALL Totals						
							$ 9[illegible]	$ [illegible]	$ 591,118.15	$ 60[illegible]	$ 947,857.04	$ 4,8[illegible]

EHA Supplies	Unit/Annual	Y1	Y2	Y3	OY1	OY2	
Laptop	$ 2,[illegible]	$ 5,[illegible]					$ 5,[illegible]
[illegible]	$	$	$	$	$	$	$
[illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
[illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
[illegible]	$ 248.95	$ 248.95					$ 248.95
MS Office	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
							$
[illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
Zoom	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
[illegible]	$ 25.00	$ 25.00	$ 25.00	$ 25.00	$ 25.00	$ 25.00	$ 125.00
TOTALS		**$ 8,240.45**	**$ 3,533.50**	**$ 2,312.50**	**$ 2,532.50**	**$ 2,312.50**	**$17,490.45**

Consultant Services	Y1	Y2	Y3	OY1	OY2
[illegible]	$ [illegible]	$ 500.00	$ [illegible]	$ 500.00	$ [illegible]
[illegible]	$ [illegible]				
TOTAL	**$ 5,500.00**	**$ 500.00**	**$ 500.00**	**$ 500.00**	**$ 500.00**

Publication fees	Y1	Y2	Y3	OY1	OY2
PLOS One		1675	[illegible]		
Scientific Reports		1[illegible]	[illegible]		
PNAS		[illegible]	[illegible]		
Total	0	[illegible]	[illegible]	0	0

International Travel						TOTAL
Traveler 1 - William Karesh (Amman)						
Hotel Max Per Diem	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	
Meals and Incidental Expenses Per Diem	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	
Taxi Estimate	$ 570.00	$ 570.00	$ 570.00	$ 570.00	$ 570.00	
Flight Estimate	$ 2,566	$ 2,566	$ 2,566	$ 2,566	$	
No. Days	5	5	5	5	5	
No. Trips per Year	2	2	2	2	2	
Total	$ 6,346.00	$ 6,346.00	$ 6,346.00	$ 6,346.00	$ 3,780.00	$ 29,164.00
Traveler 2 - William Karesh (Field)						
Hotel Max Per Diem	$ 584.00	$ 584.00	$ 584.00	$ 584.00	$ 584.00	
Meals and Incidental Expenses Per Diem	$ 472.50	$ 472.50	$ 472.50	$ 472.50	$ 472.50	
Taxi Estimate	$ 285.00	$ 285.00	$ 285.00	$ 285.00	$ 285.00	
Flight Estimate						
No. Days	5	5	5	5	5	
No. Trips per Year	1	1	1	1	1	
Total	$ 1,341.50	$ 1,341.50	$ 1,341.50	$ 1,341.50	$ 1,341.50	$ 6,707.50
Traveler 3 - Catherine Machalaba (Amman)						
Hotel Max Per Diem	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	
Meals and Incidental Expenses Per Diem	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	
Taxi Estimate	$ 570.00	$ 570.00	$ 570.00	$ 570.00	$ 570.00	
Flight Estimate	$ 2,566	$ 2,566	$ 2,566	$ 2,566	$ 2,566	
No. Days	5	5	5	5	5	
No. Trips per Year	2	2	2	2	2	
Total	$ 6,346.00	$ 6,346.00	$ 6,346.00	$ 6,346.00	$ 6,346.00	$ 31,730.00
Traveler 4 - Catherine Machalaba (Field)						
Hotel Max Per Diem	$ 1,314.00	$ 2,628.00	$ 2,628.00	$ 2,628.00	$ 2,628.00	
Meals and Incidental Expenses Per Diem	$ 997.50	$ 1,995.00	$ 1,995.00	$ 1,995.00	$ 1,995.00	
Taxi Estimate	$ 435.00	$ 870.00	$ 870.00	$ 870.00	$ 870.00	
Flight Estimate						
No. Days	10	10	10	10	10	
No. Trips per Year	1	2	2	2	2	
Total	$ 2,746.50	$ 5,493.00	$ 5,493.00	$ 5,493.00	$ 5,493.00	$ 24,718.50
Traveler 5 - Cindy Hagan (Amman)						
Hotel Max Per Diem	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	
Meals and Incidental Expenses Per Diem	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	
Taxi Estimate	$ 570.00	$ 570.00	$ 570.00	$ 570.00	$ 570.00	
Flight Estimate	$ 6,415	$ 6,415	$ 6,415	$ 6,415	$ 6,415	
No. Days	5	5	5	5	5	
No. Trips per Year	2	2	2	2	2	
Total	$ 10,195.00	$ 10,195.00	$ 10,195.00	$ 10,195.00	$ 10,195.00	$ 50,975.00

Traveler 6 - International Conferences (IMED)	Vienna					
Hotel Max Per Diem	$ 819	$ 819	$ 1,638	$ 1,638	$ 1,638	
Meals and Incidental Expenses Per Diem	$ 240	$ 240	$ 480	$ 480	$ 480	
Taxi Estimate	$ 255.00	$ 255.00	$ 510.00	$ 510.00	$ 510.00	
Flight Estimate	$ 1,493	$ 1,493	$ 2,986	$ 2,986	$ 2,986	
No. Days	4	4	4	4	4	
No. Trips per Year	1	1	2	2	2	
Total	$ 2,807.00	$ 2,807.00	$ 5,614.00	$ 5,614.00	$ 5,614.00	$ 22,456.00
Visa Fees	$ 504.00	$ 504.00	$ 504.00	$ 504.00	$ 504.00	$ 2,520.00
Vaccination Costs	$ 853.00					$ 853.00
Conference Registration Fees	$ 500.00	$ 500.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 4,000.00
YEARLY TOTALS	$ 31,639.00	$ 33,532.50	$ 36,839.50	$ 36,839.50	$ 34,273.50	$ 173,124.00
conference			visa			
$ IMED	500		Jordan	56		

Domestic Travel						TOTAL
Traveler 1 - William Karesh (NY DC)						
Hotel Max Per Diem	$ 512	$ 256	$ 512	$ 512	$ 512	
Meals and Incidental Expenses Per Diem	$ 228	$ 114	$ 228	$ 228	$ 228	
Taxi Estimate	$ 90.00	$ 45.00	$ 90.00	$ 90.00	$ 90.00	
Transportation Estimate	$ 392	$ 196	$ 392	$ 392	$ 392	
No. Days	2	2	2	2	2	
No. Trips per Year	2	1	2	2	2	
Total	$ 1,222.00	$ 611.00	$ 1,222.00	$ 1,222.00	$ 1,222.00	$ 5,499.00
Traveler 2 - Catherine Machalaba (NY DC)						
Hotel Max Per Diem	$ 256	$ 256	$ 256	$ 256	$ 256	
Meals and Incidental Expenses Per Diem	$ 114	$ 114	$ 114	$ 114	$ 114	
Taxi Estimate	$ 45.00	$ 45.00	$ 45.00	$ 45.00	$ 45.00	
Transportation Estimate	$ 196	$ 196	$ 196	$ 196	$ 196	
No. Days	2	2	2	2	2	
No. Trips per Year	1	1	1	1	1	
Total	$ 611.00	$ 611.00	$ 611.00	$ 611.00	$ 611.00	$ 3,055.00
Traveler 3 - Attending Meeting in VA						
Hotel Max Per Diem	$ 1,024	$ 1,024	$ 1,024	$ 1,024	$ 1,024	
Meals and Incidental Expenses Per Diem	$ 380	$ 380	$ 380	$ 380	$ 380	
Taxi Estimate	$ 450.00	$ 450.00	$ 450.00	$ 450.00	$ 450.00	
Transportation Estimate	$ 1,011	$ 1,011	$ 1,011	$ 1,011	$ 1,011	
No. Days	3	3	3	3	3	
No. Trips per Year	2	2	2	2	2	
Total	$ 2,864.80	$ 2,864.80	$ 2,864.80	$ 2,864.80	$ 2,864.80	$ 14,324.00
Traveler 4 - Presenting Domestic Mtg ASTMH (Maryland)						
Hotel Max Per Diem	$	$ 924	$ 924	$ 924	$ 924	
Meals and Incidental Expenses Per Diem	$ -	$ 497	$ 497	$ 497	$ 497	
Taxi Estimate	$ -	$ 210.00	$ 210.00	$ 210.00	$ 210.00	
Transportation Estimate	$ -	$ 684	$ 684	$ 684	$ 684	
No. Days	0	4	4	4	4	
People Attending	0	2	2	2	2	
Total	$ -	$ 2,315.00	$ 2,315.00	$ 2,315.00	$ 2,315.00	$ 9,260.00

Conference Registration Fees	$ -	$ 930.00	$ 930.00	$ 930.00	$ 930.00	
YEARLY TOTALS	$ 4,697.80	$ 7,331.80	$ 7,942.80	$ 7,942.80	$ 7,942.80	$ 35,858.00
astmh	$ 455.00					

Y1	Y2	Y3	OY1	OY2	Base
7.5	7.5	7.5	0.5	0.5	$ [illegible]

Fringe Rate: [illegible]

IDC Rate: [illegible] | IBR: [illegible]
ODC Rate: [illegible]

Human Link

	Y1	Y2	Y3	OY1	OY2	Total
A. Senior Key Persons						
[illegible]	$ 7,770.15	$ 7,770.15	$ 7,770.15	$ [illegible]	$ [illegible]	$ [illegible]
	$	$	$	$	$	$
Total Senior Key Persons	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
B. Other Persons						
Total Other Persons	$	$	$	$	$	$
C. Equipment						
Total Equipment	$	$	$	$ -	$ -	$ -
D. Travel						
1. Domestic Travel						$
2. Foreign Travel	$	$ 3,147.00	$ 3,147.00	$ 3,147.00	$ 3,147.00	$ 12,588.00
Total Travel	$	$ 3,147.00	$ 3,147.00	$ 3,147.00	$ 3,147.00	$ 12,588.00
E. Participant/Trainee Support Costs						
1. Tuition/Fees/Health Insurance						$
2. Stipends						$ -
3. Travel						$ -
4. Subsistence						$
5. Other						$
Total Participant/Trainee Support Costs	$	$	$	$ -	$ -	$ -
F. Other Direct Costs						
1. Materials and Supplies		$ 2,000.00	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ 8,000.00
2. Publication Costs						$
3. Consultant Services						$ -
4. ADP/Computer Services						$ -
5. Subawards/Consortium/Contractual Costs						$
6. Equipment or Facility Rental/User Fees						$
7. Alterations and Renovations						$ -
8. Other - Meetings						$ -
9. Other						$
Total Other Direct Costs	$	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ 8,000.00
G. Direct Costs and Modified Direct Costs						
Direct Costs	$ 7,770.15	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
Modified Direct Costs						$
H. Indirect Costs						
1. Indirect Cost Type	$ 720.62	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
2. Indirect Cost Type						$
I. Total Direct and Indirect Costs						
Direct + Indirect	$ 8,490.77	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
J. Fee						
Fee						
K. Total Costs and Fee						
Total Costs	$ 8,490.77	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]

[illegible]					
[illegible]	$	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
[illegible]	$	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
[illegible]	$	$	$	$	$
[illegible]	$	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
[illegible]	0	4	8	6	4
[illegible]	0	2	1	1	2
[illegible]	$	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]

						JUST	Y1	Y2	Y3	OY1	OY2	Total
Y1	Y2	Y3	OY1	OY2	Base	A. Senior/Key Personnel						
12	12	12	12	12	$ 127,940.00	Dr. Ehab Abu-Basha, CoPI	$ 127,940.00	$ 127,940.00	$ 127,940.00	$ 127,940.00	$ 127,940.00	$ 639,700.00
						Dr. Ehab Abu-Basha Fringe	$ -	$ -	$ -	$ -	$ -	$ -
8	8	8	8	8	$ 19,301.80	Hani Talafha, Biologist	$ 12,867.87	$ 12,867.87	$ 12,867.87	$ 12,867.87	$ 12,867.87	$ 64,339.33
						Hani Talafha Fringe	$ -	$ -	$ -	$ -	$ -	$ -
2	12	12	12	12	$ 32,520.00	Zaidoun Hijazeen, Veterinarian	$ 5,420.00	$ 32,520.00	$ 32,520.00	$ 32,520.00	$ 32,520.00	$ 135,500.00
						Zaidoun Hijazeen Fringe	$ -	$ -	$ -	$ -	$ -	$ -
3	3	3	3	3	$ 54,391.53	Mustafa Ababneh, Virologist/Lab Director	$ 13,597.88	$ 13,597.88	$ 13,597.88	$ 13,597.88	$ 13,597.88	$ 67,989.41
						Mustafa Ababneh Fringe	$ -	$ -	$ -	$ -	$ -	$ -
2.5	2.5	2.5	2.5	2.5	$ 57,903.18	Zuhair Bani Ismail, Livestock ID Expert	$ 12,063.16	$ 12,063.16	$ 12,063.16	$ 12,063.16	$ 12,063.16	$ 60,315.81
						Zuhair Bani Ismail Fringe	$ -	$ -	$ -	$ -	$ -	$ -
3	3	3	3	3	$ 69,597.00	Borhan Al-zoghoul, Molecular Biologist/Lab Director	$ 17,399.25	$ 17,399.25	$ 17,399.25	$ 17,399.25	$ 17,399.25	$ 86,996.25
						Borhan Al-zoghoul Fringe	$ -	$ -	$ -	$ -	$ -	$ -
3	3	3	3	3	$ 23,112.00	Bilal Al-Omari, Lab Supervisor	$ 5,778.00	$ 5,778.00	$ 5,778.00	$ 5,778.00	$ 5,778.00	$ 28,890.00
						Bilal Al-Omari Fringe	$ -	$ -	$ -	$ -	$ -	$ -
1	1	1	1	1	$ 177,018.63	Wail Hayajneh, Human ID Expert	$ 14,751.55	$ 14,751.55	$ 14,751.55	$ 14,751.55	$ 14,751.55	$ 73,757.76
						Wail Hayajneh Fringe	$ -	$ -	$ -	$ -	$ -	$ -
			Fringe Rate-->			Total Senior/Key Personnel	$ 209,817.71	$ 236,917.71	$ 236,917.71	$ 236,917.71	$ 236,917.71	$ 1,157,488.57
						B. Other Personnel						
1	1	1	2	2	$ 58,241.66	Saad Gharaibeh, Avian Pathologist	$ 4,853.47	$ 4,853.47	$ 4,853.47	$ 9,706.94	$ 9,706.94	$ 33,974.30
						Saad Gharaibeh Fringe	$ -	$ -	$ -	$ -	$ -	$ -
3.5	3.5	3.5	3.5	3.5	$ 28,219.16	Admin	$ 8,230.59	$ 8,230.59	$ 8,230.59	$ 8,230.59	$ 8,230.59	$ 41,152.94
						Admin Fringe	$ -	$ -	$ -	$ -	$ -	$ -
2	4	4	3	0	$ 47,860.32	Nurses (x2)	$ 15,953.44	$ 31,906.88	$ 31,906.88	$ 23,930.16	$ -	$ 103,697.36
12	12	12	12	12	$ 2,538.84	Undergrad Student Stipends (x2)	$ 5,077.68	$ 5,077.68	$ 5,077.68	$ 5,077.68	$ 5,077.68	$ 25,388.40
12	12	12	12	12	$ 3,385.08	Graduate Student Stipends (x2)	$ 6,770.16	$ 6,770.16	$ 6,770.16	$ 6,770.16	$ 6,770.16	$ 33,850.80
			Fringe Rate-->			Total Other Personnel	$ 40,885.34	$ 56,838.78	$ 56,838.78	$ 53,715.53	$ 29,785.37	$ 204,089.50
						C. Equipment						
						Vehicle	$ 37,150.00	$ 1,830.00	$ 1,830.00	$ 1,830.00	$ 1,830.00	$ 44,470.00
						Luminescence plate reader	$ 28,846.00					
						Total Equipment	$ 65,996.00	$ 1,830.00	$ 1,830.00	$ 1,830.00	$ 1,830.00	$ 73,316.00
						D. Travel						
						1. Domestic Travel	$ 40,108.00	$ 62,626.00	$ 62,626.00	$ 51,367.00	$ 12,360.00	$ 229,087.00
						2. Foreign Travel	$ 37,433.50	$ 26,890.00	$ 26,890.00	$ 26,890.00	$ 29,915.50	$ 148,019.00
						Total Travel	$ 77,541.50	$ 89,516.00	$ 89,516.00	$ 78,257.00	$ 42,275.50	$ 377,106.00
						E. Participant/Trainee Support Costs						
						1. Tuition/Fees/Health Insurance						$ -
						2. Stipends						$ -
						3. Travel						$ -
						4. Subsistence						$ -
						5. Other						$ -
						Total Participant/Trainee Support Costs	$ -	$ -	$ -	$ -	$ -	$ -
						F. Other Direct Costs						
						1. Materials and Supplies	$ 36,933.96	$ 18,784.77	$ 7,666.97	$ 10,255.19	$ -	$ 73,640.89
						2. Publication Costs						$ -
						3. Consultant Services						$ -
						4. ADP/Computer Services						$ -
						5. Subawards/Consortium/Contractual Costs						$ -
						6. Equipment or Facility Rental/User Fees						$ -
						7. Alterations and Renovations						$ -
						8. Other - Testing	$ 53,500.00	$ 53,500.00	$ 77,500.00	$ 65,500.00	$ -	$ 250,000.00
						9. Other - Meetings and Conferences	$ 27,589.08	$ 39,205.05	$ 17,366.69	$ 39,205.05	$ 91,885.27	$ 215,251.14
						Total Other Direct Costs	$ 118,023.04	$ 111,489.82	$ 102,533.66	$ 114,960.24	$ 91,885.27	$ 538,892.03
						G. Direct Costs and Modified Direct Costs						
						Direct Costs	$ 512,263.59	$ 496,592.31	$ 487,636.15	$ 485,680.49	$ 402,693.86	$ 2,384,866.40
						Modified Direct Costs						$ -
						H. Indirect Costs						
				IDC Rate-->	8%	1. Indirect Cost Type	$ 40,981.09	$ 39,727.39	$ 39,010.89	$ 38,854.44	$ 32,215.51	$ 190,789.31
				IDC Rate-->		2. Indirect Cost Type						$ -
						I. Total Direct and Indirect Costs						
						Direct + Indirect	$ 553,244.68	$ 536,319.70	$ 526,647.05	$ 524,534.92	$ 434,909.36	
						J. Fee						
						Fee						
						K. Total Costs and Fee						
						Total Costs	$ 553,244.68	$ 536,319.70	$ 526,647.05	$ 524,534.92	$ 434,909.36	$ 2,575,655.72

International Travel						TOTAL
International Conferences (MED Vienna)						
Hotel Max Per Diem	$ 3,276	$ 3,276	$ 3,276	$ 3,276	$ 3,276	
Meals and Incidental Expenses Per Diem	$ 1,680	$ 1,680	$ 1,680	$ 1,680	$ 1,680	
Taxi Estimates	$ 1,020.00	$ 1,020.00	$ 1,020.00	$ 1,020.00	$ 1,020.00	
Flight Estimate	$ 3,192	$ 3,192	$ 3,192	$ 3,192	$ 3,192	
No. Days	4	4	4	4	4	
No. Trips per Year	4	4	4	4	4	
Total	$ 9,168.00	$ 9,168.00	$ 9,168.00	$ 9,168.00	$ 9,168.00	$ 45,840.00
Regional Conferences (EMED Istanbul)						
Hotel Max Per Diem	$ 2,691	$ 3,588	$ 3,588	$ 3,588	$ 4,485	
Meals and Incidental Expenses Per Diem	$ 1,376	$ 1,834	$ 1,834	$ 1,834	$ 2,293	
Taxi Estimates	$ 765.00	$ 1,020.00	$ 1,020.00	$ 1,020.00	$ 1,275.00	
Flight Estimate	$ 1,698	$ 2,264	$ 2,264	$ 2,264	$ 2,830	
No. Days	4	4	4	4	4	
No. Trips per Year	3	4	4	4	5	
Total	$ 6,529.50	$ 8,706.00	$ 8,706.00	$ 8,706.00	$ 10,882.50	$ 43,530.00
DTRA Mtg (DC)						
Hotel Max Per Diem	$ 1,282	$ 1,282	$ 1,282	$ 1,282	$ 1,282	
Meals and Incidental Expenses Per Diem	$ 416	$ 416	$ 416	$ 416	$ 416	
Taxi Estimates	$ 315.00	$ 315.00	$ 315.00	$ 315.00	$ 315.00	
Flight Estimate	$ 1,083	$ 1,083	$ 1,083	$ 1,083	$ 1,083	
No. Days	6	6	6	6	6	
No. Trips per Year	1	1	1	1	1	
Total	$ 3,096.00	$ 3,096.00	$ 3,096.00	$ 3,096.00	$ 3,096.00	$ 15,480.00
Training (Local) (3 staff, 2 students)						
Hotel Max Per Diem	$ 5,100	$ -	$ -	$	$	
Meals and Incidental Expenses Per Diem	$ 3,822	$	$	$	$	
Taxi Estimates	$ 1,107.00	$	$	$	$	
Flight Estimate	$ 3,540	$	$	$	$	
No. Days	7	7	7	7	7	
No. Trips per Year	1	0	0	0	0	
Total	$ 13,569.00	$	$	$	$	$ 13,569.00
Conference Fees	$ 4,547.00	$ 5,396.00	$ 5,396.00	$ 4,896.00	$ 6,245.00	$ 26,480.00
Visa Fees	$ 524.00	$ 524.00	$ 524.00	$ 524.00	$ 524.00	$ 2,620.00
YEARLY TOTALS	$ 37,433.50	$ 26,890.00	$ 26,890.00	$ 26,390.00	$ 29,915.50	$ 147,519.00

	Y1	Y2	Y3	Y4	Y5	
visa fees						
Visa C (x2)	364	364	364	364	364	1820
[illegible] visa (DOA entry visa) (x2)	160	160	160	160	160	800
Total Visas	524	524	524	524	524	2620
conference fees						
ISID 300	2000	2000	2000	2000	2000	10000
EMED 2.862	2547	3396	3396	2896	4245	16480
Total Conference	4547	5396	5396	4896	6245	26480

Annual Conference (Y1-OY2)			# People	# Days		
Hotel Max Per Diem	$	246.00	10	2	$	4,920.00
M&IE Expenses Per Diem	$	138.00	10	2	$	2,760.00
Domestic Transport	$	414.31	10	1	$	4,143.10
Printing/Supplies	$	140.00	1	1	$	140.00
Translation and Sound	$	1,974.64	1	1	$	1,974.64
Room Rental	$	1,350.00	1	1	$	1,350.00
Lunch and Coffee	$	46.02	45	1	$	2,070.90
					$	17,358.64
KickOff Meeting (Y1 Only)			# People	# Days		
Hotel Max Per Diem	$	246.00	5	2	$	2,460.00
M&IE Expenses Per Diem	$	138.00	5	2	$	1,380.00
Domestic Transport	$	414.31	5	1	$	2,071.55
Printing/Supplies	$	65.80	1	1	$	65.80
Translation and Sound	$	1,974.64	1	1	$	1,974.64
Room Rental	$	1,350.00	1	1	$	1,350.00
Lunch and Coffee	$	46.02	20	1	$	920.40
					$	10,222.39
Regional Meeting (Y2, OY1, OY2 ONLY)			# People	# Days		
Regional Transport - Egypt	$	350.00	2	1	$	700.00
Regional Transport - Lebanon	$	409.00	2	1	$	818.00
Regional Transport - Iraq	$	493.00	2	1	$	986.00
Hotel Max Per Diem	$	246.00	5	3	$	3,690.00
M&IE Expenses Per Diem	$	138.00	5	3	$	2,070.00
Translation and Sound	$	1,974.64	1	3	$	5,923.92
Room Rental	$	1,350.00	1	3	$	4,050.00
Lunch and Coffee	$	46.02	24	3	$	3,313.44
					$	21,551.36
Threat Reduction Workshop (OY2)			# People	# Days		
Hotel Max Per Diem	$	246.00	22	4	$	21,648.00
M&IE Expenses Per Diem	$	138.00	10	4	$	5,520.00
Domestic Transport	$	414.31	10	1	$	4,143.10
Printing/Supplies	$	1,974.50	1	1	$	1,974.50
Translation and Sound	$	1,974.64	1	3	$	5,923.92
Room Rental	$	1,350.00	1	3	$	4,050.00
Lunch and Coffee	$	46.02	45	3	$	6,212.70
Regional Transport - Lebanon	$	409.00	4	1	$	1,636.00
Regional Transport - Iraq	$	493.00	4	1	$	1,972.00
					$	53,080.22

	Y1	Y2	Y3	OY1	OY2
Meetings/Conference Costs	$ 27,581.03	$ 38,910.00	$ 17,358.64	$ 38,910.00	$ 91,990.22

Field Travel Costs	Y1	Y2	Y3	OY1	OY2	
Food/Lodging Per Diems	$ 15,000.00	$ 30,000.00	$ 30,000.00	$ 22,500.00	$	
Fuel	$ 4,590.00	$ 4,590.00	$ 4,590.00	$ 4,590.00	$ 1,360.00	
Vehicle Maintenance Costs	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	
Tokens of Appreciation	$ 19,518.00	$ 27,036.00	$ 27,036.00	$ 23,277.00	$ 10,000.00	
TOTAL	$ 40,108.00	$ 62,626.00	$ 62,626.00	$ 51,367.00	$ 12,360.00	
Food/Lodging Per Diems	Y1	Y2	Y3	OY1	OY2	
# trips	2	4	4	3	0	
Per Diem	500	500	500	500	500	(3 lead, 2 [illegible] students)
# days	3	3	3	3	5	
# Staff	5	5	5	5	5	
Total	$ 15,000.00	$ 30,000.00	$ 30,000.00	$ 22,500.00	0	
Tokens of Appreciation - Farmers	Y1	Y2	Y3	OY1	OY2	
# Samples/ Qtr	300	300	300	300	300	
# Quarters	2	4	4	3	0	
Energy snacks	$ 0.25	$ 0.25	$ 0.25	$ 0.25	$ 0.25	
Prepaid phone card	$ 12.28	$ 12.28	$ 12.28	$ 12.28	$ 12.28	[illegible]
Total	$ 7,518.00	$ 15,036.00	$ 15,036.00	$ 11,277.00	$	
Tokens of Appreciation - Camels/Poultry	Y1	Y2	Y3	OY1	OY2	
# Samples/ Qtr	60	60	60	60	30	30 owners of each type animal
# Quarters	2	2	2	2	2	visiting quarterly, tokens every other visit
Prizes/drugs/supplies	$ 100.00	$ 100.00	$ 100.00	$ 100.00	$ 100.00	
Total	$ 12,000.00	$ 12,000.00	$ 12,000.00	$ 12,000.00	$ 10,000.00	
Sites	Dist km	Travel	$/l	Total		
Al Hamdha	175	17.5	$ 1.53	$ 26.78		
Al Zinga	58.2	5.82	$ 1.53	$ 8.90		
Al Karas	262	26.2	$ 1.53	$ 40.09		
Mala	438	43.8	$ 1.53	$ 67.01		
Aqaba	668	66.8	$ 1.53	$ 102.20		
				$ 244.98		
	30000	3000	$ 1.53	$ 4,590.00		

Field Supplies

Type	Units/Price	Price	Y1		Y2		Y3		OY1		OY2	
			Qy Needed	Total	Qy Needed	Total	Qy Needed	Total	Qy Needed	Total	Qy Needed	Total
Nunc 1.8 internal cryovials	450	$ 516.42	12	$ 6,197.04	17	$ 8,779.14	8	$ 4,131.36	10	$ 5,164.20		
Serum tubes 10 mL	100	$ 31.09	25	$ 777.25	23	$ 715.07	12	$ 373.08	12	$ 373.08		
Serum tubes 3 mL	100	$ 27.31	2	$ 54.62	0	$ -	1	$ 27.31		$ -		
Vaccutatiner holder	250	$ 20.77	50	$ 1,038.50	50	$ 1,038.50		$ -		$ -		
21g 1in vacutainer safety needles	48	$ 39.92	30	$ 1,197.60	28	$ 1,117.76	15	$ 598.80	14	$ 558.88		
18g 1in vacutainer needles	100	$ 32.19	5	$ 160.95	5	$ 160.95	3	$ 96.57	2	$ 64.38		
3cc luer lock syringe	100	$ 21.80	2	$ 43.60		$	1	$ 21.80		$		
22g 1in needle	100	$ 19.80	2	$ 39.60		$ -	1	$ 19.80		$ -		
Cotton Swabs	500	$ 400.00	5	$ 2,000.00	10	$ 4,000.00	0	$	5	$ 2,000.00		
Gloves	50	$ 29.65	7	$ 207.55	14	$ 415.10	0	$ -	6	$ 177.90	0	$ -
Masks N95	50	$ 47.75	7	$ 334.25	7	$ 334.25	7	$ 334.25	5	$ 238.75	0	$
Tyvek Suits (project supply)	25	$ 350.00	52	$ 18,200.00	0	$ -	0	$ -	0	$ -	0	$ -
Googgles (project supply)	12	$ 135.00	2	$ 270.00	0	$ -	0	$ -	0	$ -	0	$ -
Booties (project supply)	200	$ 300.00	7	$ 2,100.00	0	$ -	0	$ -	0	$ -	0	$ -
Biohazard Bag (project supply)	200	$ 155.00	2	$ 310.00	0	$ -	0	$ -	0	$ -	0	$ -
Sharps Container	20	$ 200.00	1	$ 200.00	1	$ 200.00	1	$ 200.00	1	$ 200.00		$ -
Alcohol Swabs	1200	$ 32.00	4	$ 128.00	7	$ 224.00	2	$ 64.00	4	$ 128.00		$ -
Tablets	1	$ 200.00	5	$ 1,000.00		$		$		$		$
Dry Ice	1 week	$ 150.00	6	$ 900.00	12	$ 1,800.00	12	$ 1,800.00	9	$ 1,350.00		$ -
Eye wash station	1	$ 275.00	1	$ 275.00		$		$		$		$
Card reader system		$ 1,500.00	1	$ 1,500.00		$ -		$ -		$ -		$ -
TOTALS				**$ 36,933.96**		**$ 18,784.77**		**$ 7,666.97**		**$ 10,255.19**		**$ -**

Nunc 1.8 internal cryovials	PCRs - 2 swabs/animal or person
Serum tubes 10 mL	1 per human, 2 per animal serology
Serum tubes 3 mL	1 per chicken serology
Vaccutatiner holder	100
21g 1in vacutainer safety needles	1 per human serology
18g 1in vacutainer needles	1 per camel serology
3cc luer lock syringe	1 per chicken serology
22g 1in needle	1 per chicken serology
Cotton Swabs	PCRs - 2 swabs/animal or person

TESTS	YEAR 1			YEAR 2			YEAR 3			OPTION YEAR 1			OPTION YEAR 2		
	# Y1	Price	Total	# Y2	Price	Total	# Y3	Price	Total	# OY1	Price	Total	# OY2	Price	Total
MERS PCR Humans	600	$ 15.00	$ 9,000.00	1200	$ 15.00	$ 18,000.00	1200	$ 15.00	$ 18,000.00	900	$ 15.00	$ 13,500.00		$ 15.00	$ -
MERS PCR camels	200	$ 15.00	$ 3,000.00	400	$ 15.00	$ 6,000.00	400	$ 15.00	$ 6,000.00	300	$ 15.00	$ 4,500.00		$ 15.00	$ -
MERS PCR Sequencing of positives	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00		$ 100.00	$ -
AI PCR Humans	600	$ 15.00	$ 9,000.00	1200	$ 15.00	$ 18,000.00	1200	$ 15.00	$ 18,000.00	900	$ 15.00	$ 13,500.00		$ 15.00	$ -
AI PCR poultry	200	$ 15.00	$ 3,000.00	400	$ 15.00	$ 6,000.00	400	$ 15.00	$ 6,000.00	300	$ 15.00	$ 4,500.00		$ 15.00	$
AI PCR Sequencing of positives	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00		$ 100.00	$
MERS Serology Humans PP	330	$ 40.00	$ 13,200.00	0	$ 40.00	$ -	330	$ 40.00	$ 13,200.00	330	$ 40.00	$ 13,200.00			
MERS Serology camels ELIZA	100	$ 15.00	$ 1,500.00	0	$ 15.00	$ -	100	$ 15.00	$ 1,500.00	100	$ 15.00	$ 1,500.00		$ 15.00	$ -
AI serology humans	300	$ 6.00	$ 1,800.00	0	$ 6.00	$ -	300	$ 6.00	$ 1,800.00	300	$ 6.00	$ 1,800.00		$ 6.00	$ -
AI serology poultry	100	$ 6.00	$ 600.00	0	$ 6.00	$	100	$ 6.00	$ 600.00	100	$ 6.00	$ 600.00		$ 6.00	$
AI serology Subtype Tesing	100	$ 15.00	$ 1,500.00	100	$ 15.00	$ 1,500.00	100	$ 15.00	$ 1,500.00	100	$ 15.00	$ 1,500.00		$ 15.00	$ -
Brucella serology humans	300	$ 1.00	$ 300.00	0	$ 1.00	$ -	300	$ 1.00	$ 300.00	300	$ 1.00	$ 300.00		$ 1.00	$ -
Brucella serology camels	100	$ 1.00	$ 100.00	0	$ 1.00	$ -	100	$ 1.00	$ 100.00	100	$ 1.00	$ 100.00		$ 1.00	$ -
Brucella serology other ruminants	100	$ 1.00	$ 100.00	0	$ 1.00	$	100	$ 1.00	$ 100.00	100	$ 1.00	$ 100.00		$ 1.00	$
Brucella Complement Fixation Test	100	$ 10.00	$ 1,000.00	0	$ 10.00	$	100	$ 10.00	$ 1,000.00	100	$ 10.00	$ 1,000.00	0	$ 10.00	$
Lepto serology humans	400	$ 8.00	$ 3,200.00	0	$ 8.00	$ -	400	$ 8.00	$ 3,200.00	400	$ 8.00	$ 3,200.00		$ 8.00	$ -
Lepto serology camels	100	$ 8.00	$ 800.00	0	$ 8.00	$ -	100	$ 8.00	$ 800.00	100	$ 8.00	$ 800.00		$ 8.00	$ -
Lepto serology other ruminants	100	$ 8.00	$ 800.00	0	$ 8.00	$ -	100	$ 8.00	$ 800.00	100	$ 8.00	$ 800.00		$ 8.00	$ -
Lepto Serovar Test	60	$ 10.00	$ 600.00	0	$ 10.00	$	60	$ 10.00	$ 600.00	60	$ 10.00	$ 600.00	0	$ 10.00	$
Lepto PCR humans			$ -			$ -			$ -			$ -			$ -
Lepto PCR camels			$ -			$ -			$ -			$ -			$ -
Lepto PCR other ruminants			$ -			$ -			$ -			$ -			$ -
			$ -			$ -			$ -			$ -			$ -
		Y1 Total	$ 53,500.00		Y2 Total	$ 53,500.00		Y3 Total	$ 77,500.00		OY1 Total	$ 65,500.00		OY2 Total	$ -

<mailto(b)(6)
Subject: Re: [Non-DoD Source] FRBA14-6-2-0471 Clarifications

All active links contained in this email were disabled. Please verify the identity of the sender, and confirm the authenticity of all links contained within the message prior to copying and pasting the address to a Web browser.

Much appreciated(b)(6)

I cannot imagine how you get through all these documents. We only have a few proposals/awards to justify and it seems like an enormous task for us!

If I may help you quickly locate certain documents in our forms and files, please call or text my handphone anytime day or night.

Many thanks again!

-Aleksei

Aleksei Chmura, PhD
Chief of Staff

EcoHealth Alliance
520 Eighth Avenue, Suite 1200
New York, NY 10018-4182

(b)(6) < tel:1.646.413.3437 > (mobile)
Caution-www.ecohealthalliance.org <http://caution-www.ecohealthalliance.org/> <
Caution-http://www.ecohealthalliance.org >

EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation.

On Sep 2, 2020, at 12:17,(b)(6)
<mailto(b)(6) > wrote:

Yes , they were received. Thank you

-----Original Message-----
From: William B. Karesh <karesh@ecohealthalliance.org <mailto:karesh@ecohealthalliance.org> <
Caution-mailto:karesh@ecohealthalliance.org > >
Sent: Wednesday, September 2, 2020 11:16 AM
To:(b)(6)
<mailto(b)(6) > >
Cc: Aleksei Chmura <chmura@ecohealthalliance.org <mailto:chmura@ecohealthalliance.org> <
Caution-mailto:chmura@ecohealthalliance.org > >
Subject: Fwd: [Non-DoD Source] FRBA14-6-2-0471 Clarifications

All active links contained in this email were disabled. Please verify the identity of the sender, and confirm the authenticity of all links contained within the message prior to copying and pasting the address to a Web browser.

Dear (b)(6)

I just wanted to confirm that you received the email below earlier this week.

Thanks!!

William B. Karesh, D.V.M
Executive Vice President for Health and Policy

EcoHealth Alliance
520 Eighth Avenue, Suite 1200
New York, NY 10018 USA

+1.212.380.4463 (direct)
+1.212.380.4465 (fax)
Caution-Caution-www.ecohealthalliance.org <http://caution-caution-www.ecohealthalliance.org/> < Caution-http://caution-Caution-www.ecohealthalliance.org/ > < Caution-Caution-mailto:karesh@ecohealthalliance.org < Caution-mailto:karesh@ecohealthalliance.org > >

President, OIE Working Group on Wildlife

Co-chair, IUCN Species Survival Commission - Wildlife Health Specialist Group

EPT Partners Liaison, USAID Emerging Pandemic Threats - PREDICT-2 Program

EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation.

Begin forwarded message:

From:Aleksei Chmura <chmura@ecohealthalliance.org <mailto:chmura@ecohealthalliance.org> < Caution-mailto:chmura@ecohealthalliance.org > < Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > > >

Subject:Re: [Non-DoD Source] FRBA14-6-2-0471 Clarifications

Date:August 30, 2020 at 8:14:36 PM EDT

To (b)(6)
<mailto aution-
Caution > >>

C (b)(6)
<mailt aution-
Cautio > >>, Billy Karesh
<karesh@ecohealthalliance.org <mailto:karesh@ecohealthalliance.org> <
Caution-mailto:karesh@ecohealthalliance.org > < Caution-Caution-mailto:karesh@ecohealthalliance.org <
Caution-mailto:karesh@ecohealthalliance.org > >>, Whitney Bagge <bagge@ecohealthalliance.org
<mailto:bagge@ecohealthalliance.org> < Caution-mailto:bagge@ecohealthalliance.org > < Caution-
Caution-mailto:bagge@ecohealthalliance.org < Caution-mailto:bagge@ecohealthalliance.org > >>, Catherine
Machalaba <machalaba@ecohealthalliance.org <mailto:machalaba@ecohealthalliance.org> <
Caution-mailto:machalaba@ecohealthalliance.org > < Caution-Caution-mailto:machalaba@ecohealthalliance.org <
Caution-mailto:machalaba@ecohealthalliance.org > >>, Joe Riccardi <riccardi@ecohealthalliance.org
<mailto:riccardi@ecohealthalliance.org> < Caution-mailto:riccardi@ecohealthalliance.org > < Caution-
Caution-mailto:riccardi@ecohealthalliance.org < Caution-mailto:riccardi@ecohealthalliance.org > >>

Dear (b)(6)

Please find attached seven files:

1) FRBAA14-6-2-0471_Clarifications_FINAL.xlsx
2) EHA Budget Justification_FINAL.docx
3) EHA Documentation_FINAL.pdf
4) Human Link Budget Justification_FINAL.docx
5) Human Link Documentation_FINAL.pdf
6) JUST Budget Justification_FINAL.docx
7) JUST Documentation_FINAL.pdf

There are three sets of paired files with the requested documentation (PDFs) and track-change budget justifications (MS Word) for EcoHealth Alliance and our two subcontracts under this proposal. We have also included the clarifications (MS Excel) with responses to the specific questions in each tab.

Please let me know, if there are additional questions or any other documentation is required.

Many thanks!

-Aleksei

Aleksei Chmura, PhD
Chief of Staff &
Authorized Organizational Representative

EcoHealth Alliance
520 Eighth Avenue, Suite 1200
New York, NY 10018-4182

+1.212.380.4473 < tel:1.212.380.4469 < tel:1.212.380.4469 > > (office)
(b)(6) > (mobile)
Caution-Caution-www.ecohealthalliance.org <http://caution-caution-www.ecohealthalliance.org/> <
Caution-http://caution-Caution-www.ecohealthalliance.org/ > < Caution-Caution-http://www.ecohealthalliance.org/
< caution-Caution-http://www.ecohealthalliance.org/ > >

EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation.

From: Aleksei Chmura
To: (b)(6)
Cc: (b)(6) Whitney Bagge; Joe Riccardi; Billy Karesh
Subject: Re: [Non-DoD Source] FRBA14-6-2-0471 Clarifications
Date: Thursday, September 17, 2020 11:38:05 AM
Attachments: DTRA Jordan Budget 28 Aug 2020.xlsx

All active links contained in this email were disabled. Please verify the identity of the sender, and confirm the authenticity of all links contained within the message prior to copying and pasting the address to a Web browser.

Dear (b)(6)

Please find our excel file with a breakdown of EcoHealth Alliance costs and with separate tabs for our subcontracts.

Call me anytime, if you have additional questions or need other documents.

Many thanks!

-Aleksei

Aleksei Chmura, PhD
Chief of Staff &
Authorized Organizational Representative

EcoHealth Alliance
520 Eighth Avenue, Suite 1200
New York, NY 10018-4182

+1.212.380.4473 < tel:1.212.380.4469 > (office)
(b)(6) > (mobile)
Caution-www.ecohealthalliance.org < Caution-http://www.ecohealthalliance.org/ >

EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation.

> On Sep 14, 2020, at 11:23, Lyles, Latrice D CTR DTRA AL (USA) (b)(6)
<mailt(b)(6) > wrote:

> Good morning,

> Thank you for documents as they will come in handy. Would you be able to provide an excel breakdown of EHA and subs?

> -----Original Message-----
> From: Aleksei Chmura <chmura@ecohealthalliance.org <mailto:chmura@ecohealthalliance.org> >
> Sent: Wednesday, September 2, 2020 12:34 PM
> To (b)(6)

						PRIME Budget	Y1	Y2	Y3	OY1	OY2	Total
Y1	Y2	Y3	OY1	OY2	Rate	A. Senior Key Personnel						
2	2	2	2	2	$ 201,[illegible]	Arthur Karash PI	$ 46,536.20	$ 50,[illegible]	$ 53,[illegible]	$ 55,165.66	$ 58,[illegible]	$ 26[illegible]
						Arthur Karash Fringe	$ 17,[illegible].95	$ 18,[illegible]	$ 19,[illegible]	$ 20,[illegible]	$ 21,[illegible]	$ [illegible]
3	3	3	3	3	$ 67,747.18	Emily Hogan, Behavioral Risk Scientist	$ 16,[illegible].80	$ 17,[illegible]	$ 18,[illegible]	$ [illegible]	$ [illegible]	$ [illegible]
						Emily Hogan Fringe	$ 6,232.74	$ 6,544.36	$ 6,871.50	$ 7,215.18	$ 7,573.94	$ 34,436.83
4	4	4	4	3	$ 85,884.88	Catherine [illegible], Co-Investigator	$ 28,628.29	$ 30,030.71	$ 31,[illegible]	$ 33,140.60	$ 43,497.34	$ 166,856.86
						Catherine [illegible] Fringe	$ 10,533.21	$ 11,[illegible]	$ 11,615.07	$ 12,195.82	$ 16,007.02	$ 61,413.10
2	2	2	2	2	$ 90,100.00	Whitney Baggs, Modeler	$ 14,050.11	$ 15,007.02	$ 15,321.00	$ 16,612.07	$ 17,442.65	$ 78,293.40
						Whitney Baggs Fringe	$ [illegible]	$ 5,544.95	$ 5,822.13	$ [illegible]	$ 6,418.90	$ 29,179.99
		Fringe Rate ->			36.80%	Total Senior Key Personnel	$ 143,000.15	$ 150,779.10	$ 160,307.00	$ 171,745.42	$ 192,232.90	$ 831,084.05
						B. Other Personnel						
1	1	1	1	1	$ 59,[illegible]	Amanda Andre, Program Coordinator	$ 14,[illegible]	$ 15,577.[illegible]	$ 16,[illegible]	$ 17,[illegible]	$ 18,[illegible]	$ [illegible]
						Amanda Andre Fringe	$ [illegible]	$ 5,[illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
12	12	12	12	12	$ 61,000.00	Research Assistant	$ 51,[illegible]	$ [illegible]	$ 67,252.[illegible]	$ [illegible]	$ [illegible]	$ [illegible]
						RA Fringe	$ 22,442.00	$ 23,570.40	$ 24,748.[illegible]	$ 25,985.37	$ 27,286.68	$ 124,036.[illegible]
		Fringe Rate ->			36.[illegible]%	Total Other Personnel	$ 103,873.41	$ 108,[illegible]	$ 114,620.40	$ 120,246.45	$ 126,258.77	$ 573,[illegible]
						C. Equipment						
						Total Equipment	$ -	$ -	$ -	$ -	$ -	$ -
						D. Travel						
						1. Domestic Travel	$ 4,697.80	$ 7,321.80	$ 7,942.80	$ 7,942.80	$ 7,942.80	$ 35,858.00
						2. Foreign Travel	$ 31,610.00	$ 33,532.50	$ 36,209.50	$ 33,939.00	$ 34,273.90	$ 173,101.00
						Total Travel	$ 36,312.80	$ 40,504.30	$ 44,792.30	$ 41,792.30	$ 42,210.70	$ 208,959.00
						E. Participant/Trainee Support Costs						
						1. Tuition/Fees/Health Insurance						$
						2. Stipends						$ -
						3. Travel						$ -
						4. Subsistence						$ -
						5. Other						$ -
						Total Participant Trainee Support Costs	$ -	$ -	$ -	$ -	$ -	$ -
						F. Other Direct Costs						
						1. Materials and Supplies	$ 8,240.45	$ 3,532.50	$ 2,312.50	$ 2,312.50	$ 2,312.50	$ 17,4[illegible].45
						2. Publication Costs	$ -	$ 5,205.00	$ 5,205.00	$ -	$ -	$ 10,410.00
						3. Consultant Services	$ 5,500.00	$ 500.00	$ 500.00	$ 500.00	$ 500.00	$ 7,500.00
						4. ADP/Computer Services						$ -
						5. Subawards/Consortium/Contractual Costs						$
						JUST	$ 553,244.69	$ 536,319.70	$ 526,047.00	$ 524,934.92	$ 434,909.00	$ 2,573,850.72
						Human Link	$ 3,479.17	$ 14,140.97	$ 14,140.57	$ 14,140.37	$ 14,140.97	$ 60,042.00
						6. Equipment or Facility Rental/User Fees						$ -
						7. Alterations and Renovations						$ -
						8. Other						$ -
						9. Other						$ -
						Total Other Direct Costs	$ 13,740.45	$ 8,[illegible]	$ 8,[illegible]	$ 2,812.50	$ 2,812.50	$ 35,4[illegible].45
						G. Direct Costs and Modified Direct Costs						
						Direct Costs	$ 3[illegible],267.81	$ [illegible]	$ 3[illegible]	$ [illegible]	$ 360,521.13	$ 1,65[illegible]
						Modified Direct Costs						$ -
						H. Indirect Costs						
		IDC Rate ->			39.54%	1. Indirect Cost Type	$ 108,339.05	$ 112,430.77	$ 118,300.01	$ 121,707.60	$ 130,253.07	$ 591,362.66
		IDC Rate ->			39.54%	2. Indirect Cost Type	511,095.97	$ 3,309.00	$ 392.00	$		$ 17,920.00
						I. Total Direct and Indirect Costs						
						Direct + Indirect	$ 422,020.69	$ 421,234.99	$ 450,330.23	$ 461,294.10	$ 490,997.11	$ 2,256,293.90
						J. Fee						
						Fee						
						K. Total Costs and Fee						
						Total Costs	$ 42[illegible]	$ [illegible]	$ 450,330.2[illegible]	$ 461,294.10	$ [illegible]	$ 2,249,2[illegible].50
						OVERALL Totals						
							$ 954,354.54	$ [illegible]	$ 981,118.15	$ [illegible]	$ 942,657.04	$ 4,8[illegible]

EHA Supplies	Unit/Amount	Y1	Y2	Y3	OY1	OY2	
Laptop	$ [illegible]	$ [illegible]					$ [illegible]
[illegible]	$	$	$	$	$	$	$
Dropbox	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
Adobe	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
Endnote	$ 249.95	$ 249.95					$ 249.95
MS Office	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
							$
Communications	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ 2,[illegible]
Zoom	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
[illegible]	$ 25.00	$ 25.00	$ 25.00	$ 25.00	$ 25.00	$ 25.00	$ 125.00
TOTALS		**$ 8,240.45**	**$ 3,533.50**	**$ 2,312.50**	**$ 2,532.50**	**$ 2,312.50**	**$17,490.45**

Consultant Services	Y1	Y2	Y3	OY1	OY2
[illegible]	$ [illegible]	$ 500.00	$ [illegible]	$ 500.00	$ [illegible]
[illegible]	$ [illegible]				
TOTAL	**$ 5,500.00**	**$ 500.00**	**$ 500.00**	**$ 500.00**	**$ 500.00**

publications	Y1	Y2	Y3	OY1	OY2
[illegible]		[illegible]	[illegible]		
[illegible]		[illegible]	[illegible]		
[illegible]		[illegible]	[illegible]		
Total	0	[illegible]	[illegible]	0	0

International Travel						TOTAL
Traveler 1 - William Karesh (Amman)						
Hotel Max Per Diem	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	
Meals and Incidental Expenses Per Diem	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	
Taxi Estimate	$ 570.00	$ 570.00	$ 570.00	$ 570.00	$ 570.00	
Flight Estimate	$ 2,566	$ 2,566	$ 2,566	$ 2,566	$	
No. Days	5	5	5	5	5	
No. Trips per Year	2	2	2	2	2	
Total	$ 6,346.00	$ 6,346.00	$ 6,346.00	$ 6,346.00	$ 3,780.00	$ 29,164.00
Traveler 2 - William Karesh (Field)						
Hotel Max Per Diem	$ 584.00	$ 584.00	$ 584.00	$ 584.00	$ 584.00	
Meals and Incidental Expenses Per Diem	$ 472.50	$ 472.50	$ 472.50	$ 472.50	$ 472.50	
Taxi Estimate	$ 285.00	$ 285.00	$ 285.00	$ 285.00	$ 285.00	
Flight Estimate						
No. Days	5	5	5	5	5	
No. Trips per Year	1	1	1	1	1	
Total	$ 1,341.50	$ 1,341.50	$ 1,341.50	$ 1,341.50	$ 1,341.50	$ 6,707.50
Traveler 3 - Catherine Machalaba (Amman)						
Hotel Max Per Diem	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	
Meals and Incidental Expenses Per Diem	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	
Taxi Estimate	$ 570.00	$ 570.00	$ 570.00	$ 570.00	$ 570.00	
Flight Estimate	$ 2,566	$ 2,566	$ 2,566	$ 2,566	$ 2,566	
No. Days	5	5	5	5	5	
No. Trips per Year	2	2	2	2	2	
Total	$ 6,346.00	$ 6,346.00	$ 6,346.00	$ 6,346.00	$ 6,346.00	$ 31,730.00
Traveler 4 - Catherine Machalaba (Field)						
Hotel Max Per Diem	$ 1,314.00	$ 2,628.00	$ 2,628.00	$ 2,628.00	$ 2,628.00	
Meals and Incidental Expenses Per Diem	$ 997.50	$ 1,995.00	$ 1,995.00	$ 1,995.00	$ 1,995.00	
Taxi Estimate	$ 435.00	$ 870.00	$ 870.00	$ 870.00	$ 870.00	
Flight Estimate						
No. Days	10	10	10	10	10	
No. Trips per Year	1	2	2	2	2	
Total	$ 2,746.50	$ 5,493.00	$ 5,493.00	$ 5,493.00	$ 5,493.00	$ 24,718.50
Traveler 5 - Cindy Hagan (Amman)						
Hotel Max Per Diem	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	
Meals and Incidental Expenses Per Diem	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	
Taxi Estimate	$ 570.00	$ 570.00	$ 570.00	$ 570.00	$ 570.00	
Flight Estimate	$ 6,415	$ 6,415	$ 6,415	$ 6,415	$ 6,415	
No. Days	5	5	5	5	5	
No. Trips per Year	2	2	2	2	2	
Total	$ 13,195.00	$ 13,195.00	$ 13,195.00	$ 13,195.00	$ 13,195.00	$ 65,975.00

Traveler 6 - International Conferences (IMED)	Vienna					
Hotel Max Per Diem	$ 819	$ 819	$ 1,638	$ 1,638	$ 1,638	
Meals and Incidental Expenses Per Diem	$ 240	$ 240	$ 480	$ 480	$ 480	
Taxi Estimate	$ 255.00	$ 255.00	$ 510.00	$ 510.00	$ 510.00	
Flight Estimate	$ 1,493	$ 1,493	$ 2,986	$ 2,986	$ 2,986	
No. Days	4	4	4	4	4	
No. Trips per Year	1	1	2	2	2	
Total	$ 2,807.00	$ 2,807.00	$ 5,614.00	$ 5,614.00	$ 5,614.00	$ 22,456.00
Visa Fees	$ 504.00	$ 504.00	$ 504.00	$ 504.00	$ 504.00	$ 2,520.00
Vaccination Costs	$ 850.00					$ 850.00
Conference Registration Fees	$ 500.00	$ 500.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 4,000.00
YEARLY TOTALS	$ 34,636.00	$ 36,532.50	$ 39,839.50	$ 39,839.50	$ 37,273.50	$ 173,101.00
conference		visa				
$ IMED	530	Jordan	56			

Domestic Travel						TOTAL
Traveler 1 - William Karesh (NY DC)						
Hotel Max Per Diem	$ 512	$ 256	$ 512	$ 512	$ 512	
Meals and Incidental Expenses Per Diem	$ 228	$ 114	$ 228	$ 228	$ 228	
Taxi Estimate	$ 90.00	$ 45.00	$ 90.00	$ 90.00	$ 90.00	
Transportation Estimate	$ 392	$ 196	$ 392	$ 392	$ 392	
No. Days	2	2	2	2	2	
No. Trips per Year	2	1	2	2	2	
Total	$ 1,222.00	$ 611.00	$ 1,222.00	$ 1,222.00	$ 1,222.00	$ 5,499.00
Traveler 2 - Catherine Machalaba (NY DC)						
Hotel Max Per Diem	$ 256	$ 256	$ 256	$ 256	$ 256	
Meals and Incidental Expenses Per Diem	$ 114	$ 114	$ 114	$ 114	$ 114	
Taxi Estimate	$ 45.00	$ 45.00	$ 45.00	$ 45.00	$ 45.00	
Transportation Estimate	$ 196	$ 196	$ 196	$ 196	$ 196	
No. Days	2	2	2	2	2	
No. Trips per Year	1	1	1	1	1	
Total	$ 611.00	$ 611.00	$ 611.00	$ 611.00	$ 611.00	$ 3,055.00
Traveler 3 - Attending Meeting in VA						
Hotel Max Per Diem	$ 1,024	$ 1,024	$ 1,024	$ 1,024	$ 1,024	
Meals and Incidental Expenses Per Diem	$ 380	$ 380	$ 380	$ 380	$ 380	
Taxi Estimate	$ 450.00	$ 450.00	$ 450.00	$ 450.00	$ 450.00	
Transportation Estimate	$ 1,011	$ 1,011	$ 1,011	$ 1,011	$ 1,011	
No. Days	3	3	3	3	3	
No. Trips per Year	2	2	2	2	2	
Total	$ 2,864.80	$ 2,864.80	$ 2,864.80	$ 2,864.80	$ 2,864.80	$ 14,324.00
Traveler 4 - Presenting Domestic Mtg ASTMH (Maryland)						
Hotel Max Per Diem	$	$ 924	$ 924	$ 924	$ 924	
Meals and Incidental Expenses Per Diem	$ -	$ 497	$ 497	$ 497	$ 497	
Taxi Estimate	$ -	$ 210.00	$ 210.00	$ 210.00	$ 210.00	
Transportation Estimate	$ -	$ 684	$ 684	$ 684	$ 684	
No. Days	0	4	4	4	4	
People Attending	0	2	2	2	2	
Total	$ -	$ 2,315.00	$ 2,315.00	$ 2,315.00	$ 2,315.00	$ 9,260.00

Conference Registration Fees	$ -	$ 930.00	$ 930.00	$ 930.00	$ 930.00	
YEARLY TOTALS	$ 4,697.80	$ 7,331.80	$ 7,942.80	$ 7,942.80	$ 7,942.80	$ 35,858.00
astmh	$ 455.00					

Y1	Y2	Y3	OY1	OY2	Base
7.5	7.5	7.5	0.5	0.3	$ 105,000.00

Fringe Rate: [illegible]

IDC Rate	[illegible]	IIR
IDC Rate	[illegible]	

Human Link	Y1	Y2	Y3	OY1	OY2	Total
A. Senior Key Personnel						
(Name/Role) ... (Name/Role)	$ 7,770.17	$ 7,770.17	$ 7,770.17	$ 7,905.01	$ 7,905.01	$ 39,054.07
	$	$	$	$	$	$
Total Senior Key Personnel	$ 6,628.15	$ 6,628.15	$ 6,628.15	$ 2,905.82	$ 2,905.82	$ 24,841.57
B. Other Personnel						
Total Other Personnel	$	$	$	$	$	$
C. Equipment						
Total Equipment	$	$	$	$ -	$ -	$ -
D. Travel						
1. Domestic Travel						$
2. Foreign Travel	$	$ 3,147.00	$ 3,147.00	$ 3,147.00	$ 3,147.00	$ 12,588.00
Total Travel	$	$ 3,147.00	$ 3,147.00	$ 3,147.00	$ 3,147.00	$ 12,588.00
E. Participant/Trainee Support Costs						
1. Tuition/Fees/Health Insurance						$
2. Stipends						$ -
3. Travel						$ -
4. Subsistence						$
5. Other						$
Total Participant/Trainee Support Costs	$	$	$	$ -	$ -	$ -
F. Other Direct Costs						
1. Materials and Supplies		$ 2,000.00	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ 8,000.00
2. Publication Costs						$
3. Consultant Services						$ -
4. ADP/Computer Services						$ -
5. Subawards/Consortium/Contractual Costs						$
6. Equipment or Facility Rental/User Fees						$
7. Alterations and Renovations						$ -
8. Other Savings						$ -
9. Other						$
Total Other Direct Costs	$	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ 8,000.00
G. Direct Costs and Modified Direct Costs						
Direct Costs	$ 7,770.17	$ 12,075.17	$ 12,075.17	$ 2,575.01	$ 2,575.01	$ 56,129.07
Modified Direct Costs						$
H. Indirect Costs						
1. Indirect Cost Type	$ 728.62	$ 1,295.52	$ 1,295.52	$ 1,265.51	$ 1,265.51	$ [illegible]
2. Indirect Cost Type						$
I. Total Direct and Indirect Costs						
Direct + Indirect	$ 8,479.17	$ 14,140.47	$ 14,140.47	$ 14,140.87	$ 14,140.87	$ 65,044.58
[illegible]						
Fee						
K. Total Costs and Fee						
Total Costs	$ 8,479.17	$ 14,140.47	$ 14,140.47	$ 14,140.87	$ 14,140.87	$ 65,044.58

[illegible]						
[illegible]	$	$ [illegible]	$ 1,222	$ [illegible]	$ [illegible]	
[illegible]	$	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	
[illegible]	$	$		$	$	
[illegible]	$	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	
[illegible]	0	4	8	6	4	
[illegible]	0	2	1	1	2	
Total	$	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]

Y1	Y2	Y3	OY1	OY2	Base	JUST	Y1	Y2	Y3	OY1	OY2	Total
						A. Senior/Key Personnel						
12	12	12	12	12	$ 127,940.00	Dr. Ehab Abu-Basha, CoPI	$ 127,940.00	$ 127,940.00	$ 127,940.00	$ 127,940.00	$ 127,940.00	$ 639,700.00
						Dr. Ehab Abu-Basha Fringe	$ -	$ -	$ -	$ -	$ -	$ -
8	8	8	8	8	$ 19,301.80	Hani Talafha, Biologist	$ 12,867.87	$ 12,867.87	$ 12,867.87	$ 12,867.87	$ 12,867.87	$ 64,339.33
						Hani Talafha Fringe	$ -	$ -	$ -	$ -	$ -	$ -
2	12	12	12	12	$ 32,520.00	Zaidoun Hijazeen, Veterinarian	$ 5,420.00	$ 32,520.00	$ 32,520.00	$ 32,520.00	$ 32,520.00	$ 135,500.00
						Zaidoun Hijazeen Fringe	$ -	$ -	$ -	$ -	$ -	$ -
3	3	3	3	3	$ 54,391.53	Mustafa Ababneh, Virologist/Lab Director	$ 13,597.88	$ 13,597.88	$ 13,597.88	$ 13,597.88	$ 13,597.88	$ 67,989.41
						Mustafa Ababneh Fringe	$ -	$ -	$ -	$ -	$ -	$ -
2.5	2.5	2.5	2.5	2.5	$ 57,903.18	Zuhair Bani Ismail, Livestock ID Expert	$ 12,063.16	$ 12,063.16	$ 12,063.16	$ 12,063.16	$ 12,063.16	$ 60,315.81
						Zuhair Bani Ismail Fringe	$ -	$ -	$ -	$ -	$ -	$ -
3	3	3	3	3	$ 69,597.00	Borhan Al-zoghoul, Molecular Biologist/Lab Director	$ 17,399.25	$ 17,399.25	$ 17,399.25	$ 17,399.25	$ 17,399.25	$ 86,996.25
						Borhan Al-zoghoul Fringe	$ -	$ -	$ -	$ -	$ -	$ -
3	3	3	3	3	$ 23,112.00	Bilal Al-Omari, Lab Supervisor	$ 5,778.00	$ 5,778.00	$ 5,778.00	$ 5,778.00	$ 5,778.00	$ 28,890.00
						Bilal Al-Omari Fringe	$ -	$ -	$ -	$ -	$ -	$ -
1	1	-	1	1	$ 177,018.63	Wail Hayajneh, Human ID Expert	$ 14,751.55	$ 14,751.55	$ 14,751.55	$ 14,751.55	$ 14,751.55	$ 73,757.76
						Wail Hayajneh Fringe	$ -	$ -	$ -	$ -	$ -	$ -
				Fringe Rate-->		Total Senior/Key Personnel	$ 209,817.71	$ 236,917.71	$ 236,917.71	$ 236,917.71	$ 236,917.71	$ 1,157,488.57
						B. Other Personnel						
1	1	-	2	2	$ 58,241.66	Saad Gharaibeh, Avian Pathologist	$ 4,853.47	$ 4,853.47	$ 4,853.47	$ 9,706.94	$ 9,706.94	$ 33,974.30
						Saad Gharaibeh Fringe	$ -	$ -	$ -	$ -	$ -	$ -
3.5	3.5	3.5	3.5	3.5	$ 28,219.16	Admin	$ 8,230.59	$ 8,230.59	$ 8,230.59	$ 8,230.59	$ 8,230.59	$ 41,152.94
						Admin Fringe	$ -	$ -	$ -	$ -	$ -	$ -
2	4	4	3	0	$ 47,860.32	Nurses (x2)	$ 15,953.44	$ 31,906.88	$ 31,906.88	$ 23,930.16	$ -	$ 103,697.36
12	12	12	12	12	$ 2,538.84	Undergrad Student Stipends (x2)	$ 5,077.68	$ 5,077.68	$ 5,077.68	$ 5,077.68	$ 5,077.68	$ 25,388.40
12	12	12	12	12	$ 3,385.08	Graduate Student Stipends (x2)	$ 6,770.16	$ 6,770.16	$ 6,770.16	$ 6,770.16	$ 6,770.16	$ 33,850.80
				Fringe Rate-->		Total Other Personnel	$ 40,885.34	$ 56,838.78	$ 56,838.78	$ 53,715.53	$ 29,785.37	$ 204,089.50
						C. Equipment						
						Vehicle	$ 37,150.00	$ 1,830.00	$ 1,830.00	$ 1,830.00	$ 1,830.00	$ 44,470.00
						Luminescence plate reader	$ 28,846.00					
						Total Equipment	$ 65,996.00	$ 1,830.00	$ 1,830.00	$ 1,830.00	$ 1,830.00	$ 73,316.00
						D. Travel						
						1. Domestic Travel	$ 40,108.00	$ 62,626.00	$ 62,626.00	$ 51,367.00	$ 12,360.00	$ 229,087.00
						2. Foreign Travel	$ 37,433.50	$ 26,890.00	$ 26,890.00	$ 26,890.00	$ 29,915.50	$ 148,019.00
						Total Travel	$ 77,541.50	$ 89,516.00	$ 89,516.00	$ 78,257.00	$ 42,275.50	$ 377,106.00
						E. Participant/Trainee Support Costs						
						1. Tuition/Fees/Health Insurance						$ -
						2. Stipends						$ -
						3. Travel						$ -
						4. Subsistence						$ -
						5. Other						$ -
						Total Participant/Trainee Support Costs	$ -	$ -	$ -	$ -	$ -	$ -
						F. Other Direct Costs						
						1. Materials and Supplies	$ 36,933.96	$ 18,784.77	$ 7,666.97	$ 10,255.19	$ -	$ 73,640.89
						2. Publication Costs						$ -
						3. Consultant Services						$ -
						4. ADP/Computer Services						$ -
						5. Subawards/Consortium/Contractual Costs						$ -
						6. Equipment or Facility Rental/User Fees						$ -
						7. Alterations and Renovations						$ -
						8. Other - Testing	$ 53,500.00	$ 53,500.00	$ 77,500.00	$ 65,500.00	$ -	$ 250,000.00
						9. Other - Meetings and Conferences	$ 27,589.08	$ 39,205.05	$ 17,366.69	$ 39,205.05	$ 91,885.27	$ 215,251.14
						Total Other Direct Costs	$ 118,023.04	$ 111,489.82	$ 102,533.66	$ 114,960.24	$ 91,885.27	$ 538,892.03
						G. Direct Costs and Modified Direct Costs						
						Direct Costs	$ 512,263.59	$ 496,592.31	$ 487,636.15	$ 485,680.49	$ 402,693.86	$ 2,384,866.40
						Modified Direct Costs						$ -
						H. Indirect Costs						
				IDC Rate-->	8%	1. Indirect Cost Type	$ 40,981.09	$ 39,727.39	$ 39,010.89	$ 38,854.44	$ 32,215.51	$ 190,789.31
				IDC Rate-->		2. Indirect Cost Type						$ -
						I. Total Direct and Indirect Costs						
						Direct + Indirect	$ 553,244.68	$ 536,319.70	$ 526,647.05	$ 524,534.92	$ 434,909.36	
						J. Fee						
						Fee						
						K. Total Costs and Fee						
						Total Costs	$ 553,244.68	$ 536,319.70	$ 526,647.05	$ 524,534.92	$ 434,909.36	$ 2,575,655.72

International Travel						TOTAL
International Conferences (MED Venue)						
Hotel Max Per Diem	$ 3,276	$ 3,276	$ 3,276	$ 3,276	$ 3,276	
Meals and Incidental Expenses Per Diem	$ 1,680	$ 1,680	$ 1,680	$ 1,680	$ 1,680	
Taxi Est. [illegible]	$ 1,020.00	$ 1,020.00	$ 1,020.00	$ 1,020.00	$ 1,020.00	
Flight Estimate	$ 3,192	$ 3,192	$ 3,192	$ 3,192	$ 3,192	
No. Days	4	4	4	4	4	
No. Trips per Year	4	4	4	4	4	
Total	$ 9,168.00	$ 9,168.00	$ 9,168.00	$ 9,168.00	$ 9,168.00	$ 45,840.00
Regional Conferences (EMID Istanbul)						
Hotel Max Per Diem	$ 3,691	$ 3,588	$ 3,588	$ 3,588	$ 4,485	
Meals and Incidental Expenses Per Diem	$ 1,376	$ 1,834	$ 1,834	$ 1,834	$ 2,293	
Taxi Est. [illegible]	$ 765.00	$ 1,020.00	$ 1,020.00	$ 1,020.00	$ 1,275.00	
Flight Estimate	$ 1,698	$ 2,264	$ 2,264	$ 2,264	$ 2,830	
No. Days	3	4	4	4	5	
No. Trips per Year	1	4	4	4	5	
Total	$ 6,529.50	$ 8,706.00	$ 8,706.00	$ 8,706.00	$ 10,882.50	$ 43,530.00
DTRA Mtg (VA)						
Hotel Max Per Diem	$ 1,290	$ 1,290	$ 1,290	$ 1,290	$ 1,290	
Meals and Incidental Expenses Per Diem	$ 416	$ 416	$ 416	$ 416	$ 416	
Taxi Est. [illegible]	$ 315.00	$ 315.00	$ 315.00	$ 315.00	$ 315.00	
Flight Estimate	$ 1,083	$ 1,083	$ 1,083	$ 1,083	$ 1,083	
No. Days	6	6	6	6	6	
No. Trips per Year	1	1	1	1	1	
Total	$ 3,096.00	$ 3,096.00	$ 3,096.00	$ 3,096.00	$ 3,096.00	$ 15,480.00
Training (Local) ([illegible] students)						
Hotel Max Per Diem	$ 5,103	$ -	$ -	$	$	
Meals and Incidental Expenses Per Diem	$ 3,822	$	$	$	$	
Taxi Est. [illegible]	$ 1,107.00	$	$	$	$	
Flight Estimate	$ 3,340	$	$	$	$	
No. Days	7	7	7	7	7	
No. Trips per Year	6	0	0	0	0	
Total	$ 13,569.00	$	$	$	$	$ 13,569.00

Conference Fees	$ 4,547.00	$ 5,396.00	$ 5,396.00	$ 5,396.00	$ 6,245.00	$ 26,980.00
Visa Fees	$ 524.00	$ 524.00	$ 524.00	$ 524.00	$ 524.00	$ 2,620.00
YEARLY TOTALS	$ 37,432.50	$ 26,596.00	$ 26,596.00	$ 26,596.00	$ 29,915.50	$ 148,019.00

	Y1	Y2	Y3	Y4	Y5	
VISA FEES						
Visa C (EU)	364	364	364	364	364	1820
[illegible] visa (Turkey)	160	160	160	160	160	800
Total Visas	524	524	524	524	524	2620
conference fees						
ISID 300	2000	2000	2000	2000	2000	10000
EMID 2017	2547	3396	3396	3396	4245	16980
Total Conferences	4547	5396	5396	5396	6245	26980

Annual Conference (Y1-OY2)		# People	# Days	
Hotel Max Per Diem	$ 246.00	10	2	$ 4,920.00
M&IE Expenses Per Diem	$ 138.00	10	2	$ 2,760.00
Domestic Transport	$ 414.30	10	1	$ 4,143.00
Printing/Supplies	$ 140.00	1	1	$ 140.00
Translation and Sound	$ 1,974.64	1	1	$ 1,974.64
Room Rental	$ 1,350.00	1	1	$ 1,350.00
Lunch and Coffee	$ 46.00	45	1	$ 2,070.00
				$ 17,357.64

KickOff Meeting (Y1 Only)		# People	# Days	
Hotel Max Per Diem	$ 246.00	5	2	$ 2,460.00
M&IE Expenses Per Diem	$ 138.00	5	2	$ 1,380.00
Domestic Transport	$ 414.31	5	1	$ 2,071.55
Printing/Supplies	$ 65.80	1	1	$ 65.80
Translation and Sound	$ 1,974.64	1	1	$ 1,974.64
Room Rental	$ 1,350.00	1	1	$ 1,350.00
Lunch and Coffee	$ 46.00	20	1	$ 920.00
				$ 10,221.99

Regional Meeting (Y2, OY1, OY2 ONLY)		# People	# Days	
Regional Transport - Egypt	$ 350.00	2	1	$ 700.00
Regional Transport - Lebanon	$ 409.00	2	1	$ 818.00
Regional Transport - Iraq	$ 493.00	2	1	$ 986.00
Hotel Max Per Diem	$ 246.00	6	[illegible]	$ [illegible]
M&IE Expenses Per Diem	$ 138.00	6	[illegible]	$ [illegible]
Translation and Sound	$ 1,974.64	1	3	$ 5,923.92
Room Rental	$ 1,350.00	1	3	$ 4,050.00
Lunch and Coffee	$ 46.02	24	3	$ 3,313.44
				$ [illegible]

Threat Reduction Workshop (OY2)		# People	# Days	
Hotel Max Per Diem	$ 246.00	22	4	$ 21,648.00
M&IE Expenses Per Diem	$ 138.00	10	4	$ 5,520.00
Domestic Transport	$ 414.30	10	1	$ 4,143.00
Printing/Supplies	$ 1,974.50	1	1	$ 1,974.50
Translation and Sound	$ 1,974.64	1	3	$ 5,923.92
Room Rental	$ 1,350.00	1	3	$ 4,050.00
Lunch and Coffee	$ 46.02	45	3	$ 6,212.70
Regional Transport - Lebanon	$ 409.00	4	1	$ 1,636.00
Regional Transport - Iraq	$ 493.00	4	1	$ 1,972.00
				$ 53,080.12

	Y1	Y2	Y3	OY1	OY2
Meetings/Conference Costs	$ 27,579.63	$ [illegible]	$ 17,357.64	$ [illegible]	$ [illegible]

Field Travel Costs	Y1	Y2	Y3	OY1	OY2
Food/Lodging Per Diems	$ 15,000.00	$ 30,000.00	$ 30,000.00	$ 22,500.00	$
Fuel	$ 4,990.00	$ 4,990.00	$ 4,990.00	$ 4,990.00	$ 1,360.00
Vehicle Maintenance Costs	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00
Tokens of Appreciation	$ 19,318.00	$ 27,096.00	$ 27,096.00	$ 23,277.00	$ 10,000.00
TOTAL	$ 40,308.00	$ 63,086.00	$ 63,086.00	$ 51,767.00	$ 12,360.00

Food/Lodging Per Diems	Y1	Y2	Y3	OY1	OY2	
# trips	2	4	4	3	0	
Per Diem	300	300	300	300	300	(3 field, 1-3 nurses or students)
# days	5	5	5	5	5	
# Staff	5	5	5	5	5	
Total	$ 15,000.00	$ 30,000.00	$ 30,000.00	$ 22,500.00	0	
Tokens of Appreciation - Humans	Y1	Y2	Y3	OY1	OY2	
# Samples/ Qtr	300	300	300	300	300	
# Quarters	2	4	4	1	0	
Sampling supplies	$ 1.25	$ 1.25	$ 1.25	$ 1.25	$ 1.25	
Prepaid phone card	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	[illegible]
Total	$ 7,318.00	$ 15,096.00	$ 15,096.00	$ 11,277.00	$	
Tokens of Appreciation - Camels/Poultry	Y1	Y2	Y3	OY1	OY2	
# Samples/ Qtr	60	60	60	60	30	30 owners of each type animal
# Quarters	2	2	2	2	2	sampling quarterly, taken every other visit
Price of drugs/supplies	$ 100.00	$ 100.00	$ 100.00	$ 100.00	$ 100.00	
Total	$ 12,000.00	$ 12,000.00	$ 12,000.00	$ 12,000.00	$ [illegible]	

Sites	[illegible]	[illegible]	$/l	Total
A. [illegible]	175	17.5	$ 1.53	$ 26.78
A. Zinga	58.2	5.82	$ 1.53	$ 8.90
A. [illegible]	262	26.2	$ 1.53	$ 40.09
Mala	438	43.8	$ 1.53	$ 67.01
Acaba	668	66.8	$ 1.53	$ 102.20
				$ 244.98
	30000	3000	$ 1.53	$ 4,590.00

Field Supplies			Y1		Y2		Y3		OY1		OY2	
Type	Units/Price	Price	Qy Needed	Total	Qy Needed	Total	Qy Needed	Total	Qy Needed	Total	Qy Needed	Total
Nunc 1.8 internal cryovials	450	$ 516.42	12	$ 6,197.04	17	$ 8,779.14	8	$ 4,131.36	10	$ 5,164.20		
Serum tubes 10 mL	100	$ 31.09	25	$ 777.25	23	$ 715.07	12	$ 373.08	12	$ 373.08		
Serum tubes 3 mL	100	$ 27.31	2	$ 54.62	0	$ -	1	$ 27.31		$ -		
Vaccutatiner holder	250	$ 20.77	50	$ 1,038.50	50	$ 1,038.50		$ -		$ -		
21g 1in vacutainer safety needles	48	$ 39.92	30	$ 1,197.60	28	$ 1,117.76	15	$ 598.80	14	$ 558.88		
18g 1in vacutainer needles	100	$ 32.19	5	$ 160.95	5	$ 160.95	3	$ 96.57	2	$ 64.38		
3cc luer lock syringe	100	$ 21.80	2	$ 43.60		$	1	$ 21.80		$		
22g 1in needle	100	$ 19.80	2	$ 39.60		$ -	1	$ 19.80		$ -		
Cotton Swabs	500	$ 400.00	5	$ 2,000.00	10	$ 4,000.00	0	$	5	$ 2,000.00		
Gloves	50	$ 29.65	7	$ 207.55	14	$ 415.10	0	$ -	6	$ 177.90	0	$ -
Masks N95	50	$ 47.75	7	$ 334.25	7	$ 334.25	7	$ 334.25	5	$ 238.75	0	$
Tyvek Suits (project supply)	25	$ 350.00	52	$ 18,200.00	0	$ -	0	$ -	0	$ -	0	$ -
Googgles (project supply)	12	$ 135.00	2	$ 270.00	0	$ -	0	$ -	0	$ -	0	$ -
Booties (project supply)	200	$ 300.00	7	$ 2,100.00	0	$ -	0	$ -	0	$ -	0	$ -
Biohazard Bag (project supply)	200	$ 155.00	2	$ 310.00	0	$ -	0	$ -	0	$ -	0	$ -
Sharps Container	20	$ 200.00	1	$ 200.00	1	$ 200.00	1	$ 200.00	1	$ 200.00		$ -
Alcohol Swabs	1200	$ 32.00	4	$ 128.00	7	$ 224.00	2	$ 64.00	4	$ 128.00		$ -
Tablets	1	$ 200.00	5	$ 1,000.00		$		$		$		$
Dry Ice	1 week	$ 150.00	6	$ 900.00	12	$ 1,800.00	12	$ 1,800.00	9	$ 1,350.00		$ -
Eye wash station	1	$ 275.00	1	$ 275.00		$		$		$		$
Card reader system		$ 1,500.00	1	$ 1,500.00		$ -		$ -		$ -		$ -
TOTALS				**$ 36,933.96**		**$ 18,784.77**		**$ 7,666.97**		**$ 10,255.19**		**$ -**

Nunc 1.8 internal cryovials	PCRs - 2 swabs/animal or person
Serum tubes 10 mL	1 per human, 2 per animal serology
Serum tubes 3 mL	1 per chicken serology
Vaccutatiner holder	100
21g 1in vacutainer safety needles	1 per human serology
18g 1in vacutainer needles	1 per camel serology
3cc luer lock syringe	1 per chicken serology
22g 1in needle	1 per chicken serology
Cotton Swabs	PCRs - 2 swabs/animal or person

	YEAR 1			YEAR 2			YEAR 3			OPTION YEAR 1			OPTION YEAR 2		
TESTS	# Y1	Price	Total	# Y2	Price	Total	# Y3	Price	Total	# OY1	Price	Total	# OY2	Price	Total
MERS PCR Humans	600	$ 15.00	$ 9,000.00	1200	$ 15.00	$ 18,000.00	1200	$ 15.00	$ 18,000.00	900	$ 15.00	$ 13,500.00		$ 15.00	$ -
MERS PCR camels	200	$ 15.00	$ 3,000.00	400	$ 15.00	$ 6,000.00	400	$ 15.00	$ 6,000.00	300	$ 15.00	$ 4,500.00		$ 15.00	$ -
MERS PCR Sequencing of positives	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00		$ 100.00	$ -
A PCR Humans	600	$ 15.00	$ 9,000.00	1200	$ 15.00	$ 18,000.00	1200	$ 15.00	$ 18,000.00	900	$ 15.00	$ 13,500.00		$ 15.00	$ -
A PCR poultry	200	$ 15.00	$ 3,000.00	400	$ 15.00	$ 6,000.00	400	$ 15.00	$ 6,000.00	300	$ 15.00	$ 4,500.00		$ 15.00	$
A PCR Sequencing of positives	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00		$ 100.00	$
MERS Serology Humans RP	330	$ 40.00	$ 13,200.00	0	$ 40.00	$ -	330	$ 40.00	$ 13,200.00	330	$ 40.00	$ 13,200.00			
MERS Serology camels ELIZA	100	$ 15.00	$ 1,500.00	0	$ 15.00	$ -	100	$ 15.00	$ 1,500.00	100	$ 15.00	$ 1,500.00		$ 15.00	$ -
A serology humans	300	$ 6.00	$ 1,800.00	0	$ 6.00	$ -	300	$ 6.00	$ 1,800.00	300	$ 6.00	$ 1,800.00		$ 6.00	$ -
A serology poultry	100	$ 6.00	$ 600.00	0	$ 6.00	$	100	$ 6.00	$ 600.00	100	$ 6.00	$ 600.00		$ 6.00	$
A serology Subtype Tesing	100	$ 15.00	$ 1,500.00	100	$ 15.00	$ 1,500.00	100	$ 15.00	$ 1,500.00	100	$ 15.00	$ 1,500.00		$ 15.00	$ -
Brucella serology humans	300	$ 1.00	$ 300.00	0	$ 1.00	$ -	300	$ 1.00	$ 300.00	300	$ 1.00	$ 300.00		$ 1.00	$ -
Brucella serology camels	100	$ 1.00	$ 100.00	0	$ 1.00	$ -	100	$ 1.00	$ 100.00	100	$ 1.00	$ 100.00		$ 1.00	$ -
Brucella serology other ruminants	100	$ 1.00	$ 100.00	0	$ 1.00	$	100	$ 1.00	$ 100.00	100	$ 1.00	$ 100.00		$ 1.00	$
Brucella Complement Fixation Test	100	$ 10.00	$ 1,000.00	0	$ 10.00	$	100	$ 10.00	$ 1,000.00	100	$ 10.00	$ 1,000.00	0	$ 10.00	$
Lepto serology humans	400	$ 8.00	$ 3,200.00	0	$ 8.00	$ -	400	$ 8.00	$ 3,200.00	400	$ 8.00	$ 3,200.00		$ 8.00	$ -
Lepto serology camels	100	$ 8.00	$ 800.00	0	$ 8.00	$ -	100	$ 8.00	$ 800.00	100	$ 8.00	$ 800.00		$ 8.00	$ -
Lepto serology other ruminants	100	$ 8.00	$ 800.00	0	$ 8.00	$ -	100	$ 8.00	$ 800.00	100	$ 8.00	$ 800.00		$ 8.00	$ -
Lepto Serovar Test	60	$ 10.00	$ 600.00	0	$ 10.00	$	60	$ 10.00	$ 600.00	60	$ 10.00	$ 600.00	0	$ 10.00	$
Lepto PCR humans			$ -			$ -			$ -			$ -			$ -
Lepto PCR camels			$ -			$ -			$ -			$ -			$ -
Lepto PCR other ruminants			$ -			$ -			$ -			$ -			$ -
			$ -			$ -			$ -			$ -			$ -
		Y1 Total	$ 53,500.00		Y2 Total	$ 53,500.00		Y3 Total	$ 77,500.00		OY1 Total	$ 65,500.00		OY2 Total	$ -

<mailt(b)(6)

Subject: Re: [Non-DoD Source] FRBA14-6-2-0471 Clarifications

All active links contained in this email were disabled. Please verify the identity of the sender, and confirm the authenticity of all links contained within the message prior to copying and pasting the address to a Web browser.

Much appreciated(b)(6)

I cannot imagine how you get through all these documents. We only have a few proposals/awards to justify and it seems like an enormous task for us!

If I may help you quickly locate certain documents in our forms and files, please call or text my handphone anytime day or night.

Many thanks again!

-Aleksei

Aleksei Chmura, PhD
Chief of Staff

EcoHealth Alliance
520 Eighth Avenue, Suite 1200
New York, NY 10018-4182

(b)(6) > (mobile)
Caution-www.ecohealthalliance.org <http://caution-www.ecohealthalliance.org/> <
Caution-http://www.ecohealthalliance.org >

EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation.

On Sep 2, 2020, at 12:17,(b)(6)
<mailto:(b)(6) > wrote:

Yes , they were received. Thank you

-----Original Message-----
From: William B. Karesh <karesh@ecohealthalliance.org <mailto:karesh@ecohealthalliance.org> <
Caution-mailto:karesh@ecohealthalliance.org > >
Sent: Wednesday, September 2, 2020 11:16 AM
To(b)(6)
<mailto(b)(6)>
Cc: Aleksei Chmura <chmura@ecohealthalliance.org <mailto:chmura@ecohealthalliance.org> <
Caution-mailto:chmura@ecohealthalliance.org > >
Subject: Fwd: [Non-DoD Source] FRBA14-6-2-0471 Clarifications

All active links contained in this email were disabled. Please verify the identity of the sender, and confirm the authenticity of all links contained within the message prior to copying and pasting the address to a Web browser.

Dear (b)(6)

I just wanted to confirm that you received the email below earlier this week.

Thanks!!

William B. Karesh, D.V.M
Executive Vice President for Health and Policy

EcoHealth Alliance
520 Eighth Avenue, Suite 1200
New York, NY 10018 USA

+1.212.380.4463 (direct)
+1.212.380.4465 (fax)
Caution-Caution-www.ecohealthalliance.org <http://caution-caution-www.ecohealthalliance.org/> < Caution-http://caution-Caution-www.ecohealthalliance.org/ > < Caution-Caution-mailto:karesh@ecohealthalliance.org < Caution-mailto:karesh@ecohealthalliance.org > >

President, OIE Working Group on Wildlife

Co-chair, IUCN Species Survival Commission - Wildlife Health Specialist Group

EPT Partners Liaison, USAID Emerging Pandemic Threats - PREDICT-2 Program

EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation.

Begin forwarded message:

From:Aleksei Chmura <chmura@ecohealthalliance.org <mailto:chmura@ecohealthalliance.org> < Caution-mailto:chmura@ecohealthalliance.org > < Caution-Caution-mailto:chmura@ecohealthalliance.org < Caution-mailto:chmura@ecohealthalliance.org > > >

Subject:Re: [Non-DoD Source] FRBA14-6-2-0471 Clarifications

Date:August 30, 2020 at 8:14:36 PM EDT

To(b)(6)
<mailto aution-
Caution > >

Cc(b)(6)
<mailto aution-
Caution > >, Billy Karesh <karesh@ecohealthalliance.org <mailto:karesh@ecohealthalliance.org> < Caution-mailto:karesh@ecohealthalliance.org > < Caution-Caution-mailto:karesh@ecohealthalliance.org < Caution-mailto:karesh@ecohealthalliance.org > > >, Whitney Bagge <bagge@ecohealthalliance.org <mailto:bagge@ecohealthalliance.org> < Caution-mailto:bagge@ecohealthalliance.org > < Caution-Caution-mailto:bagge@ecohealthalliance.org < Caution-mailto:bagge@ecohealthalliance.org > > >, Catherine Machalaba <machalaba@ecohealthalliance.org <mailto:machalaba@ecohealthalliance.org> < Caution-mailto:machalaba@ecohealthalliance.org > < Caution-Caution-mailto:machalaba@ecohealthalliance.org < Caution-mailto:machalaba@ecohealthalliance.org > > >, Joe Riccardi <riccardi@ecohealthalliance.org <mailto:riccardi@ecohealthalliance.org> < Caution-mailto:riccardi@ecohealthalliance.org > < Caution-Caution-mailto:riccardi@ecohealthalliance.org < Caution-mailto:riccardi@ecohealthalliance.org > > >

Dear(b)(6)

Please find attached seven files:

1) FRBAA14-6-2-0471_Clarifications_FINAL.xlsx
2) EHA Budget Justification_FINAL.docx
3) EHA Documentation_FINAL.pdf
4) Human Link Budget Justification_FINAL.docx
5) Human Link Documentation_FINAL.pdf
6) JUST Budget Justification_FINAL.docx
7) JUST Documentation_FINAL.pdf

There are three sets of paired files with the requested documentation (PDFs) and track-change budget justifications (MS Word) for EcoHealth Alliance and our two subcontracts under this proposal. We have also included the clarifications (MS Excel) with responses to the specific questions in each tab.

Please let me know, if there are additional questions or any other documentation is required.

Many thanks!

-Aleksei

Aleksei Chmura, PhD
Chief of Staff &
Authorized Organizational Representative

EcoHealth Alliance
520 Eighth Avenue, Suite 1200
New York, NY 10018-4182

+1.212.380.4473 < tel:1.212.380.4469 < tel:1.212.380.4469 > > (office)
(b)(6) > > (mobile)
Caution-Caution-www.ecohealthalliance.org <http://caution-caution-www.ecohealthalliance.org/> < Caution-http://caution-Caution-www.ecohealthalliance.org/ > < Caution-Caution-http://www.ecohealthalliance.org/ < caution-Caution-http://www.ecohealthalliance.org/ > >

EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation.

From: (b)(6)
To: "William B. Karesh"; "Aleksei Chmura"
Cc: (b)(6)
(USA); DTRA Ft Belvoir SI Mailbox SI-FMKA SPS Contracts; "onr_boston@navy.mil"; (b)(6)
(b)(6)
Subject: Jordan Award
Date: Tuesday, September 29, 2020 4:22:00 PM
Attachments: Terms and Conditions (DTRA-specific)_14Sep2020 FINAL.pdf
HDTRA1-20-1-0029 Award.pdf
EHA Jordan SOW.pdf

Attached you will find the award documentation for grant HDTRA1-20-1-0029: Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan & Strengthening Regional Disease Surveillance Capacity. Please confirm once you have received this email, thank you.

V/r

(b)(6)

Contract Specialist ▪ Broadleaf

Defense Threat Reduction Agency (DTRA)

Office Phone (b)(6)

(b)(6)

DEFENSE THREAT REDUCTION AGENCY (DTRA)
GENERAL TERMS AND CONDITIONS FOR GRANT AWARDS

Table of Contents

1. Terms and Conditions Incorporated by Reference.

The DoD Research and Development General Terms and Conditions, most current version as of the date of grant award, are hereby incorporated by reference and are available for download at website http://www.onr.navy.mil/Contracts-Grants/submit-proposal/grants-proposal/grants-terms-conditions.aspx.

2. Acceptance of Grant.

The recipient is not required to countersign the Grant document; however, the recipient agrees to the conditions specified in the Research Grant and the Articles contained herein unless notice of disagreement is furnished to the Grants Officer within fifteen (15) calendar days after the date of the Grants Officer's signature. In case of disagreement, the recipient shall not assess the Grant any costs of the research unless and until such disagreement(s) is resolved.

3. Recipient Responsibilities.

The recipient will bear primary responsibility for the conduct of the research and will exercise judgment towards attaining the stated research objectives within the limits of the Grant's Terms and Conditions.

The Principal Investigator(s) (PI) specified in the Grant award will be continuously responsible for the conduct of the research project and will be closely involved with the research effort. The PI, operating within the policies of the recipient, is in the best position to determine the means by which the research may be conducted most effectively.

4. Standards for Financial Management Systems.

Where the Federal Government guarantees or insures the repayment of money borrowed by the recipient, DTRA, at its discretion, may require adequate bonding and insurance if the bonding and insurance requirements of the recipient are not deemed adequate to protect the interest of the Federal Government.

DTRA may require adequate fidelity bond coverage where the recipient lacks sufficient coverage to protect the Federal Government's interest.

Where bonds are required in the situations described above, the bonds shall be obtained from companies holding certificates of authority as acceptable sureties, as prescribed in 31 CFR Part 223, "Surety Companies Doing Business with the United States."

5. Modification of the Grant.

The only method by which this Grant may be modified is by a formal, written modification signed by the Grants Officer. No other communications, whether oral or in writing, are valid.

Prior Approvals are required as follows:

1) Expenditures on equipment costing $5,000 or more not specifically identified in the budget at time of award. (Approval via written notification from the Grants Officer.)
2) Expenditures for foreign travel not specifically identified in the budget at time of award. (Approval via written notification from the Grants Officer.)

3) Prior approval is not required to transfer amounts budgeted for indirect costs to absorb increases in direct costs, or vice versa.
4) Prior approval is not required to carry forward an unobligated balance to a subsequent period of performance under this award.

6. Payments.

The 2 CFR 200 governs responsibilities concerning payments, with the following clarifications:

Recipients shall submit requests for payment using Invoicing, Receipt, Acceptance, and Property Transfer (iRAPT) at https://wawf.eb.mil/. Any request for advance payments must be approved by the Administrative Grants Office shown in Block 6 of the award. The request shall be submitted to the Administrative Office identified in Block 6 of the Research Grant by entering the following routing codes:

1) *Pay Office DoDAAC*: See Block 12 (Code) on the first page of the Grant.
2) *Invoice Type*: Non Procurement Instrument (NPI) Voucher.
3) *Issue By DoDAAC*: See Block 5 (Code) on the first page of the Grant.
4) *Admin DoDAAC*: See Block 6 (Code) on the first page of the Grant.
5) *Grant Approver*: Same as Admin DoDAAC (Leave Ext. blank).

Payments will be made by the Defense Finance and Accounting Service (DFAS) office specified in the Research Grant (Block 12).

A foreign awardee must have a U.S. bank account and be signed up for electronic payments (electronic funds transfers (EFT)).

7. Funding Increments and/or Options.

The recipient is advised that the Grantor's obligation to provide funding for increments and/or options included in the Grant is contingent upon satisfactory performance in the judgment of the DTRA Scientific Officer/Technical Monitor and the availability of funds. Other factors will be considered before options will be exercised (for example, expenditure rate and current programmatic objectives). Accordingly, no legal liability on the part of the Grantor exists unless or until funds are made available to the Grantor and notice of such availability is confirmed in writing to the recipient. Refer to the Funding Profile in Section G of the Grant for additional incremental funding planned, but not currently obligated for the Grant.

Funding Increments – In no event is the Government obligated to reimburse the recipient for expenditures in excess of the total funds allotted by the Government to this agreement. Recipients should note that low expenditure rates reported on payment requests may be cause for deferral of future increments. The Government anticipates unilateral modifications for funding increments.

Options – If the agreement contains Option(s), the Government reserves the right to exercise the Option(s) unilaterally.

8. Patent Rights.

Patent Rights are governed by 37 CFR 401.14 with the following clarifications: All DTRA-related disclosures, confirmatory licenses to the government, patent applications, and other communications should be submitted using iEdison (https://public.era.nih.gov/iedison), a single web interface for government grantees to report details of inventions and patents. .

The 37 CFR Part 401 invention reporting requirements are summarized at iEdison (https://era.nih.gov/iedison/invention_timeline.htm). If the grantee organization is not already an iEdison registrant, then iEdison registration is required prior to submission of the below invention reports. The grant shall not be closed out until all invention reporting requirements are met.

The recipient shall also submit interim and final Reports of Inventions using the DD882 form (https://www.arl.army.mil/www/pages/218/d882.pdf). Interim invention reports shall be submitted annually, listing subject inventions reported during that period or that there are no such inventions. These reports are due no later than 1 July of each year. Grants effective after 31 January will not require a report until 1 July the following year. A final report shall be submitted within ninety (90) days after end of the project, listing all subject inventions or stating that there were no such inventions. These Reports of Inventions should be submitted to:

1) The DTRA Grants Officer via email (the address specified in the grant's clause 252.601-9000 may be used);
2) The Administrative Officer listed in the Grant via email (Block 6 of the SF-26 award or Block 7 of the SF-30 modification);
3) As directed by DTRA, email or portal; and
4) E-mailed to dtrabasicresearch@mail.mil (file size must be less than 10MB). File should be named by the Grant number and "Invention Report" (e.g. HDTRA1-12-1-9999 Invention Report).

9. Technical Reporting Requirements.

Research Performance Progress Report (RPPR). Except under rare cases, RPPRs are required annually. The RPPR is due no later than 1 July of each year. Grants effective after 31 January will not require a RPPR until 1 July of the following year.

The RPPR is *not* a cumulative report. The first RPPR shall only include actions that occurred from the Period of Performance start date up to submission of the first RPPR. Each subsequent report shall only include actions that occurred during the 12-month period following the previous year's RPPR.

A RPPR is not required in the final year of the award if the period of performance ends within 60 days of the RPPR due date. In this instance the Final Report will satisfy the requirement. Broadly the RPPR shall address the following items:

- Accomplishments
- Products
- Participants and Other Collaborating Organizations

- Impact
- Changes/Problems

Templates and specific instructions will be provided each year in advance of the submission deadline. All files must be submitted via email to dtrabasicresearch@mail.mil (individual file size must be less than 10MB). A copy of the RPPR should also be provided to the Administrative Office identified in the Grant. The file names should be as follows:

- RPPR: Year Annual Report Grant Number, e.g. 2017 Annual Report HDTRA1-12-1-9999.
- Metrics: Year Metrics Grant Number, e.g. 2017 Metrics HDTRA1-12-1-9999.

Quad Chart. An updated quad chart must be submitted annually. A template will be provided each year in advance of the submission deadline. All files must be submitted via email to dtrabasicresearch@mail.mil (individual file size must be less than 10MB). The file name should be as follows:

- Quad Chart: Year Quad Chart Grant Number, e.g. 2017 Quad Chart HDTRA1-12-1-9999.

Annual Technical Review. At least one representative (preferably the PI) for each award is expected to attend and present at an annual technical program review meeting, unless otherwise exempted by DTRA in writing. For planning purposes reviews will typically be for two days in Northern Virginia during the spring or summer months.

Final Technical Report. A comprehensive final technical report is required: the draft document is required forty-five (45) days prior to the end of the Period of Performance and the final document is required ninety (90) days after the expiration or termination of the award.

The purpose of the final report is to document and to transition the results of the effort into the DTRA and DoD applied research community. The final report will always be sent to the Defense Technical Information Center (DTIC) and unclassified reports may be made available to the public through the National Technical Information Service (NTIS).

The final report is more than an extension of previous annual reports. The final report shall be a **comprehensive** technical summary of the significant work accomplished. The final report, where it is not readily accessible in published form should, where applicable:

- Clearly describe and illustrate the experimental equipment, setup, and procedures;
- Characterize and tabulate collected/computed data in an appendix;
- Sufficiently describe computational codes so they can be reproduced. Include a listing of the code in an appendix if possible and appropriate; and
- When the research effort culminates in the production of one or more student theses or dissertations, in these cases, the most significant advancements and conclusions (equations, figures, relationships, etc.) should be included in an executive summary. The theses or dissertations should be attached as appendices only if they are not readily available. If they are, clearly reference them and how they can be obtained. Also include in the executive summary, cumulative lists of people involved in, and publications

stemming from, the research effort. Do not include copies of already submitted or published articles in the final report.

Standard Form (SF) 298, Report Documentation Page, must be used. Item 13 of the SF-298 should contain a 100 to 200 word abstract summarizing technical progress during the reporting period. The SF-298 may be found on the Internet at: http://www.gsa.gov/portal/forms/download/116146

All of the report pages should be prepared for acquisition and distribution by DTIC. All of the report pages should be of good quality for copying purposes. No pages should be missing.

The format and standard required by your institution for the preparation of theses and dissertations shall be used for the final report. In the absence of any institutional standards, you may wish to refer to the American National Standards Institute (ANSI) document Z39.18-1987, "Scientific and Technical Reports: Organization, Preparation, and Production," for guidance. The report may be obtained from:

American National Standards Institute, Inc.
1430 Broadway
New York, NY 10018

It is anticipated that all final technical reports will be unclassified and that distribution will not be limited. However, for final technical reports that require a limited distribution as deemed necessary by DTRA, a Distribution List will be provided with the comments on the draft final technical report. The Distribution List should be formatted to match the rest of the report, placed at the end of the report, and added to the Table of Contents. The number of pages in the Distribution List should be added to the total page count and included in the total number of pages cited in Block 15 of the SF-298.

The draft of the final technical report will be due not later than forty-five (45) days prior to the end of the period of performance. The draft of the final technical report (including a draft SF-298) must be submitted electronically as follows:

- Email the draft of the final technical report to dtrabasicresearch@mail.mil (file size must be less than 10MB). The file name should be 'Draft Final Report' and the Grant number, e.g. Draft Final Report HDTRA1-12-1-9999.
- Provide a copy of the report to the Administrative Office identified in the Grant.

Within thirty (30) days, this draft will be reviewed by DTRA and comments will be provided to the Grantee to ensure the report complies with DTRA final report requirements. Such review and comment does not restrict the conduct or reporting of the project research findings/outcomes and, in accordance with Article 35, does not restrict Grantee's ability to publish. Grantee shall incorporate such requested changes so that the report incorporates and complies with agreement final reporting requirements terms. Final Technical Reports are due ninety (90) days after the expiration or termination of the award. The final submission should be made in accordance with the draft final report submission instructions.

Final Metrics. A final metrics table (in MS Excel format) is required. A template and specific instructions will be provided in advance of the submission deadline. The final metrics file should be submitted along with the Final Technical Report. The fields contained in the final metrics file are analogous to those of the annual submissions. The final metrics file shall contain only data from the last annual reporting period until the end of the award's funded Period of Performance.

- Email the final Metrics File to dtrabasicresearch@mail.mil (file size must be less than 10MB). The file name should be 'Final Metrics' and the Grant number, e.g. Final Metrics HDTRA1-12-1-9999.

10. Financial Reporting Requirements.

Federal Financial Reports (SF-425) are due no later than 1 July of each year with data "as of" 30 May of that year. Grants effective after 31 January will not require a Federal Financial Report until 1 July of the following year. All financial reports shall be submitted to the Administration Office identified in Block 6 of the Research Grant. In addition, the Federal Financial Report must be submitted electronically as follows:

- Email the Federal Financial Report to dtrabasicresearch@mail.mil (file size must be less than 10MB). The file name should be the Year, 'Federal Financial Report' and the Grant number, e.g. 2015 Federal Financial Report HDTRA1-12-1-9999.

11. Delegation of Administration Duties.

Certain grant administration duties have been delegated to the Administration Office identified in Block 6 of the Research Grant. These duties are as follows:

1) Provisionally approve all Grant and Cooperative Agreement Vouchers.
2) Perform all property administration services except the approval of recipient's requests to purchase equipment with grant funds. Such approvals must be granted by the DTRA Grants Officer.
3) Perform all plant clearance functions.
4) Approve requests for Registration for Scientific and Technical Information Services (DD Form 1540).
5) Obtain all financial report(s) (see Article 10 of this document).
6) Execute administrative closeout procedures, which include the following:
   a. Obtain the final Report of Inventions and Subcontracts (DD Form 882).
   b. Obtain final payment request, if any.
   c. Obtain final property report and dispose of purchased property and government furnished equipment (GFE) in accordance with the DoDGARs Part 22, Subpart G.
   d. Perform a review of final incurred costs and assist the Grants Officer in resolving exceptions, if any, resulting from questioned costs.
   e. Assure that all refunds due the Government are received by the Grantor.

NOTE: This term and condition is **not applicable** to instrumentation and equipment grant awards.

12. Security.

As a general rule, PI's will not need access to classified security information in the conduct of research supported under this Grant. Should it appear that access to such information is desirable the recipient shall advise the Grantor and request clearance for the investigator. Should information be developed during the course of work under this Grant that, in the judgment of the PI or the recipient, should be classified, the Grants Officer shall be notified immediately.

13. Representations and Assurances.

By accepting funds under this Grant, the recipient assures that it will comply with applicable provisions of the national policies and statutory/regulatory/executive-based requirements detailed below.

LIVE ORGANISMS. By signing this agreement or accepting funds under this agreement, the recipient assures that it will comply with applicable provisions of the following national policies concerning live organisms:

1) For human subjects:

   a) Adhere to the requirements for protection of human subjects per the DoD level terms and conditions as well as the following DTRA requirements:
   b) The recipient shall adhere to DTRA local clause 252.223-9002 – Protection of Human Subjects (Aug 2010). The full text of this clause is as follows:

   All research under this grant involving human subjects must be conducted in accordance with 32 CFR 219, 10 U.S.C 980, and DoDD 3216.02, as well as other applicable federal and state regulations. Grantees must be cognizant of and abide by the additional restrictions and limitations imposed on the DoD regarding research involving human subjects, specifically as regards vulnerable populations (32 CFR 219 modifications to subparts B-D of 45 CFR 46), recruitment of military research subjects (32 CFR 219), and surrogate consent (10 U.S.C. 980).

   DTRA Directive 3216.01 of June 9, 2010 establishes the DTRA Human Subjects Protection Program, sets forth the policies, defines the applicable terms, and delineates the procedures necessary to ensure DTRA compliance with federal and DoD regulations and legislation governing human subject research. The regulations mandate that all DoD activities, components, and agencies protect the rights and welfare of human subjects of study in DoD-supported research, development, test and evaluation, and related activities hereafter referred to as "research". The requirement to comply with the regulations applies to new starts and to continuing research.

   The DTRA directive requires that research using human subjects may not begin or continue until the Defense Threat Reduction Agency's Research Oversight Board (ROB) has reviewed and approved the proposed protocol. Grantees and subcontractors are required to submit a valid federal assurance for their organization (institution, laboratory, facility) that has been issued by either DoD or the Department of Health and Human Services, and documentation of review of proposed protocols by the local Institutional Review Board (IRB) to include consent forms for any planned research using human subjects to the DTRA ROB for its review through the Grants Officer's representative (if assigned) or the Grants Officer. The ROB review is separate from, and in addition to, local IRB review.

   A study is considered to involve human research subjects if: 1) there is interaction with the subject (simply talking to the subject qualifies; no needles are required); and

2) if the study involves collection and/or analysis of personal/private information about an individual, or if material used in the study contains links to such information.

Written approval to begin research or subcontract for the use of human subjects under the proposed protocol will be provided in writing from the DTRA ROB, through the Grants Officer. A copy of this approval shall be maintained by both the Grantee and the government. Any proposed modifications or amendments to the approved protocol or consent forms must be submitted to the local IRB and the DTRA ROB for review and approval. Examples of modifications/ amendments to the protocol include but are not limited to:

- a change of the PI;
- changes in duration or intensity of exposure to some stimulus or agent;
- changes in the information requested of volunteers, or changes to the use of specimens or data collected; or
- changes in perceived or measured risks or benefits to volunteers that require changes to the study.

Research pursuant to such modifications or amendments shall not be initiated without IRB and ROB approval except when necessary to eliminate apparent and immediate hazards to the subject(s).

Research projects lasting more than one year require IRB review at least annually, or more frequently as required by the responsible IRB. ROB review and approval is required annually. The Grantee or subcontractor must provide documentation of continued IRB review of protocols for ROB review and approval in accordance with these Terms and Conditions. Research must not continue without renewed ROB approval unless necessary to eliminate apparent and immediate hazards to the subject(s).

Non-compliance with any provision of this clause may result in withholding of payments under the grant pursuant to the grant's payments clause(s) and/or grant termination pursuant to the grant's termination clause(s). The government shall not be responsible for any costs incurred for research involving human subjects prior to protocol approval by the ROB.

2) For animals:

a. Adhere to the requirements for protection of animal subjects per the DoD level terms and conditions as well as the following DTRA requirements:

b. DTRA local clause 252.235-9001 – Prohibition of Use of Laboratory Animals (Jul 2010). The full text of this clause is as follows:

The grant recipient shall obtain approval from the US Army Medical Research and Material Command (MRMC), Animal Care and Use Review Office (ACURO) prior to conducting research on live nonhuman vertebrates. Studies involving non-human primates, dogs, cats, or marine mammals will require a site visit by an ACURO laboratory animal veterinarian as a condition of approval. DoD may also conduct site visits involving research on other animals when deemed appropriate. The animal research facility is responsible for notifying the DoD sponsor if Association for the Assessment and Accreditation of Laboratory Animal Care accreditation is lost or the facility is under USDA inspection. DoD also has the right to a site inspection under these circumstances.

The grant recipient (including subcontractors) is expressly forbidden to use laboratory animals in any manner whatsoever without the express written approval of MRMC ACURO.

The grant recipient shall complete the ACURO Animal Use Appendix for Research Involving Animals found at the following web site: http://mrmc.amedd.army.mil/index.cfm?pageid=research_protections.acuro_animalappendix. Submit the completed ACURO appendix, contact information, the DTRA grant number and a copy of the grant for processing to the email address listed at the ACURO website. Once ACURO approves the effort, the grant recipient will receive written approval to begin animal use from the US Army MRMC ACURO by separate email. The grant recipient shall promptly provide a copy of the approval to the Grants Officer and Grants Officer representative. After approval, changes or protocol amendments must be submitted to and approved by ACURO before implementation.

The grant recipient, or subcontractors as appropriate, shall submit the most recent U.S. Department of Agriculture Animal Care Inspection Report annually in accordance with instructions provided.

Non-compliance with any provision of this clause may result in termination of the grant.

DoD Instruction 3216.01, dated September 13, 2010, provides policy and requirements for the use of animals in DoD-funded research based on Army Regulation 40-33. The DoD definition of animal is any live nonhuman vertebrate. All proposals that involve the use of animals must be in compliance with DoD Instruction 3216.01 and AR 40-33. DTRA requires that research using animals not begin or continue until the ACURO has reviewed and approved the proposed animal use. For animals, the provisions include rules on animal acquisition, transport, care, handling, and use in: (i) 9 CFR parts 1-4, Department of Agriculture rules that implement the Laboratory Animal Welfare Action of 1966 (U.S.C. 2131-2156); and (ii) the "Guide for the Care and Use of Laboratory Animals," National Institutes of Health Publication No. 86-23

RESEARCH INVOLVING RECOMBINANT DNA MOLECULES. Any recipient performing research involving recombinant DNA molecules and/or organisms and viruses containing recombinant DNA molecules agrees by acceptance of this award to comply with the National Institutes of Health "Guidelines for Research Involving Recombinant DNA Molecules," July 5, 1994 (59 FR34496) amended August 5, 1994 (59 FR40170) amended April 27, 1995 (60 FR 20726), or such later revision of those guidelines as may be published in the Federal Register.

COMBATING TRAFFICKING IN PERSONS. The recipient agrees to comply with the trafficking in persons requirement in Section 106(g) of the Trafficking Victims Protection Act of 2000 (TVPA), as amended (22 U.S.C. 7104(g)) as implemented by 2 CFR 175.

1) Provisions applicable to a recipient that is a private entity.

    a. You as the recipient, your employees, sub-recipients under this award, and sub-recipients' employees may not—
        - Engage in severe forms of trafficking in persons during the period of time that the award is in effect;
        - Procure a commercial sex act during the period of time that the award is in effect; or
        - Use forced labor in the performance of the award or subawards under the award.

    b. We as the Federal awarding agency may unilaterally terminate this award, without penalty, if you or a sub-recipient that is a private entity—
        - Is determined to have violated a prohibition in paragraph 1)a. of this award term; or
        - Has an employee who is determined by the agency official authorized to terminate the award to have violated a prohibition in paragraph 1)a. of this award term through conduct that is either—
            - Associated with performance under this award; or
            - Imputed to you or the sub-recipient using the standards and due process for imputing the conduct of an individual to an organization that are provided in 2 CFR Part 180, "OMB Guidelines to Agencies on Government-wide Debarment and Suspension (Non-procurement)," as implemented by our agency at 2 CFR Part 376.

2) Provision applicable to a recipient other than a private entity.

    a. We as the Federal awarding agency may unilaterally terminate this award, without penalty, if a sub-recipient that is a private entity—
        - Is determined to have violated an applicable prohibition in paragraph 1)a. of this award term; or
        - Has an employee who is determined by the agency official authorized to terminate the award to have violated an applicable prohibition in paragraph 1)a. of this award term through conduct that is either—
            - Associated with performance under this award; or
            - Imputed to the sub-recipient using the standards and due process for imputing the conduct of an individual to an organization that are provided in 2 CFR Part 180, "OMB Guidelines to Agencies on Government-wide Debarment and Suspension (Non-procurement)," as implemented by our agency at 2 CFR Part 376.

3) Provisions applicable to any recipient.

    a. You must inform us immediately of any information you receive from any source alleging a violation of a prohibition in paragraph 1)a. of this award term.

    b. Our right to terminate unilaterally that is described in paragraph 1)b. or 2)a. of this Article:
        - Implements Section 106(g) of the TVPA, as amended (22 U.S.C. 7104(g)), and

  - Is in addition to all other remedies for noncompliance that are available to us under this award.

c. You must include the requirements of paragraph 1)a. of this award term in any subaward you make to a private entity.

4) Definitions. For purposes of this award term:

a. "Employee" means either:
  - An individual employed by you or a sub-recipient who is engaged in the performance of the project or program under this award; or
  - Another person engaged in the performance of the project or program under this award and not compensated by you including, but not limited to, a volunteer or individual whose services are contributed by a third party as an in-kind contribution toward cost sharing or matching requirements.

b. "Forced labor" means labor obtained by any of the following methods: the recruitment, harboring, transportation, provision, or obtaining of a person for labor or services, through the use of force, fraud, or coercion for the purpose of subjection to involuntary servitude, peonage, debt bondage, or slavery.

c. "Private entity":
  - Means any entity other than a State, local government, Indian tribe, or foreign public entity, as those terms are defined in 2 CFR 175.25.
  - Includes:
    - A non-profit organization, including any non-profit institution of higher education, hospital, or tribal organization other than one included in the definition of Indian tribe at 2 CFR 175.25(b).
    - A for-profit organization.

d. "Severe forms of trafficking in persons," "commercial sex act," and "coercion" have the meanings given at Section 103 of the TVPA, as amended (22 U.S.C. 7102).

PROHIBITION ON USING FUNDS UNDER GRANTS AND COOPERATIVE AGREEMENTS WITH ENTITIES THAT REQUIRE CERTAIN INTERNAL CONFIDENTIALITY AGREEMENTS. The recipient agrees to comply with the requirements in section 743 of the Financial Services and General Government Appropriations Act, 2015 (Division E of the Consolidated and Further Continuing Appropriations Act, 2015, Pub. L. 113-235):

1) The recipient may not require its employees, contractors, or sub-recipients seeking to report fraud, waste, or abuse to sign or comply with internal confidentiality agreements or statements prohibiting or otherwise restricting them from lawfully reporting that waste, fraud, or abuse to a designated investigative or law enforcement representative of a Federal department or agency authorized to receive such information.

2) The recipient must notify its employees, contractors, or sub-recipients that the prohibitions and restrictions of any internal confidentiality agreements inconsistent with paragraph 1) of this award provision are no longer in effect.

3) The prohibition in paragraph 1) of this award provision does not contravene requirements applicable to Standard Form 312, Form 4414, or any other form issued by a Federal department or agency governing the nondisclosure of classified information.
4) If the Government determines that the recipient is not in compliance with this award provision, it:
    a. Will prohibit the recipient's use of funds under this award, in accordance with section 743 of Division E of the Consolidated and Further Continuing Resolution Appropriations Act, 2015, (Pub. L. 113-235) or any successor provision of law; and
    b. May pursue other remedies available for the recipient's material failure to comply with award terms and conditions.

14. Data Collection.

Data collection activities, if any, performed under this Grant are the responsibility of the recipient. Awarding agency support of the project does not constitute approval of the survey design, questionnaire content, or data collection procedures. The recipient shall not represent to respondents that such data are being collected for or in association with the awarding agency without the specific written approval of the cognizant awarding agency official. However, this requirement is not intended to preclude mention of the awarding agency support of the project in response to an inquiry or acknowledgment of such support in any publication of this data.

15. Publications and Acknowledgement of Sponsorship.

Publication of results of the research project in an appropriate professional journal is encouraged as an important method of recording and reporting scientific information. .

The recipient agrees that in the release of information relating to the grant, such release shall include the following statement, "The project or effort depicted was or is sponsored by the Department of the Defense, Defense Threat Reduction Agency. The content of the information does not necessarily reflect the position or the policy of the federal government, and no official endorsement should be inferred." For purposes of this provision, information includes news releases, articles, manuscripts, brochures, advertisements, still and motion pictures, speeches, trade association proceedings, symposia, etc.

When issuing statements, press releases, requests for proposals, bid solicitations, and other documents describing projects or programs funded in whole or in part with federal money, all recipients receiving federal funds, shall clearly state: (i) the percentage of total costs of the program or project which will be financed with federal money, and (ii) the dollar amount of federal funds for the project or program.

16. Authorization to Perform Activities Abroad.

If the award recipient is a foreign institution, the recipient assures that it has been duly authorized to operate and do business in the country or countries in which the grant is to be performed; that it has obtained all appropriate licenses, permits, and approvals required in connection with the grant's proposed activities; and that it will fully comply with all the laws, decrees, labor standards and regulations of such country or countries during the performance of the grant. U.S. Government funds may not be used in support of a project which is prohibited by law in the country or countries in which it is undertaken. DTRA does not assume responsibility for the recipient's compliance with the laws and regulations of the country or countries in which the activities are to be conducted.

17. Inconsistency between English Version and Translation of Grant.

The foreign recipient shall ensure that all contract correspondence that is addressed to the U.S. Government is submitted in English or with an English translation. In the event of inconsistency between the terms of the grant and any translation thereof into another language, the meaning in the English language shall control.

18. Value Added Tax (VAT) and Other Taxes

During implementation of grant activities, the recipient will notify DTRA as soon as they become aware of any VAT or other taxes, exceeding $500.00 per transaction, not identified in the grant proposal and outside those considered VAT costs associated with travel, including and limited to lodging, meals, and transportation. A "transaction" is defined as a single purchase by the recipient and transactions may not be deliberately split in order to avoid compliance with the $500.00 limit. DTRA approval in writing with documentation of extraordinary circumstances is required prior to the recipient using any DTRA funds for VAT or other taxes exceeding $500.00 per transaction, and a grant modification may be required. The recipient understands that in the event that DTRA is unable to secure approval to use DTRA funds for VAT or other taxes exceeding $500.00 per transaction, the purchase of applicable items may not proceed. For those instances where the recipient has received written approval to use DTRA funds to pay VAT or other taxes on any item(s) exceeding $500.00 per transaction, the recipient will include this information in its financial reports (e.g., SF 425) to DTRA.

19. Prohibition on the Use of Cooperative Threat Reduction Funds in the Russian Federation

Recipients of grants or cooperative agreements in Thrust Area 6 are prohibited from using DTRA funds for activities in the Russian Federation.

AWARD/CONTRACT

1. THIS CONTRACT IS A RATED ORDER UNDER DPAS (15 CFR 700)

RATING

PAGE OF PAGES 1 10

2. CONTRACT *(Proc. Inst. Ident.)* NO.
HDTRA12010029

3. EFFECTIVE DATE
29 Sep 2020

4. REQUISITION/PURCHASE REQUEST/PROJECT NO.

5. ISSUED BY CODE HDTRA1
DEFENSE THREAT REDUCTION AGENCY/AL-AC
8725 JOHN J. KINGMAN ROAD, MSC 6201
FORT BELVOIR VA 22060-6201

6. ADMINISTERED BY *(If other than Item 5)* CODE N62879
OFFICE OF NAVAL RESEARCH-BOSTON
495 SUMMER STREET, ROOM 627
BOSTON MA 02110-2109

7. NAME AND ADDRESS OF CONTRACTOR *(No., street, city, county, state and zip code)*
ECOHEALTH ALLIANCE INC.
MR. ALEKSEI CHMURA
460 W 34TH ST 17TH FL
NEW YORK NY 10001-2317

CODE 3MMU3

FACILITY CODE

8. DELIVERY
[ ] FOB ORIGIN [X] OTHER *(See below)*

9. DISCOUNT FOR PROMPT PAYMENT

10. SUBMIT INVOICES *(4 copies unless otherwise specified)* TO THE ADDRESS SHOWN IN:

ITEM

11. SHIP TO/MARK FOR CODE HDTRA1
DEFENSE THREAT REDUCTION AGENCY/CT-I
(b)(6)
8725 JOHN J. KINGMAN ROAD MSC 6201
FORT BELVOIR VA 22060-6201

12. PAYMENT WILL BE MADE BY CODE HQ0337
DFAS COLUMBUS CENTER
DFAS-CO/NORTH ENTITLEMENT OPERATIONS
P.O. BOX 182317
COLUMBUS OH 43218-2317

13. AUTHORITY FOR USING OTHER THAN FULL AND OPEN COMPETITION:
[ ] 10 U.S.C. 2304(c)( ) [ ] 41 U.S.C. 253(c)( )

14. ACCOUNTING AND APPROPRIATION DATA
See Schedule

15A. ITEM NO.	15B. SUPPLIES/ SERVICES	15C. QUANTITY	15D. UNIT	15E. UNIT PRICE	15F. AMOUNT
	SEE SCHEDULE				

15G. TOTAL AMOUNT OF CONTRACT **$2,957,164.19**

16. TABLE OF CONTENTS

(X)	SEC.	DESCRIPTION	PAGE(S)	(X)	SEC.	DESCRIPTION	PAGE(S)
		PART I - THE SCHEDULE				**PART II - CONTRACT CLAUSES**	
X	A	SOLICITATION/ CONTRACT FORM			I	CONTRACT CLAUSES	
	B	SUPPLIES OR SERVICES AND PRICES/ COSTS				**PART III – LIST OF DOCUMENTS, EXHIBITS AND OTHER ATTACH.**	
	C	DESCRIPTION/ SPECS./ WORK STATEMENT			J	LIST OF ATTACHMENTS	
	D	PACKAGING AND MARKING				**PART IV - REPRESENTATIONS AND INSTRUCTIONS**	
	E	INSPECTION AND ACCEPTANCE			K	REPRESENTATIONS, CERTIFICATIONS AND OTHER STATEMENTS OF OFFERORS	
	F	DELIVERIES OR PERFORMANCE					
	G	CONTRACT ADMINISTRATION DATA			L	INSTRS., CONDS., AND NOTICES TO OFFERORS	
	H	SPECIAL CONTRACT REQUIREMENTS			M	EVALUATION FACTORS FOR AWARD	

CONTRACTING OFFICER WILL COMPLETE ITEM 17 (SEALED-BID OR NEGOTIATED PROCUREMENT) OR 18 (SEALED-BID PROCUREMENT) AS APPLICABLE

17. [ ] CONTRACTOR'S NEGOTIATED AGREEMENT (Contractor is required to sign this document and return copies to issuing office.) Contractor agrees to furnish and deliver all items or perform all the services set forth or otherwise identified above and on any continuation sheets for the consideration stated herein. The rights and obligations of the parties to this contract shall be subject to and governed by the following documents: (a) this award/contract, (b) the solicitation, if any, and (c) such provisions, representations, certifications, and specifications, as are attached or incorporated by reference herein. (Attachments are listed herein.)

18. [ ] SEALED-BID AWARD (Contractor is not required to sign this document.) Your bid on Solicitation Number ________________ including the additions or changes made by you which additions or changes are set forth in full above, is hereby accepted as to the terms listed above and on any continuation sheets. This award consummates the contract which consists of the following documents: (a) the Government's solicitation and your bid, and (b) this award/contract. No further contractual document is necessary. (Block 18 should be checked only when awarding a sealed bid contract.)

19A. NAME AND TITLE OF SIGNER *(Type or print)*

20A. NAME OF CONTRACTING OFFICER
(b)(6) / CONTRACTING OFFICER
TEL: (b)(6) EMAIL: (b)(6)

19B. NAME OF CONTRACTOR
BY ________________
(Signature of person authorized to sign)

19C. DATE SIGNED

20B. UNITED STATES OF AMERICA
BY (b)(6)
(Signature of Contracting Officer)

20C. DATE SIGNED
29-Sep-2020

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STANDARD FORM 26 (REV. 5/2011)
Prescribed by GSA – FAR (48 CFR) 53.214(a)

Section B - Supplies or Services and Prices

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0001		1	Lot	$2,957,164.19	$2,957,164.19
	Years 1-3: FRBAA14-6-2-0471 FFP Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan & Strengthening Regional Disease Surveillance Capacity. In accordance with the following attachements: SOW at attachment 1 dated 3/18/2020 and DTRA Terms and Conditions for Grant Awards dated 09/14/2020 at attachment 2 FOB: Destination U009				
				NET AMT	$2,957,164.19

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
000101					$0.00
	Funding to support CLIN 0001 FFP				
				NET AMT	$0.00
	ACRN AA CIN: HDTRA10361120001				$2,956,308.78

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0002 OPTION	Year 4: FRBAB14-6-2-0471 FFP Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan & Strengthening Regional Disease Surveillance Capacity. In accordance with the following attachements: SOW at attachment 1 dated 3/18/2020 and DTRA Terms and Conditions for Grant Awards dated 09/14/2020 at attachment 2 FOB: Destination U009	1	Lot	$999,970.32	$999,970.32
				NET AMT	$999,970.32

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0003 OPTION	Year 5: FRBAA14-6-2-0471 FFP Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan & Strengthening Regional Disease Surveillance Capacity. In accordance with the following attachements: SOW at attachment 1 dated 3/18/2020 and DTRA Terms and Conditions for Grant Awards dated 09/14/2020 at attachment 2 FOB: Destination U009	1	Lot	$942,857.34	$942,857.34
				NET AMT	$942,857.34

Section C - Descriptions and Specifications

CLAUSES INCORPORATED BY FULL TEXT

252.601-9002 GRANT REFERENCE INFORMATION (MAY 2009)

a. This grant is awarded as a result of Broad Agency Announcement (BAA) **HDTRA1-11-16-BRCWMD-BAA**, Research and Development Enterprise, Basic and Applied Sciences Directorate, Basic Research for Combating Weapons of Mass Destruction (C-WMD).

b. **CFDA #:** 12.351

c. **Authority:** 10 U.S.C 2358 as amended.

(End of Clause)

Section E - Inspection and Acceptance

INSPECTION AND ACCEPTANCE TERMS

Supplies/services will be inspected/accepted at:

CLIN	INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
0001	Destination	Government	Destination	Government
000101	N/A	N/A	N/A	N/A
0002	Destination	Government	Destination	Government
0003	Destination	Government	Destination	Government

Section F - Deliveries or Performance

DELIVERY INFORMATION

CLIN	DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
0001	POP 29-SEP-2020 TO 28-SEP-2023	N/A	DEFENSE THREAT REDUCTION AGENCY/CT-I (b)(6) 8725 JOHN J. KINGMAN ROAD MSC 6201 FORT BELVOIR VA 22060-6201 (b)(6) FOB: Destination	HDTRA1
000101	N/A	N/A	N/A	N/A
0002	1 yr. AOE	1	DEFENSE THREAT REDUCTION AGENCY/CT-I (b)(6) 8725 JOHN J. KINGMAN ROAD MSC 6201 FORT BELVOIR VA 22060-6201 (b)(6) FOB: Destination	HDTRA1
0003	1 yr. AOE	1	(SAME AS PREVIOUS LOCATION) FOB: Destination	HDTRA1

Section G - Contract Administration Data

ACCOUNTING AND APPROPRIATION DATA

AA: 044315 097 0134 000 N 20182020 D 34HQ 0901515BR_KD_BP_OT_18 1820_0134_34HQ_SCNCT DTRA 410
AMOUNT: $2,956,308.78

ACRN	CLIN/SLIN	CIN	AMOUNT
AA	000101	HDTRA10361120001	$2,956,308.78

CLAUSES INCORPORATED BY FULL TEXT

252.601-9000 GRANT POINTS OF CONTACT (MAY 2009)

a. Grant Specialist:
Name: (b)(6)
Defense Threat Reduction Agency/AL-ACC
8725 John J. Kingman Road, MS 6201
Fort Belvoir, VA 22060-6201
Telephone (b)(6)
Email address: (b)(6)

b. Grantee Business Office:
Name: Dr. Aleksei Chmura
Title: Executive Organizational Representative
Phone: (212) 380 - 4473
E-mail: chmura@ecohealthalliance.org

c. Grantee Principal Investigator (PI):
Name: Dr. William Karesh
Title: Executive Vice President of Health and Policy
Phone: (212) 380 - 4463
E-mail: karesh@ecohealthalliance.org

(End of Clause)

252.601-9001 GRANTS OFFICER'S REPRESENTATIVE (GOR) (MAY 2009)

d. Grants Officer's Representative (GOR) for this Grant is:
Name: (b)(6)
Defense Threat Reduction Agency/BTRP
8725 John J. Kingman Road
Fort Belvoir, VA 22060-6201
telephone (b)(6)
email address: (b)(6)

b. SCOPE AND LIMITATIONS OF AUTHORITY FOR DTRA GRANTS OFFICER'S REPRESENTATIVE

1. The Grants Officer's Representative (GOR) is responsible for monitoring the technical and programmatic performance of the grant or cooperative agreement (hereinafter referred to as agreement) including compliance with the agreement's reporting requirements. Perceived deviations from the agreement's terms and conditions shall be brought to the attention of appropriate recipient personnel and if not corrected, to the attention of the Grants Officer. Deviations or other occurrences indicative of the recipient's inability or unwillingness to conform to the agreement's requirements shall be brought to the immediate attention of the Grants Officer.

2. The GOR has no authority to modify the stated terms of the agreement or specifications in any manner, or to approve any action that would result in additional charges to the Government. The DTRA Grants Officer must make all such changes in writing.

3. The GOR is authorized to correspond directly with the recipient on matters within the scope and limitations of his or her authority. All such correspondence shall be signed personally by the GOR and a copy will be furnished the Grants Officer for placement in the official agreement file.

4. The GOR will provide technical advice to the recipient to the extent such advice will not alter any of the agreement's terms and conditions or result in an increase in the estimated cost of the agreement's performance as specified in the agreement. The GOR is encouraged to discuss with the recipient new ideas related to the original scope of the agreement that may be of special interest to DTRA. The GOR should also be alert for indications that any part of the research is becoming unfruitful. If, as a result of such discussions, questions arise as to the possible need for a modification, the matter shall be brought to the immediate attention of the Grants Officer. The GOR shall not direct the recipient to undertake any action that the recipient believes to be contrary to the agreement's scope, terms or conditions without the written approval of the Grants Officer.

5. Any visits to the recipient's facilities on matters pertaining to the agreement will be documented in a brief memorandum. A copy will be provided the Grants Officer for placement in the official agreement file.

6. The GOR will maintain such work files as he or she deems necessary to properly document performance of the duties and responsibilities as a GOR. Upon completion of the agreement and delivery of all required reports, such work files will be forwarded to the Grants Officer for placement in the official agreement file.

7. In performance of the GOR's duties, the GOR shall constantly stress protection of the Government's interests. Similarly, the GOR shall avoid any act which may tend to compromise the position of DTRA, any individual member of DTRA or which will impact confidence in the integrity of DTRA with the business community.

(End of Clause)

252.632-9000 GRANT FUNDING PROFILE (MAR 2012)

FUNDING PROFILE:

The amount of $2,956,308.78 is obligated for work to be performed during the period beginning with grant award and continuing through September 28, 2023. Additional incremental funding planned, but not obligated, is:

FY 21 $855.41

The Government's liability is limited to the amount obligated

Invoice Schedule

1	9/29/2020	$79,900.24
2	10/29/2020	$79,900.24
3	11/29/2020	$79,900.24
4	12/29/2020	$79,900.24
5	1/29/2021	$79,900.24
6	2/28/2021	$79,900.24
7	3/29/2021	$79,900.24
8	4/29/2021	$79,900.24
9	5/29/2021	$79,900.24
10	6/29/2021	$79,900.24
11	7/29/2021	$79,900.24
12	8/29/2021	$79,900.24
13	9/29/2021	$79,900.24
14	10/29/2021	$79,900.24
15	11/29/2021	$79,900.24
16	12/29/2021	$79,900.24
17	1/29/2022	$79,900.24
18	2/28/2022	$79,900.24
19	3/29/2022	$79,900.24
20	4/29/2022	$79,900.24
21	5/29/2022	$79,900.24
22	6/29/2022	$79,900.24
23	7/29/2022	$79,900.24
24	8/29/2022	$79,900.24
25	9/29/2022	$79,900.24
26	10/29/2022	$79,900.24
27	11/29/2022	$79,900.24
28	12/29/2022	$79,900.24
29	1/29/2023	$79,900.24
30	2/28/2023	$79,900.24
31	3/29/2023	$79,900.24
32	4/29/2023	$79,900.24
33	5/29/2023	$79,900.24
34	6/29/2023	$79,900.24
35	7/29/2023	$79,900.24
36	8/29/2023	$79,900.24
37	9/28/2023	$79,900.14

(End of Clause)

Section J - List of Documents, Exhibits and Other Attachments

Exhibit/Attachment Table of Contents

DOCUMENT TYPE	DESCRIPTION	PAGES	DATE
Attachment 1	Statement of Work	7	18-MAR-2020
Attachment 2	Terms and Conditions	14	14-SEP-2020

Statement of Work

Project Title: Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan & Strengthening Regional Disease Surveillance Capacity.

Document Date: 18 March 2020.

Objective: The objective of this grant is to reduce the threat of high-consequence zoonotic pathogens in Jordan and improve regional disease surveillance capacity. Jordan faces risk of several zoonoses of concern to human and animal health, including Middle East Respiratory Syndrome (MERS-CoV) and Avian Influenza (AI), with fundamental knowledge and capacity gaps around the distribution and determinants of zoonoses. Recent work by our team detected MERS-CoV in camels and people in Jordan, suggesting ongoing and unmitigated transmission risk of a priority pathogen. The proposed study will generate critical advances in determining the presence of zoonotic pathogens in the country and opportunities for public health intervention. Through a prospective human cohort study coordinated with animal sampling, we will conduct biological and behavioral surveillance in five regions of Jordan with livestock production interfaces to determine the presence and risk factors for MERS-CoV, AI, brucellosis, and leptospirosis to identify modifiable risk factors. By testing three core policy-relevant hypotheses and providing multi-disciplinary training opportunities, the awardee shall enhance scientific capacity in Jordan and support disease detection and reporting in Jordan, Iraq and Lebanon. Taking a coordinated, multi-hazard approach to threat reduction, the proposed study will add critical understanding of presence and risk factors for zoonotic diseases in Jordan and advance scientific capacity and application of the One Health concept to counter biothreats in the region.

Scope: The awardee proposes a five-year One Health study of zoonotic diseases in Jordan. The awardee team shall focus on the following major goals and milestones:

1) Determine the presence of MERS-CoV, AI, and other zoonoses among livestock and poultry in Jordan: *Implement animal study (Y1-OY1); Conduct PCR and serology testing (Y1-OY2)*
2) Determine whether (and if so, the extent to which) humans at human-livestock/poultry interfaces display evidence of infection with these zoonoses: *Implement human cohort study (Y1-OY1); Conduct PCR and serology testing (Y1-OY2)*
3) Characterize causal factors in animal-to-human transmission of these zoonoses: *Implement behavioral risk survey (Y1-OY1); Conduct epidemiological analyses (Y1-OY2)*
4) Produce geospatial maps of zoonoses in livestock and poultry and of human zoonotic transmission risk: *Generate geospatial distribution and risk maps (Y1-OY2)*
5) Strengthen local capacity for detection and reporting of MERS-CoV, AI, and other zoonoses in Jordan, Iraq, and Lebanon: *Host workshops (Y1-2, OY1-2); Submit reports and publications (Y1-OY2); Attend presentations/meetings (Y1-OY2)*
6) Identify specific modifiable risk factors for human infection with these zoonoses: *Conduct causal interference analyses (Y3-OY2); Policy recommendations on modifiable risk factors (Y3-OY2)*

This research will generate critical advances in detecting the presence of and exposure risk to high-consequence zoonotic viruses and bacteria across geographic regions and interfaces in Jordan, contributing to enhanced understanding of modifiable risk factors to inform government authorities on prevention activities to reduce disease threats.

Background: Jordan has experienced outbreaks of several high-consequence zoonotic diseases, including MERS-CoV and AI. Since its emergence in 2012, MERS-CoV has resulted in over 2,400 human cases globally and is recognized as a priority disease under the WHO R&D Blueprint. While the first human cases of MERS-CoV were traced back to Jordan, little is known about its underlying and ongoing risk of zoonotic disease in animal populations, particularly around primary transmission risk factors and pathways that precede spread in healthcare settings. MERS-CoV is one of several zoonoses posing threat to animal and human populations in the country. Highly Pathogenic Avian Influenza outbreaks, including subtype H5N1, have been reported, and brucellosis is considered endemic in Jordan, with recurring spillover but inadequate understanding of specific modes of transmission and poor vaccination coverage. While human cases of leptospirosis have not been reported in Jordan to date, high rates of certain Leptospira serovars have been detected in animals. Key questions and capacity gaps hinder understanding of the presence, distribution and risk factors in the country, leaving the country vulnerable to zoonotic biothreats, as well as wider regional gaps in detection and reporting. The threat of zoonotic disease is especially pertinent given the rapidly-growing poultry production industry in Jordan and camel, livestock, and poultry rearing in the region.

Jordan has recently made recent several notable scientific advances in detection of MERS-CoV, generating preliminary data that the proposed project will build on. While camels are the presumptive source of primary human MERS-CoV infections, the exact mechanisms of transmission and the possible role of other livestock species are unclear. Blood samples collected from camels and humans in the northern region of Jordan were positive for MERS-CoV, leading to the first-ever report of this disease to OIE in camels in Jordan in 2016. To date, only few countries have reported virus-positive MERS-CoV test results to the OIE so this is a significant and important step toward improving both MERS-CoV detection and reporting in the Middle East. Studies of zoonotic pathogens in the region to date have largely focused on single sites or interfaces, cross-sectional sampling events, or select taxonomic groups, limiting understanding of causal factors. Research is needed to monitor presence and transmission of zoonotic pathogens spatially, temporally, and by biohazard exposure (e.g. blood, urine, feces, and/or nasal secretions) and practices and conduct epidemiological analyses to identify modifiable risk factors for public health intervention. As a key area of stability in the region, it is crucial to support Jordan's biosurveillance capacity, enable understanding of baseline disease risk to allow differentiation of natural versus nefarious emergence events, and ensure responsible bio-risk management to ethically monitor and reduce disease threats. The country has also recently established a One Health platform that indicates the country's commitment to countering zoonotic disease threats. Given the volume of migration between Jordan and its neighbors, including in animal trade, regional coordination in disease monitoring and threat reduction is a critical component in effectively characterizing and addressing disease risk. This project seeks to fill current capacity gaps to advance Jordan as a leader in scientific research and zoonotic disease management and creating new capacity and scientific collaboration pathways for hypothesis-driven research and zoonotic disease monitoring and threat reduction in the region.

Key references include (additional references can be found in the Project Narrative):

van Doremalen N, Hijazeen ZS, Holloway P, Al Omari B, McDowell C, Adney D, Talafha HA, Guitian J, Steel J, Amarin N, Tibbo M, Abu-Basha E, Al-Majali AM, Munster VJ, Richt JA. High Prevalence of Middle East Respiratory Coronavirus in Young Dromedary Camels in Jordan. *Vector Borne Zoonotic Dis*. 2017 Feb;17(2):155-159.

Alagaili AN, Briese T, Mishra N, Kapoor V, Sameroff SC, Burbelo PD, de Wit E, Munster VJ, Hensley LE, Zalmout IS, Kapoor A, Epstein JH, Karesh WB, Daszak P, Mohammed OB, Lipkin WI. Middle East respiratory syndrome coronavirus infection in dromedary camels in Saudi Arabia. *MBio.* 2014 Feb 25;5(2):e00884-14.

World Health Organization. Joint External Evaluation of IHR Core Capacities of the Hashemite Kingdom of Jordan. Geneva. 2016.

Tasks/Scientific Goals: **(Format: Year #(s). Task #. Subtask#).**

TASK 1: Y1.1-O2.1: Determine the presence of MERS-CoV, AI, and other zoonoses among livestock and/or poultry in Jordan.

The awardee shall study presence of MERS-CoV, AI, Brucellosis and Leptospirosis in animals. Sites will be selected in five geographically-representative regions across Jordan: Northern Jordan (Al Ramtha), Middle Jordan (Al Zarqa), and Southern Jordan (Al Karak, Ma'an, and Aqaba). These regions were selected based on preliminary findings by our team and the presence of livestock production activities. Sites in each region shall reflect interfaces with poultry, camels, and other livestock animals are represented (e.g. farms or markets). The awardee shall receive permissions and approvals to work with animals prior to initiating sampling. Nasopharyngeal and oropharyngeal swabs will be collected from 300 camels, poultry and other livestock quarterly in Year 1, Q3 through Option Year 1, Q3 (a total of 13 sampling visits). At three points during the project (in Y1, Y3, and OY1 during the 1st, 7th, and 13th sampling visits, respectively), blood samples (serum) will be collected from 300 animals. Nasopharyngeal and oropharyngeal swabs will be tested for MERS-CoV and AI using real time PCR. Serum samples will be tested using serology for MERS-CoV, AI, Brucellosis, and Leptospirosis. Staff training on proper study techniques (e.g. sampling, transport, and laboratory) will occur as detailed in Task 5. This task will contribute to testing the hypothesis that livestock species and poultry in Jordan show evidence of infection with MERS-CoV, AI, and/or other assayed zoonoses, as well as inform type of transmission pathways.

Y1.2.1 Identify sites for project study.
Y1.2.2 Obtain local permissions and approvals to work with animals.
Y1.2.3-O1.2.3 Conduct biological sampling in animals within the study area.
Y1.2.4-O2.2.4 Conduct PCR and/or serology testing for AI, MERS-CoV, brucellosis and leptospirosis.

TASK 2: Y1.2- OY2.1: Determine whether (and if so, the extent to which) humans at human-livestock/poultry interfaces display evidence of infection with these zoonoses.

The awardee shall conduct a prospective cohort study of humans to evaluate behavioral and occupational risk factors for zoonotic infectious diseases (MERS-CoV, avian influenza, brucellosis, and leptospirosis) among persons living in Jordan in any of the five study regions. The study will enroll persons regularly working with livestock or poultry or sharing their living areas with these animals as well as persons unexposed to these factors. Sites will be selected as in Task 1 and in surrounding communities to enroll both exposed and unexposed populations. In Year 1, the awardee will receive local permissions and approvals to work with human subjects prior to initiating enrollment and sampling. Nasopharyngeal and oropharyngeal swabs will be collected from 300 enrolled humans quarterly in Year 1, Q3 through Option Year 1, Q3 (a total of 13 sampling visits). At three points during the project (in Year 1, Year 3, and Option Year 1 during the 1st, 7th, and 13th sampling visits, respectively), blood samples (serum) will be collected from 300 humans. Nasopharyngeal and oropharyngeal swabs will be tested for MERS-CoV and AI using real time PCR. Serum samples will be tested using serology for MERS-CoV, AI, brucellosis, and leptospirosis (Years 1-4). Biological sampling will be paired with behavioral surveillance data as in Task 3.

Y1.2.1 Identify sites and conduct enrollment for human study component.

Y1.2.2 Obtain local permissions and approvals to work with human subjects.

Y1.2.3-O1.2.3 Conduct biological sampling (nasopharyngeal and oropharyngeal swabs, and/or blood) of in people within the study area.

Y1.2.4-O2.2.4 Conduct lab testing for AI, MERS-CoV, brucellosis and leptospirosis.

TASK 3: Y1.3-OY2.3: Characterize causal factors in animal-to-human transmission of these zoonoses.

The awardee shall monitor behaviors of persons enrolled in the prospective cohort study (as in Task 2) to identify and characterize causal factors for animal-to-human transmission of MERS-CoV, AI, brucellosis and leptospirosis. The PREDICT-2 Human Behavioral Risk Questionnaire will be augmented with animal-specific exposure frequency questions to collect demographic data, symptom and medical history data, social history data, and specific animal-related behaviors and practices that are possible risk factors for infection with MERS-CoV, avian influenza, brucellosis, or leptospirosis. The project team will administer the survey to enrolled participants at the first sampling visit (Year 1). During all future visits (Year 1- Option Year 1), enrolled participants will be administered a brief follow-up questionnaire designed primarily to capture time-varying exposure and covariate data. This longitudinal information will provide critical information about the context of exposures and pathways to link biological sampling and provide the wider context of practices and risk factors. Epidemiologic analysis of the questionnaire data (including time-varying data) in this Task will identify current practices and exposure pathways and initial modifiable risk factors. Specific animal-related behaviors and practices that involve exposure to specific animal biohazards (e.g., blood, urine, feces, and/or nasal secretions) will be assessed under Task 6 for whether they pose a greater risk of infection with MERS-CoV, avian influenza, brucellosis, or leptospirosis. Results will be shared via annual reports and stakeholder meetings as in Task 5.

Y1.3.1 Obtain local permissions and approvals to work with human subjects.

Y1.3.2-O1.3.2 Conduct behavioral risk factor surveys in people.

Y1.3.3-O2.3.3 Analyze epidemiologic causal inference to identify modifiable risk factors.

TASK 4: Y1.4-OY2.4: Produce geospatial maps of zoonoses in livestock and poultry and of human zoonotic transmission risk.

The awardee shall map findings from Tasks 1-2 to show the distribution of detected pathogens across the regions and sampling sites. Geospatial mapping is a highly relevant visual tool to assist authorities in targeting surveillance and risk management activities. Using QGIS, laboratory results of human and animal testing for MERS-CoV, avian influenza, brucellosis, and leptospirosis will be populated and mapped to show the distribution of detected pathogens. Maps will be generated beginning Y1, Q3 when laboratory findings are available. Geospatial risk maps will be generated using statistical models to link human behavioral data to laboratory findings beginning in Y1, Q4. Geospatial maps will be updated quarterly and shared with USG/DTRA and Jordanian project partners. Training on geospatial analysis will be provided to project team members and will be covered under a regional workshop to promote broader uptake of geospatial mapping as a low-cost tool to enhance disease monitoring programs in the region (Task 5).

Y1.4.1-O2.4.1 Generate maps of laboratory results

Y2.4.2-O2.4.2 Generate risk maps of human behavioral risk data

TASK 5: Y1.5-OY2.5: Strengthen local capacity for detection and reporting of MERS-CoV, AI, and other zoonoses in Jordan, Iraq, and Lebanon through meetings and workshops.

Strengthening disease detection and reporting capacity is a key contributor to health security and the ability to target risk factors for threat reduction. The project team is committed to improving this capacity in Jordan as well as more widely in the region through involvement of scientists and government officials in Iraq and Lebanon. We will train local staff in proper techniques for all project activities (Year 1 and Option Year 1). Each year we will support four students from medical and veterinary disciplines in Jordan to participate in training, field activities, project analyses and workshops to provide scientific mentorship and promote the One Health concept. Jordanian scientists and students will also be trained in laboratory techniques to be deployed in Jordan by the Human Link laboratory consultant that has led capacity development for MERS-CoV diagnostics in other countries. The awardee shall organize workshops in Jordan open to scientists from the Ministries of Health and Agriculture from Jordan, Iraq, and Lebanon (Years 1-2, Option Years 1-2). A secure project database will be developed for use in the epidemiological analyses. The awardee shall provide submission of annual sample repository information using a DTRA-specified format and shall grant access to all samples collected and data generated during the course of the project, up to and including at least 12 months after the project end date. The awardee shall conduct presentations/meetings at times and places specified in the grant schedule (Year 1 Task 5), including the DTRA Annual Technical Review. In Year 1 the awardee shall hold a kick-off meeting to introduce the project objectives and promote buy-in in study findings and capacity sustainment. Annual reports and stakeholder meetings and scientific presentations and publications will be used to disseminate results. The project will reinforce Jordan's national One Health platform, promoting the One Health concept for multiple diseases of concern for public and animal health and advancing capacity for hypothesis-driven research with direct application for policy decisions for threat reduction.

Y1.5.1 Conduct project kick-off meeting in Amman with local stakeholders.

Y1.5.2 & O1.5.2 Train local project staff in proper techniques.

Y1.5.3-O2.5.3 Host annual partners and stakeholders meeting.

Y1.5.4-O2.5.4 Complete annual report and share with project partners and local stakeholders.

Y1.5.5-Y2.5.5 & O1.5.5-O2.5.5 Conduct local/regional training workshops.

Y1.5.6- O2.5.6 Data management.

Y1.5.7- O2.5.7 Conduct presentations/meetings at times and places specified in the grant schedule, including DTRA Annual Technical Review.

TASK 6: Y3.6-OY2.6: Identify specific modifiable risk factors for human infection with these zoonoses.

The awardee shall integrate the findings of the biological testing (animal and human) and behavioral surveys in Tasks 1-3, assessing specific animal-related behaviors and practices that involve exposure to specific animal biohazards (e.g., blood, urine, feces, and/or nasal secretions) for whether they pose a greater risk of infection with MERS-CoV, avian influenza, brucellosis, or leptospirosis. These potential modifiable risk factors will be determined through epidemiologic analysis of the questionnaire data (including time-varying data) paired with individual laboratory results (e.g., detection of viral RNA, bacterial DNA, or antibodies). Using quarterly, longitudinal data collected in Tasks 1-3, we will examine any major temporal dynamics that may be associated with elevated transmission risk (e.g. seasonality, animal birthing periods). Causal inference techniques within the potential outcomes framework will be employed to solidify statistical associations as concretized biological/clinical/environmental pathways by operationalizing exposures as well-defined interventions and ensuring exchangeability is maintained through confounder control informed by directed acyclic graphs of the conceptual exposure-disease pathways. The awardee will examine multiple zoonotic pathogens (as above) to inform general threat reduction guidelines. Identification of modifiable risk factors will inform intervention development that may interrupt future zoonotic transmission of the four pathogens in this study. Findings will be shared with USG/DTRA and the Jordanian Ministry partners at the annual stakeholders meetings, the threat reduction workshop, scientific presentations and publications as specified in Task 5. This information will provide a strong basis for potential policy guidance and the generation of solutions at the threat reduction workshop in OY2.

Y3.6.1-O2.6.1 Conduct causal inference analyses bases on Tasks 1, 2, 3.
Y3.6.2-O2.6.2 Share results of analyses at annual partners and stakeholders meeting.
Y3.6.3 & O2.6.3 Submit written report to DTRA and local partners and stakeholders.

Performance Schedule:

Task	Year 1	Year 2	Year 3	OY 1	OY 2
Task 1: Determine the presence of MERS-CoV, AI, and other zoonoses among livestock and/or poultry in Jordan					
1.1. Identify sites for project study					
1.2 Obtain local permissions and approvals to work with animals					
1.3 Conduct biological sampling in animals within the study area					
1.4 Conduct lab testing for AI, MERS-CoV, brucellosis and leptospirosis					
Task 2: Determine whether (and if so, the extent to which) humans at human-livestock/poultry interfaces display evidence of infection					
2.1 Identify sites and conduct enrollment for human study component					
2.2 Obtain local permissions and approvals to work with human subjects					
2.3 Conduct biological sampling					
2.4 Conduct testing for AI, MERS-CoV, brucellosis and leptospirosis					
Task 3: Characterize causal factors in animal-to-human transmission of these zoonoses					
3.1 Obtain local permissions and approvals to work with human subjects					
3.2 Conduct behavioral risk factor surveys in people					
3.3 Analyze epi causal inference to identify modifiable risk factors					
Task 4: Produce geospatial maps of zoonoses in livestock and poultry and of human zoonotic transmission risk					
4.1 Generate maps of laboratory results					
4.2 Generate risk maps with human beh. risk data					
Task 5: Strengthen local capacity for detection and reporting of MERS-CoV, AI, and other zoonoses in Jordan, Iraq, and Lebanon					
5.1 Conduct project kick-off meeting in Amman with local stakeholders					
5.2 Train local project staff in proper techniques					
5.3 Host annual partners and stakeholders meeting					
5.4 Complete annual report and share with partners and stakeholders					
5.5 Conduct local/regional training workshops					
5.6 Data management					
5.7 Conduct presentations/meetings at times and places specified					
Task 6: Identify specific modifiable risk factors for human infection with these zoonoses					
6.1 Conduct causal inference analyses based on Task 1, 2, 3					
6.2 Share results of analyses at annual partners and stakeholders meeting					
6.3 Submit written report to DTRA and local partners and stakeholders					

Y1	Y2	Y3	OY1	OY2	Base	PRIME Budget	Y1	Y2	Y3	OY1	OY2	Total
						A. Senior Key Personnel						
2	2	2	2	2	$ 251,211.20	William Karesh, PI	$ 49,539.20	$ 50,001.90	$ 53,540.66	$ 50,155.59	$ 55,994.34	$ 265,197.02
						William Karesh Fringe	$ 17,500.00	$ 19,724.00	$ 19,691.70	$ 20,675.29	$ 21,710.10	$ 95,650.04
3	3	3	3	1	$ 67,747.17	Emily Hagan, Behavioral Risk Scientist	$ 16,976.57	$ 17,720.85	$ 18,672.02	$ 19,605.48	$ 21,565.70	$ 95,508.40
						Emily Hagan Fringe	$ 6,232.74	$ 6,544.35	$ 6,871.60	$ 7,215.18	$ 7,575.54	$ 34,439.20
4	4	4	4	3	$ 85,884.58	Catherine Machalaba, Co-Investigator	$ 28,528.26	$ 30,030.71	$ 31,562.60	$ 33,140.83	$ 43,497.34	$ 166,888.60
						Catherine Machalaba Fringe	$ 10,529.21	$ 11,001.97	$ 11,610.07	$ 12,195.92	$ 15,057.02	$ 61,415.10
2	2	2	2	2	$ 86,100.00	Whitney Bagge, Modeler	$ 14,510.11	$ 15,147.82	$ 15,621.00	$ 16,812.05	$ 17,462.15	$ 79,293.40
						Whitney Bagge Fringe	$ 5,290.54	$ 5,544.85	$ 5,822.13	$ 6,113.23	$ 6,418.50	$ 29,179.58
	Fringe Rate ->				36.8%	Total Senior Key Personnel	$ 148,260.15	$ 155,778.16	$ 163,557.06	$ 171,745.42	$ 192,233.56	$ 831,664.35
						B. Other Personnel						
3	3	3	3	3	$ 59,720.41	Amanda Andre, Program Coordinator	$ 14,930.50	$ 15,677.40	$ 16,461.26	$ 17,284.33	$ 15,145.04	$ 92,902.35
						Amanda Andre Fringe	$ 5,494.57	$ 5,769.25	$ 6,057.75	$ 6,360.63	$ 5,675.18	$ 29,060.20
12	12	12	12	12	$ 61,000.00	Research Assistant	$ 61,000.00	$ 64,050.00	$ 67,252.50	$ 70,615.13	$ 74,145.88	$ 337,063.51
						RA Fringe	$ 22,448.00	$ 23,570.40	$ 24,748.92	$ 25,986.37	$ 27,285.68	$ 124,039.37
	Fringe Rate ->				36.80%	Total Other Personnel	$ 103,873.11	$ 109,067.05	$ 114,520.40	$ 120,246.45	$ 122,256.77	$ 579,963.78
						C. Equipment						
						Total Equipment	$ -	$ -	$ -	$ -	$ -	$ -
						D. Travel						
						1. Domestic Travel	$ 4,997.50	$ 7,321.80	$ 7,842.80	$ 7,842.80	$ 7,842.80	$ 35,868.00
						2. Foreign Travel	$ 31,516.00	$ 33,532.50	$ 36,939.50	$ 36,939.50	$ 34,273.00	$ 173,191.00
						Total Travel	$ 36,513.50	$ 40,854.30	$ 44,782.30	$ 44,782.30	$ 42,115.80	$ 205,954.00
						E. Participant/Trainee Support Costs						
						1. Tuition/Fees/Health Insurance	-	-				$ -
						2. Stipends	-	-				$ -
						3. Travel						$
						4. Subsistence						$ -
						5. Other						$ -
						Total Participant/Trainee Support Costs	$ -	$ -	$ -	$ -	$ -	$ -
						F. Other Direct Costs						
						1. Materials and Supplies	$ 8,240.45	$ 2,312.50	$ 2,312.50	$ 2,312.50	$ 2,312.50	$ 17,490.45
						2. Publication Costs	$ -	$ 5,275.00	$ 5,275.00	$ -	$ -	$ 10,550.00
						3. Consultant Services	$ 5,500.00	$ 500.00	$ 500.00	$ 500.00	$ 500.00	$ 7,500.00
						4. ADP/Computer Services	-	-				$ -
						5. Subawards/Consortium/Contractual Costs						$
						CSU	$ 457,244.54	$ 506,519.70	$ 526,847.05	$ 524,574.92	$ 451,909.76	$ 2,475,855.72
						Human Links	$ 8,479.17	$ 14,140.87	$ 14,140.87	$ 14,140.87	$ 14,140.47	$ 65,042.13
						6. Equipment or Facility Rental/User Fees	-	-				$ -
						7. Alterations and Renovations	-	-				$ -
						8. Other						$
						9. Other						$ -
						Total Other Direct Costs	$ 13,740.45	$ 8,087.50	$ 8,087.50	$ 2,812.50	$ 2,812.50	$ 35,540.45
						G. Direct Costs and Modified Direct Costs						
						Direct Costs	$ 302,387.51	$ 313,727.05	$ 330,857.39	$ 339,586.67	$ 363,621.10	$ 1,650,669.94
						Modified Direct Costs						$
						H. Indirect Costs						
	IDC Rate ->				35.84%	1. Indirect Cost Type	$ 108,329.16	$ 112,439.77	$ 118,594.01	$ 121,707.86	$ 130,285.57	$ 591,356.56
	IDC Rate ->				26.84%	2. Indirect Cost Type	$ 11,998.03	$ 6,068.09	$ 852.08	$ -		$ 17,920.06
						I. Total Direct and Indirect Costs	-					
						Direct + Indirect	$ 422,526.59	$ 431,234.90	$ 450,390.29	$ 451,294.53	$ 493,907.11	$ 2,250,293.40
						J. Fee						
						Fee	-	-				-
						K. Total Costs and Fee						
						Total Costs	$ 422,526.59	$ 431,234.90	$ 450,390.29	$ 451,294.53	$ 493,907.11	$ 2,250,293.40
						OVERALL Totals						
							$ 884,860.54	$ 911,335.45	$ 951,112.10	$ 968,973.02	$ 942,857.34	$ 4,809,881.76

EHA Supplies	Unit/Amount	Y1	Y2	Y3	OY1	OY2	
Laptop	$ 2,139.00	$ 4,278.00					$ 4,278.00
Stata	$	$	$	$	$	$	$
Dropbox	$ 307.50	$ 450.00	$ 307.50	$ 150.00	$ 307.50	$ 150.00	$ 2,367.50
Adobe	$ 242.50	$ 457.50	$ 242.50	$ 457.50	$ 242.50	$ 457.50	$ 1,857.50
Endnote	$ 249.95	$ 249.95					$ 249.95
MS Office	$ 100.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 1,000.00
							$
GoToMeeting	$ 567.50	$ 550.00	$ 567.50	$ 550.00	$ 567.50	$ 550.00	$ 2,785.00
Zoom	$ 157.50	$ 250.00	$ 157.50	$ 250.00	$ 157.50	$ 250.00	$ 757.50
Shipping	$ 75.00	$ 75.00	$ 75.00	$ 75.00	$ 75.00	$ 75.00	$ 375.00
TOTALS		$ 8,240.45	$ 2,312.50	$ 2,312.50	$ 2,312.50	$ 2,312.50	$ 17,490.45

Consultant Details	Y1	Y2	Y3	OY1	OY2
EHA [illegible]	$ 1,500.00	$ 500.00	$ 500.00	$ 500.00	$ 500.00
[illegible] Trainings	$ 4,000.00				
TOTAL	$ 5,500.00	$ 500.00	$ 500.00	$ 500.00	$ 500.00

Publication Costs	Y1	Y2	Y3	OY1	OY2
PLOS One		[illegible]	[illegible]		
Scientific Reports		[illegible]	[illegible]		
PNAS		[illegible]	[illegible]		
Total	0	[illegible]	[illegible]	-	0

International Travel						TOTAL
Traveler 1 - William Karesh (Animal)						
Hotel Max Per Diem	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	
Meals and Incidental Expenses Per Diem	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	
Tax Estimate	$ 570.00	$ 570.00	$ 570.00	$ 570.00	$ 570.00	
Flight Estimate	$ 2,566	$ 2,566	$ 2,566	$ 2,566	$	
No. Days	5	5	5	5	5	
No. Trips per Year	2	2	2	2	2	
Total	$ 6,346.00	$ 6,346.00	$ 6,346.00	$ 6,346.00	$ 3,780.00	$ 29,164.00
Traveler 2 - William Karesh (Field)						
Hotel Max Per Diem	$ 584.00	$ 584.00	$ 584.00	$ 584.00	$ 584.00	
Meals and Incidental Expenses Per Diem	$ 472.50	$ 472.50	$ 472.50	$ 472.50	$ 472.50	
Tax Estimate	$ 285.00	$ 285.00	$ 285.00	$ 285.00	$ 285.00	
Flight Estimate						
No. Days	5	5	5	5	5	
No. Trips per Year	1	1	1	1	1	
Total	$ 1,341.50	$ 1,341.50	$ 1,341.50	$ 1,341.50	$ 1,341.50	$ 6,707.50
Traveler 3 - Catherine Machalaba (Animal)						
Hotel Max Per Diem	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	
Meals and Incidental Expenses Per Diem	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	
Tax Estimate	$ 570.00	$ 570.00	$ 570.00	$ 570.00	$ 570.00	
Flight Estimate	$ 2,566	$ 2,566	$ 2,566	$ 2,566	$ 2,566	
No. Days	5	5	5	5	5	
No. Trips per Year	2	2	2	2	2	
Total	$ 6,346.00	$ 6,346.00	$ 6,346.00	$ 6,346.00	$ 6,346.00	$ 31,730.00
Traveler 4 - Catherine Machalaba (Field)						
Hotel Max Per Diem	$ 1,314.00	$ 2,628.00	$ 2,628.00	$ 2,628.00	$ 2,628.00	
Meals and Incidental Expenses Per Diem	$ 997.50	$ 1,995.00	$ 1,995.00	$ 1,995.00	$ 1,995.00	
Tax Estimate	$ 435.00	$ 870.00	$ 870.00	$ 870.00	$ 870.00	
Flight Estimate						
No. Days	10	10	10	10	10	
No. Trips per Year	1	2	2	2	2	
Total	$ 2,746.50	$ 5,493.00	$ 5,493.00	$ 5,493.00	$ 5,493.00	$ 24,718.50
Traveler 5 - Cindy Hagan (Animal)						
Hotel Max Per Diem	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	$ 1,968.00	
Meals and Incidental Expenses Per Diem	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	$ 1,242.00	
Tax Estimate	$ 570.00	$ 570.00	$ 570.00	$ 570.00	$ 570.00	
Flight Estimate	$ 6,415	$ 6,415	$ 6,415	$ 6,415	$ 6,415	
No. Days	5	5	5	5	5	
No. Trips per Year	2	2	2	2	2	
Total	$ 10,195.00	$ 10,195.00	$ 10,195.00	$ 10,195.00	$ 10,195.00	$ 50,975.00

Traveler 6 - International Conferences (IMED)	Vienna					
Hotel Max Per Diem	$ 819	$ 819	$ 1,638	$ 1,638	$ 1,638	
Meals and Incidental Expenses Per Diem	$ 240	$ 240	$ 480	$ 480	$ 480	
Tax Estimate	$ 255.00	$ 255.00	$ 510.00	$ 510.00	$ 510.00	
Flight Estimate	$ 1,493	$ 1,493	$ 2,986	$ 2,986	$ 2,986	
No. Days	4	4	4	4	4	
No. Trips per Year	1	1	2	2	2	
Total	$ 2,807.00	$ 2,807.00	$ 5,614.00	$ 5,614.00	$ 5,614.00	$ 22,456.00
Visa Fees	$ 504.00	$ 504.00	$ 504.00	$ 504.00	$ 504.00	$ 2,520.00
Vaccination Costs	$ 880.00					$ 880.00
Conference Registration Fees	$ 500.00	$ 500.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 4,000.00
YEARLY TOTALS	$ 31,666.00	$ 33,532.50	$ 36,839.50	$ 36,839.50	$ 34,273.50	$ 173,151.00
conference			visa			
ISIC/IMED	500		Jordan	56		

Domestic Travel						TOTAL
Traveler 1 - William Karesh (NY-DC)						
Hotel Max Per Diem	$ 512	$ 256	$ 512	$ 512	$ 512	
Meals and Incidental Expenses Per Diem	$ 228	$ 114	$ 228	$ 228	$ 228	
Tax Estimate	$ 90.00	$ 45.00	$ 90.00	$ 90.00	$ 90.00	
Transportation Estimate	$ 392	$ 196	$ 392	$ 392	$ 392	
No. Days	2	2	2	2	2	
No. Trips per Year	2	1	2	2	2	
Total	$ 1,222.00	$ 611.00	$ 1,222.00	$ 1,222.00	$ 1,222.00	$ 5,499.00
Traveler 2 - Catherine Machalaba (NY-DC)						
Hotel Max Per Diem	$ 256	$ 256	$ 256	$ 256	$ 256	
Meals and Incidental Expenses Per Diem	$ 114	$ 114	$ 114	$ 114	$ 114	
Tax Estimate	$ 45.00	$ 45.00	$ 45.00	$ 45.00	$ 45.00	
Transportation Estimate	$ 196	$ 196	$ 196	$ 196	$ 196	
No. Days	2	2	2	2	2	
No. Trips per Year	1	1	1	1	1	
Total	$ 611.00	$ 611.00	$ 611.00	$ 611.00	$ 611.00	$ 3,055.00
Traveler 3 - Attending Meeting in VA						
Hotel Max Per Diem	$ 1,024	$ 1,024	$ 1,024	$ 1,024	$ 1,024	
Meals and Incidental Expenses Per Diem	$ 380	$ 380	$ 380	$ 380	$ 380	
Tax Estimate	$ 450.00	$ 450.00	$ 450.00	$ 450.00	$ 450.00	
Transportation Estimate	$ 1,011	$ 1,011	$ 1,011	$ 1,011	$ 1,011	
No. Days	4	4	4	4	4	
No. Trips per Year	2	2	2	2	2	
Total	$ 2,864.80	$ 2,864.80	$ 2,864.80	$ 2,864.80	$ 2,864.80	$ 14,324.00
Traveler 4 - Presenting Domestic Mtg ASTMH (Maryland)						
Hotel Max Per Diem	$ -	$ 924	$ 924	$ 924	$ 924	
Meals and Incidental Expenses Per Diem	$ -	$ 497	$ 497	$ 497	$ 497	
Tax Estimate	$ -	$ 210.00	$ 210.00	$ 210.00	$ 210.00	
Transportation Estimate	$ -	$ 684	$ 684	$ 684	$ 684	
No. Days	0	4	4	4	4	
People Attending	0	2	2	2	2	
Total	$ -	$ 2,315.00	$ 2,315.00	$ 2,315.00	$ 2,315.00	$ 9,260.00

Conference Registration Fees	$	$ 930.00	$ 930.00	$ 930.00	$ 930.00	
YEARLY TOTALS	$ 4,697.80	$ 7,331.80	$ 7,942.80	$ 7,942.80	$ 7,942.80	$ 35,858.00
[illegible]	$ 465.00					

Y1	Y2	Y3	OY1	OY2	Base
2.5	2.5	2.5	[illegible]	[illegible]	$ [illegible]
				[illegible]	

Budget Lines	Y1	Y2	Y3	OY1	OY2	Total
A. Senior Key Personnel						
[illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
	$	$	$	$	$	$ -
Total Senior Key Personnel	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
B. Other Personnel						
Total Other Personnel	$	$	$	$	$	$
C. Equipment						
Total Equipment	$	$	$	$	$	$ -
D. Travel						
1. Domestic Travel						$ -
2. Foreign Travel	$	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
Total Travel	$	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
E. Participant/Trainee Support Costs						
1. Tuition/Fees/Health Insurance						$
2. Stipends						$
3. Travel						$ -
4. Subsistence						$ -
5. Other						$ -
Total Participant/Trainee Support Costs	$	$	$	$	$	$ -
F. Other Direct Costs						
1. Materials and Supplies		$ 2,000.00	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ [illegible]
2. Publication Costs						$
3. Consultant Services						$ -
4. ADP/Computer Services						$ -
5. Subawards/Consortium/Contractual Costs						$ -
6. Equipment or Facility Rental/User Fees						$ -
7. Alterations and Renovations						$
8. Other Settings						$
9. Other						$
Total Other Direct Costs	$	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ 2,000.00	$ [illegible]
G. Direct Costs and Modified Direct Costs						
Direct Costs	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
Modified Direct Costs						$ -
H. Indirect Costs						
1. Indirect Cost Type	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
2. Indirect Cost Type						$
I. Total Direct and Indirect Costs						
Direct + Indirect	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
J. Fee						
Fee						
K. Total Costs and Fee						
Total Costs	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]

IDC Rate > 10%

IDC Rate >

[illegible]						
[illegible]	$	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	
[illegible]	$	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	
[illegible]	$	$	$	$	$	
[illegible]	$	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	
[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	0	1	[illegible]	1	1	
[illegible]	$	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]

Y1	Y2	Y3	OY1	OY2	Base	JUST	Y1	Y2	Y3	OY1	OY2	Total
						A. Senior/Key Personnel						
12	12	12	12	12	$ 127,940.00	Dr. Ehab Abu-Basha, CoPI	$ 127,940.00	$ 127,940.00	$ 127,940.00	$ 127,940.00	$ 127,940.00	$ 639,700.00
						Dr. Ehab Abu Basha Fringe	$	$	$	$	$	$
8	8	8	8	8	$ 19,301.80	Hani Talafha, Biologist	$ 12,867.87	$ 12,867.87	$ 12,867.87	$ 12,867.87	$ 12,867.87	$ 64,339.33
						Hani Talafha Fringe	$ -	$ -	$ -	$ -	$ -	$ -
2	12	12	12	12	$ 32,520.00	Zaidoun Hijazeen, Veterinarian	$ 5,420.00	$ 32,520.00	$ 32,520.00	$ 32,520.00	$ 32,520.00	$ 135,500.00
						Zaidoun Hijazeen Fringe	$ -	$ -	$ -	$ -	$ -	$ -
3	3	3	3	3	$ 54,391.53	Mustafa Ababneh, Virologist/Lab Director	$ 13,597.88	$ 13,597.88	$ 13,597.88	$ 13,597.88	$ 13,597.88	$ 67,989.41
						Mustafa Ababneh Fringe	$	$	$	$	$	$
2.5	2.5	2.5	2.5	2.5	$ 57,903.18	Zuhair Bani Ismail, Livestock ID Expert	$ 12,063.16	$ 12,063.16	$ 12,063.16	$ 12,063.16	$ 12,063.16	$ 60,315.81
						Zuhair Bani Ismail Fringe	$ -	$ -	$ -	$ -	$ -	$ -
3	3	3	3	3	$ 69,597.00	Borhan Al-zoghoul, Molecular Biologist/Lab Director	$ 17,399.25	$ 17,399.25	$ 17,399.25	$ 17,399.25	$ 17,399.25	$ 86,996.25
						Borhan Al-zoghoul Fringe	$ -	$ -	$ -	$ -	$ -	$ -
3	3	3	3	3	$ 23,112.00	Bilal Al-Omari, Lab Supervisor	$ 5,778.00	$ 5,778.00	$ 5,778.00	$ 5,778.00	$ 5,778.00	$ 28,890.00
						Bilal Al-Omari Fringe	$ -	$ -	$ -	$ -	$ -	$ -
1	1	1	1	1	$ 177,018.63	Wail Hayajneh, Human ID Expert	$ 14,751.55	$ 14,751.55	$ 14,751.55	$ 14,751.55	$ 14,751.55	$ 73,757.76
						Wail Hayajneh Fringe	$ -	$ -	$ -	$ -	$ -	$ -
				Fringe Rate-->		Total Senior/Key Personnel	$ 209,817.71	$ 236,917.71	$ 236,917.71	$ 236,917.71	$ 236,917.71	$ 1,157,480.57
						B. Other Personnel						
1	1	1	2	2	$ 58,241.66	Saad Gharaibeh, Avian Pathologist	$ 4,853.47	$ 4,853.47	$ 4,853.47	$ 9,706.94	$ 9,706.94	$ 33,974.30
						Saad Gharaibeh Fringe	$ -	$ -	$ -	$ -	$ -	$ -
3.5	3.5	3.5	3.5	3.5	$ 28,219.16	Admin	$ 8,230.59	$ 8,230.59	$ 8,230.59	$ 8,230.59	$ 8,230.59	$ 41,152.94
						Admin Fringe	$ -	$ -	$ -	$ -	$ -	$ -
2	4	4	3	0	$ 47,860.32	Nurses (x2)	$ 15,953.44	$ 31,906.88	$ 31,906.88	$ 23,930.16	$ -	$ 103,097.36
12	12	12	12	12	$ 2,538.84	Undergrad Student Stipends (x2)	$ 5,077.68	$ 5,077.68	$ 5,077.68	$ 5,077.68	$ 5,077.68	$ 25,388.40
12	12	12	12	12	$ 3,385.08	Graduate Student Stipends (x2)	$ 6,770.16	$ 6,770.16	$ 6,770.16	$ 6,770.16	$ 6,770.16	$ 33,850.80
				Fringe Rate-->		Total Other Personnel	$ 40,885.34	$ 56,838.78	$ 56,838.78	$ 53,715.53	$ 29,785.37	$ 204,089.50
						C. Equipment						
						Vehicle	$ 37,150.00	$ 1,830.00	$ 1,830.00	$ 1,830.00	$ 1,830.00	$ 44,470.00
						Luminescence plate reader	$ 28,840.00					
						Total Equipment	$ 65,996.00	$ 1,830.00	$ 1,830.00	$ 1,830.00	$ 1,830.00	$ 73,316.00
						D. Travel						
						1. Domestic Travel	$ 40,108.00	$ 62,626.00	$ 62,626.00	$ 51,367.00	$ 12,360.00	$ 229,087.00
						2. Foreign Travel	$ 37,433.50	$ 26,890.00	$ 26,890.00	$ 26,890.00	$ 29,915.50	$ 148,019.00
						Total Travel	$ 77,541.50	$ 89,516.00	$ 89,516.00	$ 78,257.00	$ 42,275.50	$ 377,106.00
						E. Participant/Trainee Support Costs						
						1. Tuition/Fees/Health Insurance						$ -
						2. Stipends						$
						3. Travel						$ -
						4. Subsistence						$ -
						5. Other						$ -
						Total Participant/Trainee Support Costs	$ -	$ -	$ -	$ -	$ -	$ -
						F. Other Direct Costs						
						1. Materials and Supplies	$ 36,933.96	$ 18,704.77	$ 7,666.97	$ 10,255.19	$ -	$ 73,640.89
						2. Publication Costs						$
						3. Consultant Services						$ -
						4. ADP/Computer Services						$ -
						5. Subawards/Consortium/Contractual Costs						$
						6. Equipment or Facility Rental/User Fees						$ -
						7. Alterations and Renovations						$ -
						8. Other - Testing	$ 53,500.00	$ 53,500.00	$ 77,500.00	$ 65,500.00	$	$ 250,000.00
						9. Other - Meetings and Conferences	$ 27,589.08	$ 39,205.05	$ 17,366.69	$ 39,205.05	$ 91,885.27	$ 215,251.14
						Total Other Direct Costs	$ 118,023.04	$ 111,489.82	$ 102,533.66	$ 114,960.24	$ 91,885.27	$ 538,892.03
						G. Direct Costs and Modified Direct Costs						
						Direct Costs	$ 512,263.59	$ 496,592.31	$ 487,636.15	$ 485,680.49	$ 402,693.86	$ 2,384,866.40
						Modified Direct Costs						$ -
						H. Indirect Costs						
				IDC Rate->	8%	1. Indirect Cost Type	$ 40,981.09	$ 39,727.39	$ 39,010.89	$ 38,854.44	$ 32,215.51	$ 190,789.31
				IDC Rate-->		2. Indirect Cost Type						$ -
						I. Total Direct and Indirect Costs						
						Direct + Indirect	$ 553,244.68	$ 536,319.70	$ 526,647.05	$ 524,534.92	$ 434,909.36	
						J. Fee						
						Fee						
						K. Total Costs and Fee						
						Total Costs	$ 553,244.68	$ 536,319.70	$ 526,647.05	$ 524,534.92	$ 434,909.36	$ 2,575,655.72

International Travel						TOTAL
International Conferences ([illegible])						
Hotel Max Per Diem	$ [illegible]	$ [illegible]	$ 3,275	$ 3,275	$ 3,275	
Meals and Incidental Expenses Per Diem	$ 1,680	$ 1,680	$ 1,680	$ 1,650	$ 1,650	
Taxi Estimates	$ 1,020.00	$ 1,020.00	$ 1,020.00	$ 1,020.00	$ 1,020.00	
Flight Estimate	$ 3,192	$ 3,192	$ 3,192	$ 3,192	$ 3,192	
No. Days	4	4	4	6	6	
No. Trips per Year	4	4	4	6	6	
Total	$ 9,168.00	$ 9,168.00	$ 9,168.00	$ 9,168.00	$ 9,168.00	$ 45,840.00
Regional Conferences (EMED Istanbul)						
Hotel Max Per Diem	$ 3,691	$ 3,588	$ 3,585	$ 3,555	$ 4,455	
Meals and Incidental Expenses Per Diem	$ 1,876	$ 1,834	$ 1,834	$ 1,834	$ 2,293	
Taxi Estimates	$ 750.00	$ 1,020.00	$ 1,020.00	$ 1,020.00	$ 1,275.00	
Flight Estimate	$ 1,698	$ 2,264	$ 2,264	$ 2,264	$ [illegible]	
No. Days	4	4	4	4	4	
No. Trips per Year	3	4	4	4	5	
Total	$ 6,529.50	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
OTRA Mtg (SA)						
Hotel Max Per Diem	$ 1,280	$ 1,280	$ 1,280	$ 1,250	$ 1,250	
Meals and Incidental Expenses Per Diem	$ 416	$ 416	$ 415	$ 415	$ 414	
Taxi Estimates	$ 315.00	$ 315.00	$ 315.00	$ 315.00	$ 315.00	
Flight Estimate	$ 1,083	$ 1,083	$ 1,083	$ 1,053	$ 1,053	
No. Days	6	6	6	6	6	
No. Trips per Year	1	1	1	1	1	
Total	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]
Training ([illegible])						
Hotel Max Per Diem	$ [illegible]	$ -	$ -	$	$	
Meals and Incidental Expenses Per Diem	$ 3,822	$	$	$	$	
Taxi Estimates	$ 1,107.00	$	$	$	$	
Flight Estimate	$ 2,940	$ -	$ -	$	$	
No. Days	7	7	7	7	7	
No. Trips per Year	6	0	0	0	0	
Total	$ 13,569.00	$	$	$	$	$ 13,569.00

Conference Fees	$ 4,547.00	$ 5,396.00	$ 5,396.00	$ 5,396.00	$ 6,245.00	$ 26,980.00
Visa Fees	$ 524.00	$ 524.00	$ 524.00	$ 524.00	$ 524.00	$ 2,620.00
YEARLY TOTALS	$ 37,439.50	$ 26,890.00	$ 26,890.00	$ 26,890.00	$ 29,915.50	$ 148,019.00

	Y1	Y2	Y3	Y4	Y5	
Visa Fees						
[illegible] (91)	364	364	364	364	364	[illegible]
Dr. Abu Basha OTRA mtg visa (160)	160	160	160	160	160	[illegible]
Total Visas	524	524	524	524	524	2620
Conference Fees						
[illegible] 300	2000	2000	2000	2000	2000	10000
EMED 840	2547	3396	3396	3396	4245	16980
Total Conferences	4547	5396	5396	5396	6245	26980

Annual Conference (Y1 OY2)			# People	# Days	
Hotel Max Per Diem	$	246.00	10	2	$ 4,920.00
M& Expenses Per Diem	$	138.00	10	2	$ 2,760.00
Domestic Transport	$	414.31	10	1	$ 4,143.10
Printing/Supplies	$	148.03	1	1	$ 148.03
Translation and Sound	$	1,974.64	1	1	$ 1,974.64
Room Rental	$	1,150.00	1	1	$ 1,150.00
Lunch and Coffee	$	46.02	65	1	$ 2,991.30
					$ 17,366.69
KickOff Meeting (Y1 Only)			# People	# Days	
Hotel Max Per Diem	$	246.00	5	2	$ 2,460.00
M& Expenses Per Diem	$	138.00	5	2	$ 1,380.00
Domestic Transport	$	414.31	5	1	$ 2,071.55
Printing/Supplies	$	65.60	1	1	$ 65.60
Translation and Sound	$	1,974.64	1	1	$ 1,974.64
Room Rental	$	1,350.00	1	1	$ 1,350.00
Lunch and Coffee	$	46.02	20	1	$ 920.40
					$ [illegible]
Regional Meeting (Y2, OY1, OY2 ONLY)			# People	# Days	
Regional Transport - Egypt	$	390.00	2	1	$ 780.00
Regional Transport - Lebanon	$	409.00	2	1	$ 818.00
Regional Transport - Iraq	$	493.00	2	1	$ 986.00
Hotel Max Per Diem	$	246.00	6	[illegible]	$ [illegible]
M& Expenses Per Diem	$	138.00	6	3	$ 3,277.00
Translation and Sound	$	1,974.64	1	3	$ 5,923.92
Room Rental	$	1,350.00	1	3	$ 4,050.00
Lunch and Coffee	$	46.02	24	3	$ 3,313.44
					$ 20,838.56
Threat Reduction Workshop (OY2)			# People	# Days	
Hotel Max Per Diem	$	246.00	22	4	$ 21,648.00
M& Expenses Per Diem	$	138.00	10	4	$ 5,520.00
Domestic Transport	$	414.31	10	1	$ 4,143.10
Printing/Supplies	$	1,574.50	1	1	$ 1,574.50
Translation and Sound	$	1,974.64	1	3	$ 5,923.92
Room Rental	$	1,350.00	1	3	$ 4,050.00
Lunch and Coffee	$	46.02	45	3	$ 6,212.70
Regional Transport - Lebanon	$	409.00	4	1	$ 1,636.00
Regional Transport - Iraq	$	493.00	4	1	$ 1,972.00
					$ 52,680.22

	Y1	Y2	Y3	OY1	OY2
Meeting/Conference Costs	$ 27,589.08	$ 39,205.08	$ 17,366.69	$ 39,205.09	$ 91,885.37

Field Travel Costs	Y1	Y2	Y3	OY1	OY2
Food/Lodging Per Diems	$ 25,000.00	$ 20,000.00	$ 20,000.00	$ 22,500.00	$
Car	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ 1,350.00
Vehicle Maintenance Costs	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00
Tokens of Appreciation	$ 10,318.00	$ 27,036.00	$ 27,036.00	$ 23,277.00	$ 10,000.00
TOTAL	$ 40,308.00	$ 62,626.00	$ 62,626.00	$ 53,367.00	$ 12,360.00

Food/Lodging Per Diems	Y1	Y2	Y3	OY1	OY2	
# trips	2	4	4	3	0	
Per Diem	300	300	300	300	300	(3 field, 1-2 nurses or student)
# days	[illegible]	[illegible]	[illegible]	[illegible]	5	
# sites	[illegible]	[illegible]	[illegible]	[illegible]	5	
Total	$ 25,000.00	$ 20,000.00	$ 20,000.00	$ 22,500.00	0	
Tokens of Appreciation - Humans	Y1	Y2	Y3	OY1	OY2	
# Samples/Qt	300	300	300	300	300	
# Quarters	2	4	4	3	0	
[illegible]	$ 1.21	$ 1.21	$ 1.25	$ 1.25	$ 1.25	
Price per phone card	$ 11.28	$ 11.28	$ 11.28	$ 11.28	$ 11.28	at 1 Phone card per sale [illegible]
Total	$ [illegible]	$ 13,036.00	$ 13,036.00	$ 11,277.00	$	
Tokens of Appreciation - Camel/Poultry	Y1	Y2	Y3	OY1	OY2	
# Samples/Qt	60	60	60	60	60	60 owners at [illegible]
# Quarters	2	2	2	2	2	visiting quarterly, [illegible] every other visit
Price per drug/supplies	$ 100.00	$ 100.00	$ 100.00	$ 100.00	$ 100.00	
Total	$ 12,000.00	$ 12,000.00	$ 12,000.00	$ 12,000.00	$ 10,000.00	

Sites	[illegible]	[illegible]	$/[illegible]	Total
A. Barutha	175	17.5	$ 1.53	$ 26.78
A. Zarqa	58.2	5.82	$ 1.53	$ 8.90
A. Karak	262	26.2	$ 1.53	$ 40.09
Ma'an	438	43.8	$ 1.53	$ 67.01
Aqaba	668	66.8	$ 1.53	$ 102.20
				$ 244.98
	30000	3000	$ 1.53	$ 4,590.00

Field Supplies

			Y1		Y2		Y3		OY1		OY2	
Type	Units/Price	Price	Qy Needed	Total	Qy Needed	Total	Qy Needed	Total	Qy Needed	Total	Qy Needed	Total
Nunc 1.8 internal cryovials	450	$ 516.42	12	$ 6,197.04	17	$ 8,779.14	8	$ 4,131.36	10	$ 5,164.20		
Serum tubes 10 mL	100	$ 31.09	25	$ 777.25	23	$ 715.07	12	$ 373.08	12	$ 373.08		
Serum tubes 3 mL	100	$ 27.31	2	$ 54.62	0	$	1	$ 27.31		$		
Vaccutainer holder	250	$ 20.77	50	$ 1,038.50	50	$ 1,038.50		$ -		$ -		
21g 1in vacutainer safety needles	48	$ 39.92	30	$ 1,197.60	28	$ 1,117.76	15	$ 598.80	14	$ 558.88		
18g 1in vacutainer needles	100	$ 32.19	5	$ 160.95	5	$ 160.95	3	$ 96.57	2	$ 64.38		
3cc luer lock syringe	100	$ 21.80	2	$ 43.60		$ -	1	$ 21.80		$ -		
22g 1in needle	100	$ 19.80	2	$ 39.60		$ -	1	$ 19.80		$ -		
Cotton Swabs	500	$ 400.00	5	$ 2.000.00	10	$ 4,000.00	0	$	5	$ 2,000.00		
Gloves	50	$ 29.65	7	$ 207.55	14	$ 415.10	0	$ -	6	$ 177.90	0	$ -
Masks N95	50	$ 47.75	7	$ 334.25	7	$ 334.25	7	$ 334.25	5	$ 238.75	0	$ -
Tyvek Suits (project supply)	25	$ 350.00	52	$ 18.200.00	0	$	0	$	0	$	0	$
Googgles (project supply)	12	$ 135.00	2	$ 270.00	0	$ -	0	$ -	0	$ -	0	$ -
Booties (project supply)	200	$ 300.00	7	$ 2,100.00	0	$ -	0	$ -	0	$ -	0	$ -
Biohazard Bag (project supply)	200	$ 155.00	2	$ 310.00	0	$ -	0	$ -	0	$ -	0	$ -
Sharps Container	20	$ 200.00	1	$ 200.00	1	$ 200.00	1	$ 200.00	1	$ 200.00		$ -
Alcohol Swabs	1200	$ 32.00	4	$ 128.00	7	$ 224.00	2	$ 64.00	4	$ 128.00		$ -
Tablets	1	$ 200.00	5	$ 1,000.00		$ -		$ -		$ -		$ -
Dry Ice	1 week	$ 150.00	6	$ 900.00	12	$ 1,800.00	12	$ 1,800.00	9	$ 1,350.00		$ -
Eye wash station	1	$ 275.00	1	$ 275.00		$ -		$ -		$ -		$ -
Card reader system		$ 1,500.00	1	$ 1,500.00		$ -		$ -		$ -		$ -
TOTALS				**$ 36,933.96**		**$ 18,784.77**		**$ 7,666.97**		**$ 10,255.19**		**$ -**

Nunc 1.8 internal cryovials	PCRs - 2 swabs/animal or person
Serum tubes 10 mL	1 per human, 2 per animal serology
Serum tubes 3 mL	1 per chicken serology
Vaccutainer holder	100
21g 1in vacutainer safety needles	1 per human serology
18g 1in vacutainer needles	1 per camel serology
3cc luer lock syringe	1 per chicken serology
22g 1in needle	1 per chicken serology
Cotton Swabs	PCRs - 2 swabs/animal or person

	YEAR 1			YEAR 2			YEAR 3			OPTION YEAR 1			OPTION YEAR 2		
TESTS	# Y1	Price	Total	# Y2	Price	Total	# Y3	Price	Total	# OY1	Price	Total	# OY2	Price	Total
MERS PCR Humans	600	$ 15.00	$ 9,000.00	1200	$ 15.00	$ 18,000.00	1200	$ 15.00	$ 18,000.00	900	$ 15.00	$ 13,500.00		$ 15.00	$ -
MERS PCR camels	200	$ 15.00	$ 3,000.00	400	$ 15.00	$ 6,000.00	400	$ 15.00	$ 6,000.00	300	$ 15.00	$ 4,500.00		$ 15.00	$ -
MERS PCR Sequencing of positives	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00		$ 100.00	$ -
AI PCR Humans	600	$ 15.00	$ 9,000.00	1200	$ 15.00	$ 18,000.00	1200	$ 15.00	$ 18,000.00	900	$ 15.00	$ 13,500.00		$ 15.00	$ -
AI PCR poultry	200	$ 15.00	$ 3,000.00	400	$ 15.00	$ 6,000.00	400	$ 15.00	$ 6,000.00	300	$ 15.00	$ 4,500.00		$ 15.00	$ -
AI PCR Sequencing of positives	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00	20	$ 100.00	$ 2,000.00		$ 100.00	$ -
MERS Serology humans PP	330	$ 40.00	$ 13,200.00	0	$ 40.00	$ -	330	$ 40.00	$ 13,200.00	330	$ 40.00	$ 13,200.00			
MERS Serology camels ELIZA	100	$ 15.00	$ 1,500.00	0	$ 15.00	$ -	100	$ 15.00	$ 1,500.00	100	$ 15.00	$ 1,500.00		$ 15.00	$ -
AI serology humans	300	$ 6.00	$ 1,800.00	0	$ 6.00	$ -	300	$ 6.00	$ 1,800.00	300	$ 6.00	$ 1,800.00		$ 6.00	$ -
AI serology poultry	100	$ 6.00	$ 600.00	0	$ 6.00	$ -	100	$ 6.00	$ 600.00	100	$ 6.00	$ 600.00		$ 6.00	$ -
AI serology Subtype Tesing	100	$ 15.00	$ 1,500.00	100	$ 15.00	$ 1,500.00	100	$ 15.00	$ 1,500.00	100	$ 15.00	$ 1,500.00		$ 15.00	$
Brucella serology humans	300	$ 1.00	$ 300.00	0	$ 1.00	$	300	$ 1.00	$ 300.00	300	$ 1.00	$ 300.00		$ 1.00	$
Brucella serology camels	100	$ 1.00	$ 100.00	0	$ 1.00	$	100	$ 1.00	$ 100.00	100	$ 1.00	$ 100.00		$ 1.00	$
Brucella serology other ruminants	100	$ 1.00	$ 100.00	0	$ 1.00	$	100	$ 1.00	$ 100.00	100	$ 1.00	$ 100.00		$ 1.00	$
Brucella Complement Fixation Test	100	$ 10.00	$ 1,000.00	0	$ 10.00	$	100	$ 10.00	$ 1,000.00	100	$ 10.00	$ 1,000.00	0	$ 10.00	$
Lepto serology humans	400	$ 8.00	$ 3,200.00	0	$ 8.00	$	400	$ 8.00	$ 3,200.00	400	$ 8.00	$ 3,200.00		$ 8.00	$
Lepto serology camels	100	$ 8.00	$ 800.00	0	$ 8.00	$	100	$ 8.00	$ 800.00	100	$ 8.00	$ 800.00		$ 8.00	$
Lepto serology other ruminants	100	$ 8.00	$ 800.00	0	$ 8.00	$	100	$ 8.00	$ 800.00	100	$ 8.00	$ 800.00		$ 8.00	$
Lepto Serovar Test	60	$ 10.00	$ 600.00	0	$ 10.00	$	60	$ 10.00	$ 600.00	60	$ 10.00	$ 600.00	0	$ 10.00	$
Lepto PCR humans			$			$			$			$			$
Lepto PCR camels			$			$			$			$			$
Lepto PCR other ruminants			$			$			$			$			$
			$ -			$ -			$ -			$ -			$ -
		Y1 Total	$ 53,500.00			Y2 Total	$ 53,500.00			Y3 Total	$ 77,500.00			OY1 Total	$ 65,500.00			OY2 Total	$ -

HDTRA1-14-24-FRCWMD-BAA
CBEP = Thrust Area 6 - Cooperative Counter WMD Research
with Global Partners FRCWMD

"Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan & Strengthening Regional Disease Surveillance Capacity"

Abstract: In line with Thrust Area 6 - Cooperative Counter WMD Research with Global Partners FRCWMD, we propose a multi-disciplinary One Health research project to identify causal factors in the transmission of Middle East Respiratory Syndrome Coronavirus (MERS), avian influenza (AI), and other zoonoses from animals to humans in Jordan, while simultaneously strengthening local capacity for prevention, detection, and reporting of these zoonoses in Jordan, Iraq, and Lebanon. Little is known about the transmission routes of MERS, AI, and other key zoonoses at human-livestock/poultry interfaces in Jordan. To fill this gap and contribute to biological threat reduction, we propose a hypothesis-driven One Health research project to characterize exposure risks for MERS and AI in Jordan using epidemiological causal inference techniques and improving serological technology. This prospective cohort study involves interviews and longitudinal sampling of humans and opportunistic non-lethal sampling of livestock and poultry at animal markets, farms, and abattoirs for MERS, *Brucella* spp., and *Leptospira* spp. (humans/livestock) and for AI subtypes (humans/poultry). Partner laboratories in Jordan will screen and characterize these zoonotic pathogens, and capacity-building cross-trainings will be conducted with visiting laboratory scientists from Iraq and Lebanon. This multifaceted One Health approach will advance scientific knowledge on the risk of MERS, AI, and other zoonoses in Jordan, strengthen local zoonotic disease surveillance capabilities, and enhance scientific partnerships in Jordan, Iraq and Lebanon to prevent, detect, and report MERS, AI, and other zoonotic threats.

Background: There have been over 2,200 cases and 790 deaths across 27 countries from MERS since 2012. Although most cases occurred in the Kingdom of Saudi Arabia (KSA), the first known human infections occurred in Jordan. Most KSA cases have been healthcare-associated, stemming from secondary generations of transmission. Identification of factors involved in *primary* transmission may inform interventions to prevent future primary cases and therefore prevent them from seeding healthcare or community outbreaks. Camels are the presumptive source of primary human MERS infections; however, the exact mechanisms of transmission and the possible role of other livestock species are unclear. These uncertainties highlight the need to better understand the causal factors of primary human infection with MERS at human-livestock interfaces. **Understanding modifiable risk factors may lead to development of public health interventions that can prevent animal-to-human transmission of zoonoses.**

Avian influenza viruses circulate worldwide among migratory bird populations and occasionally spill into poultry at mass production sites, farms, or backyard coops. Although not every AI subtype is capable of infecting humans or causing severe illness, there have been worrisome outbreaks. AI A/H5N1 has been detected in humans in 16 countries since 2003, resulting in 860 cases and 454 deaths by July 2018. Of these, nearly 42% were in neighboring Egypt. Due to antigenic shifts typical of the influenza viral genome, there is always a possibility of new AI subtypes emerging capable of infecting humans. **In Jordan, the rapidly expanding poultry industry driven by ever-increasing demand poses a distinct global health security risk.**

Identification and characterization of AI subtypes circulating among poultry across Jordan will provide critical information needed to understand baseline activity and risks. If human AI infections are detected, the project could identify causal factors in poultry-to-human influenza transmission, and therefore inform interventions to prevent future primary cases. **Given the human AI infections in neighboring countries, this is a critical gap to be filled in Jordan.**

Other zoonoses, such as *Brucella* spp. and *Leptospira* spp., also cause morbidity in Jordan, and surveillance for them can be easily integrated into the research study as secondary outcomes. All samples may be made available to other DTRA- or USG-funded researchers.

Scientific Impact for C-WMD Science: Given that transmission of high-consequence zoonotic pathogens such as MERS and AI, whether by nature or ill intent, poses a significant threat to global security, existing gaps in biosurveillance/detection capabilities, prevention/response activities, and reporting weakens our ability to counter biological WMD threats. Over 60% of emerging infectious diseases originate in animals, so it is imperative to strengthen local capacity to conduct biosurveillance for zoonotic disease threats to understand existing baselines of transmission, characterize risk factors to inform prevention activities that can interrupt transmission, and preempt and/or rapidly respond to emerging disease threats.

Our primary objectives are to characterize causal factors in animal-to-human transmission of MERS, AI, and other zoonoses in Jordan and to strengthen regional capacity for detection of these pathogens in order to reduce the threat of infectious diseases. Our proposed project will rigorously test the following initial hypotheses:

H_1. Livestock species and poultry in Jordan show evidence of infection with MERS, AI, and/or other assayed zoonoses. (*Output: Geospatial maps of naturally-occurring zoonotic viruses and bacteria capable of infecting humans developed with and shared with government authorities*)

H_2. Humans occupationally exposed to livestock and/or poultry have a greater risk of infection with MERS, AI, and/or other assayed zoonoses compared to other community members in Jordan. (*Output: Geospatial risk maps developed with and shared with government authorities*)

H_3. Some specific occupational practices that promote exposure to specific animal biohazards (e.g., blood, urine, feces, and/or nasal secretions) pose a greater risk of infection with MERS, AI, and other assayed zoonoses compared to others. (*Output: Enhanced understanding of modifiable risk factors to inform government authorities on prevention activities*)

Knowledge generated from this project will confirm the presence of MERS, AI, and other zoonoses at human-livestock/poultry interfaces in Jordan, characterize specific occupational practices as causal factors in human infection with these zoonoses, and identify modifiable risk factors that may be used to inform prevention activities. The project will build and boost local capacity for prevention, detection, and reporting of zoonotic disease threats in Jordan, Iraq and Lebanon through regional cross-training workshops held in Jordan, all of which have substantial camel and poultry production (**Fig. 1**). This will fill capacity gaps, strengthen collaborative relationships, and foster goodwill in a politically fragile region, enhancing our ability to combat biological threats.

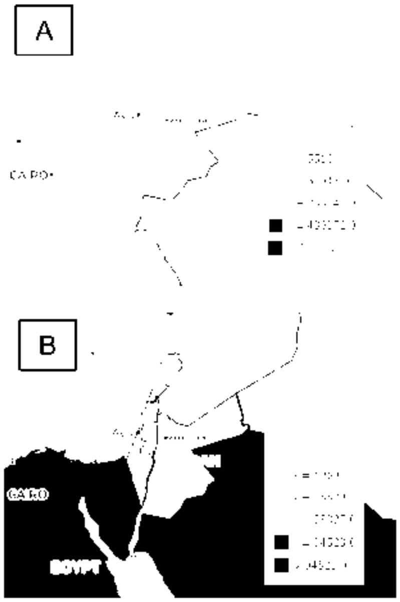


Figure 1: Regional map of live camel (A) and poultry (B) production, 2015.

Methodology: We propose to conduct a prospective cohort study with repeated surveys at various human-livestock/poultry interfaces across Northern, Middle, and Southern Jordan. Each interface will be visited thrice a year for 3 years (9 total visits per site) or 4 and 12 respectively if option years are exercised.

During each human-livestock interface visit, livestock (e.g., camels, goats, sheep, cattle) will be opportunistically tested for evidence of active infection with MERS using nasal swabs. During the first, fifth, and final visits, livestock will be opportunistically tested for past infection with MERS, *Brucella* spp., and *Leptospira* spp. using sera. Swab samples will be pooled by species + site + visit date and tested via real-time PCR. Serum samples will be tested via Luminex. During each human-poultry interface visit, poultry will be sampled for AI using oropharyngeal swabs. During the first, fifth, and final visits, poultry will be opportunistically tested for past infection with AI using sera.

Individuals at each site and its surrounding community will be approached for enrollment at the first visit. Those providing informed consent will complete a standardized questionnaire (the previously Jordan-approved and tested PREDICT-2 questionnaire augmented with study-specific items) during the first visit and complete a shorter questionnaire at each subsequent visit to account for time-varying factors. Participants will provide oropharyngeal and nasopharyngeal swabs at each visit and sera at the first, fifth, and final visits. These samples will be tested using PCR for the swab samples (MERS and AI) and Luminex serology for the serum samples (all 4 zoonoses).

Data will be analyzed to generate geospatial maps of livestock and poultry zoonoses, geospatial maps of human zoonotic disease risk (including static and seasonal versions), exposure risk models using causal inference techniques, and prediction models for transmission that can account for seasonal variations and wide-scale livestock/poultry practice trends.

Implementation of Luminex Serological Technology: Luminex technology for serology and associated equipment will be acquired for participating laboratories in Jordan. Training workshops will be held in Jordan for regional scientists, with refresher trainings held annually.

Regional Capacity Building: Iraqi and Lebanese scientists from their Ministries of Health and Agriculture will be invited to participate in capacity-building workshops in Jordan. Workshops will cover topics including implementing/using Luminex technology, animal and human sampling fieldwork, ethical human subjects research, biosafety and biosecurity best practices, data management and storage, and reporting procedures pursuant to OIE, WHO, IHR, and GHSA obligations. Advance technical training for key individuals is proposed for option years.

Our research project will serve multiple goals and objectives of the CBEP mission, by: 1) engaging partner country scientists in hypothesis-driven research; 2) supporting biosurveillance capacity building by enhancing partner capability to detect and report select agents; 3) enhancing understanding of zoonotic diseases to allow differentiation of natural versus nefarious emergence events; 4) employing responsible bio-risk management best practices; 5) training partner country researchers to think critically about ethical research and be competitive in soliciting international funding; and 6) promoting a One Health concept.

Core Team and Project Organization:

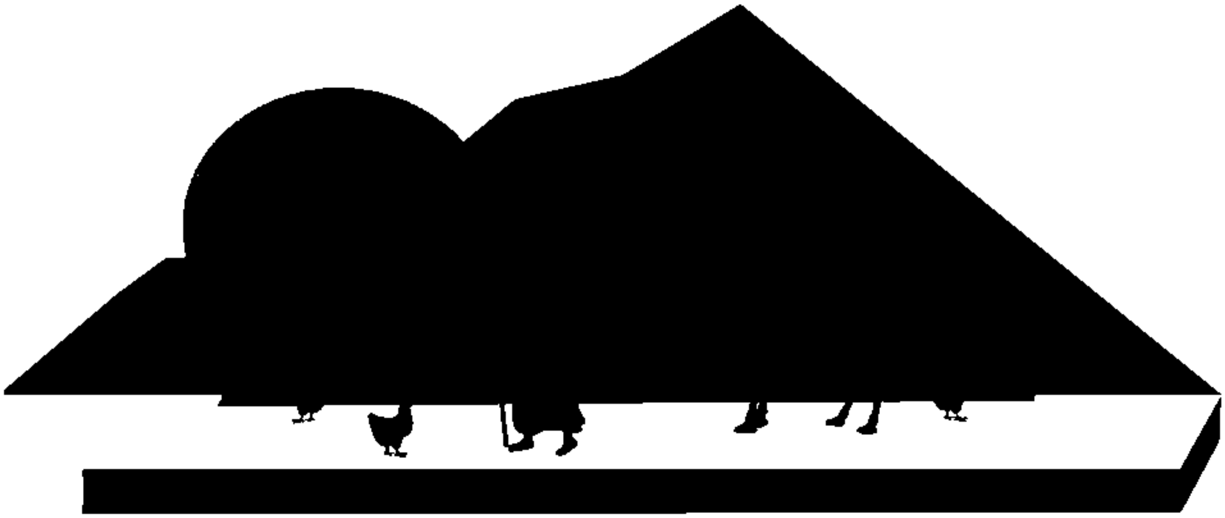
- EcoHealth Alliance (EHA, prime), led by Dr. William Karesh (PI) and Dr. Patrick Dawson (co-PI), will design, implement, and oversee the research project; lead all contractual obligations with DTRA and project sub-awardees; coordinate travel and organize workshops; manage the information database; ensure coordination between partners; and collaborate with our partners in analyzing the data and publishing it.
- Jordan University of Science and Technology (JUST), led by Dr. Ehab Abu-Basha (co-PI), will conduct fieldwork and laboratory work on the research study. EHA has worked extensively with JUST and Dr. Abu-Basha on the USAID PREDICT-2 project, conducting viral surveillance among humans and animals and risk characterization since 2016.
- Partner Laboratories: JUST (Irbid, Jordan) and Jordan Ministry of Agriculture (Amman, Jordan). These institutions have demonstrated capacities for all required laboratory work, training workshops, and specimen storage. Additional laboratory partners may be added following consultation with national partners and DTRA.

Potential Challenges, Solutions, and Statistical Considerations: The main potential challenge will be a low detection rate of MERS, AI, and other zoonoses among human participants. However, power calculations to determine an appropriate sample size will be informed using recent, credible findings from the PREDICT-2 project. Another potential challenge is addressing cultural sensitivities while conducting work, such as avoiding stigmatization of livestock workers or working with various Bedouin communities. EHA and JUST have extensive experience in this domain through PREDICT-2, and have fostered positive relationships with community leaders and liaisons throughout Jordan. To reduce regional instability risk, we will be work in Jordan, a stable bedrock in the region, and will invite regional scientists to workshops inside Jordan rather than traveling to them.

Major Goals and Milestones: 1) Determine the presence of MERS, AI, and other zoonoses among livestock and/or poultry in Jordan. 2) Determine whether (and if so, the extent to which) humans at human-livestock/poultry interfaces display evidence of infection with these zoonoses. 3) Characterize causal factors in animal-to-human transmission of these zoonoses. 4) Produce geospatial maps of zoonoses in livestock and poultry and of human zoonotic transmission risk. 5) Identify specific modifiable risk factors for human infection with these zoonoses. 6) Implement Luminex serological technology in Jordan for enhanced diagnostic and detection capabilities. 7) Strengthen local capacity for detection and reporting of MERS, AI, and other zoonoses in Jordan, Iraq, and Lebanon through workshops.

Proposed Budget (in US$)

Organization	Year 1	Year 2	Year 3	OY1	OY2
EcoHealth Alliance (Prime)	$492,000	$495,000	$498,000	$490,000	$445,000
JUST	$487,000	$493,000	$498,000	$500,000	$430,000
TOTALS	**$979,000**	**$988,000**	**$996,000**	**$990,000**	**$875,000**



Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan & Strengthening Regional Disease Surveillance Capacity

Annual Report Year 1

Principal Investigator: Dr. William Karesh, DVM

EcoHealth Alliance

Grant/Award #: HDTRA12010029
PI Name: Dr. William B. Karesh
Organization/Institution: EcoHealth Alliance
Project Title: Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan & Strengthening Disease Surveillance Capacity

Goal number, Milestone	Proposed completion
1, Implement animal study	Y1-OY1
1, Conduct PCR and serology testing	Y1-OY2
2, Implement human cohort study	Y1-OY1
2, Conduct PCR and serology testing	Y1-OY2
3, Implement behavioral risk survey	Y1-OY1
3, Conduct epidemiological analyses	Y1-OY2
4, Generate geospatial distribution and risk maps	Y1-OY2
5, Host workshops	Y1-2, OY1-2
5, Submit reports and publications	Y1-OY2
5, Attend presentations/meetings	Y1-OY2
6, Conduct causal interference analyses	Y3-OY2
6, Policy recommendations on modifiable risk factors	Y3-OY2

Project Goals

1. Determine the presence of MERS-CoV, AI, and other zoonoses among livestock and poultry in Jordan

    a. *Description:* Implement animal study (Y1-OY1); Conduct PCR and serology testing (Y1-OY2)

    b. ***Status of Effort:*** Approval for animal research has been obtained from the Jordan University of Science and Technology (JUST) and Tufts University, and surveillance determination has been obtained from ACURO. Obtaining these approvals included achieving many milestones, including drafting and finalizing procedures, and the animal owner consent to sample. The animal field and laboratory teams are finalizing SOPs for data collection and testing.

2. Determine whether (and if so, the extent to which) humans at human-livestock/poultry interfaces display evidence of infection with these zoonoses

    a. *Description:* Implement human cohort study (Y1-OY1); Conduct PCR and serology testing (Y1-OY2)

    b. ***Status of Effort:*** Approval for human subjects research has been obtained from JUST (in-country approval) and Health Media Lab Research and Ethics (HML) IRB (U.S.-based approval), and we are awaiting the determination for human subjects research approval from HRPO. The data collection tools have been finalized including the surveys, code of surveys into Open Data Kit (ODK) for use on tablets, and the data management system in Airtable for laboratory data.

3. Characterize causal factors in animal-to-human transmission of these zoonoses

    a. *Description:* Implement behavioral risk survey (Y1-OY1); Conduct epidemiological analyses (Y1-OY2)

    b. ***Status of Effort:*** Final approval for data collection is pending from HRPO, but data collection tools have been finalized. To develop the final behavioral risk survey, several milestones were met, including collaboratively determining the data analysis plan and the creation of the survey guide. Our causal inference approach necessitated a literature review of confounders and pathways, construction of causal diagrams, and a collaborative discussion amongst team members to determine which human behavioral risk questions would be important variables in our analysis (the data analysis plan). Once consensus was achieved on variables to include in our models, the team collaboratively determined the appropriate formulation of questions, the order of questions, and team responses to typical potential participant questions (addressed in the survey guide).

4. Produce geospatial maps of zoonoses in livestock and poultry and of human zoonotic transmission risk

    a. *Description:* Generate geospatial distribution and risk maps (Y1-OY2)

    b. ***Status of Effort:*** The data management system was put into place (Airtable for managing laboratory data) and a draft report written with mock data in order to ensure the data curation system is in place for the start of data collection. The final interface sites were selected for the project for the five regions.

5. Strengthen local capacity for detection and reporting of MERS-CoV, AI, and other zoonoses in Jordan, Iraq, and Lebanon

    a. *Description:* Host workshops (Y1-2, OY1-2); Submit reports and publications (Y1-OY2); Attend presentations/meetings (Y1-OY2

    b. ***Status of Effort:*** The Project Launch Workshop and Jordan Training Workshop 1 were successfully completed virtually due to the COVID-19 situation, except for the third day of the Jordan Training Workshop 1 which was safely held in-person on May 27th. Training at the Human Link lab at the National Research Centre in Egypt is slated to be held in late summer due to the COVID-19 situation in the region. The team will update and evaluate timing of this training considering team safety and local travel and government restrictions to be completed at the earliest possible date.

6. Identify specific modifiable risk factors for human infection with these zoonoses

    a. *Description:* Conduct causal interference analyses (Y3-OY2); Policy recommendations on modifiable risk factors (Y3-OY2)

    b. ***Status of Effort:*** The associated tasks are slated for Y3-OY2.

Y1 Accomplishments

Task 1: Determine the presence of MERS-CoV, AI, and other zoonoses among livestock and poultry in Jordan.

Subtask 1.1 Identify sites for project study

Activities and results this year:

Figure 1. Map of the study area and villages possible to sample from.

- Project staff reviewed site selection criteria and collaborated with the team to produce a solution for spatial sampling using a spatial sampling application. This application was developed by an EHA scientist for potential applications in studies that sample from mixed human and animal subjects, and from the environment.
- Project staff reviewed site selection criteria and with input from local subject matter experts (SMEs). With their input, the list of sites was narrowed down to include villages with the three interface sites represented and sufficient human population. Using the Shiny App, the team then randomly selected five sites in Jordan from this narrowed down list.

Subtask 1.2 Obtain local permissions and approvals to work with animals

Activities and results this year:

- The animal owner consent forms were finalized with input
  from local subject matter experts (SMEs) familiar with sampling communities.
- The JUST IACUC for research with animal subjects was submitted and full approval was obtained.
- JUST approval for use of the animal owner consent forms
  was obtained.
- ACURO approved the animal IACUC and determined the projects protocol was a surveillance project. No further action is required.
- The first draft of the animal sampling protocol has been completed and is currently being reviewed by partners.

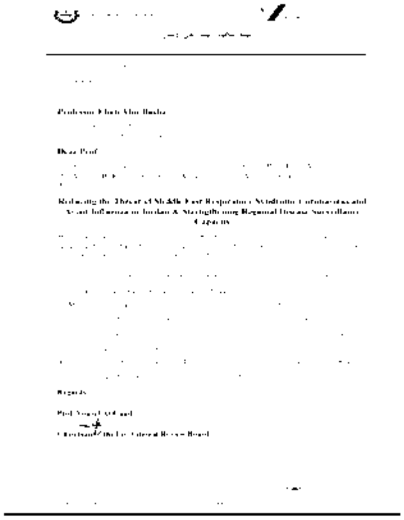


Figure 2. Approval from JUST IRB

Future Tasks

Subtask 1.3 Conduct biological sampling of animals inthe study areas

Subtask 1.4 Conduct lab testing for AI, MERS-CoV,brucellosis and leptospirosis

<u>Task 2: Determine whether (and if so, the extent to which) humans at human-livestock/poultry interfaces display evidence of infection.</u>

Subtask 2.1 Identify sites and conduct enrollment for human study component

Activities and results this year:

- The project staff determined there will likely be a higher rate of loss to follow-up than initially projected. To account for an increased loss to follow-up, the target number for human enrollment for the first year will be increased to 100 people at each site for a total of 500 people for the first year. Protocol and approval documents have been updated as appropriate.
- The project staff have selected the villages below for sampling:
    1. WC34+58 Dabet Hanut, Quaira, Aqaba
    2. HHF4+55 Al-Mansoura, Shoabak, Ma`an
    3. 8G3R83WF+5G Al Damkhi, Karak
    4. RRM8+8F Azraq, Zarqa
    5. F4PG+QH, Hosha Sub-District, Ramtha, Irbid
- The team developed a draft Human and Animal sampling protocol in preparation for enrollment of human and animal participants.

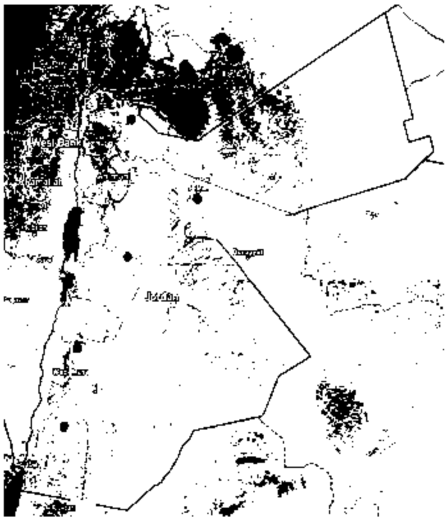


Figure 3. Map of the study area and villages selected within the 5 regions.

Subtask 2.2 Obtain local permissions and approvals to work with human subjects

Activities and results this year:

- Obtained human subjects research approval from the local ethics review board at JUST (2/23/21). The human subjects research and human sampling protocol was submitted to HML IRB for US-based approval.
- Prior to purchasing equipment, the team needs to acquire a tax exemption letter from the Jordanian government.
- Supported JUST in their application for a Federal Wide Assurance number.
- Approval of the human subjects research and human sampling protocol from HML IRB was obtained (4/23/21).
- Submitted an amendment to the local ethics review board at JUST and full approval was given (4/26/21).
- The human subjects research and human sampling protocol was submitted to the Human Research Protection Office (HRPO) (5/4/21).

Future Tasks

Subtask 2.3 Conduct biological sampling

- Equipment purchased
  - Field Vehicle: 2021 MGRX8

Subtask 2.4 Conduct testing for AI, MERS-CoV, brucellosis and leptospirosis

- Equipment purchased
  - Synergy HTX Multi-Mode microplate reader and PC

Task 3: Characterize causal factors in animal-to-human transmission of these zoonoses.

Subtask 3.1 Obtain local permissions and approvals to work with human subjects

Activities and results this year:

Figure 4. Virtual meeting regarding project questionnaire development and analysis plan

- The Jordanian team and EcoHealth Alliance (EHA) behavioral risk scientists collaboratively built and finalized the Animal History Form, Field Data Sheet, Human Questionnaire, and Site Characterization Form.
- Local JUST IRB approval obtained.
- The Human questionnaire, Site Characterization Form, and Animal History Form have been drafted and coded for Open Data Kit (ODK). Tablets were purchased for the Jordan team.
- The JUST IRB approved an amendment for the human subjects research.
- HML IRB approved the protocol for U.S.-based IRB approval.
- The human subjects research and human sampling protocol were submitted to HRPO.

Subtask 3.3 Analyze epi causal inference to identify modifiable risk factors

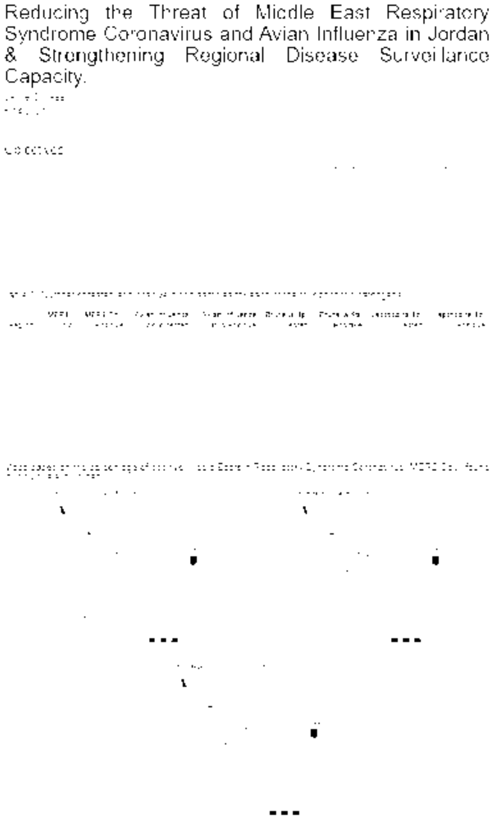
Activities and results this year:

- Worked with the project staff and SMEs to compile a list of epidemiological risk factors, behaviors, and general exposure risk factors to be used in data analysis.
- During the human subjects research workshop, the team worked to collaboratively compose the survey guide to provide clarity of question purpose and application for field staff to support data fidelity across sampling events. In scenarios where subjects might need support in understanding questions, ensuring that field staff understand the risk factors being analyzed in each

question will support survey strength.

Future Subtask(s)
Subtask 3.2 Conduct behavioral risk factor surveys in people

Task 4: Produce geospatial maps of zoonoses in livestock and poultry and of human zoonotictransmission risk.



Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan & Strengthening Regional Disease Surveillance Capacity.

Figure 5. Geospatial map R Markdown file with mock laboratory data

Subtask 4.1 Generate maps of laboratory results

Activities and results this year:

- The project staff created a geospatial risk summary report using the package R Markdown in RStudio for future stakeholder meetings that includes maps to demonstrate the percentage of positive tests over the total amount of humans and animals tested for the four zoonotic pathogens in Jordan for this project.

Future Subtask(s):
Subtask 4.2 Generate risk maps with human behavioral risk factors

Task 5. Strengthen local capacity for detection and reporting of MERS-CoV, AI, and other zoonoses in Jordan, Iraq, and Lebanon

Subtask 5.1 Conduct project kick-off meeting in Amman with local stakeholders

Activities and results this year:

- The Jordan MERS/AI project launch meeting was held on January 27th, 2021. In order to adhere to COVID-19 safety guidelines, the meeting was held virtually using a password-protected system. The launch meeting was a success and highlighted the centrality and investment in collaboration for this project. The launch was also an opportunity to engage additional key stakeholders to promote synergies with existing biodefense/health security activities, and provided a forum to share One Health approaches that could potentially be sustained by the Ministry of Health.

Subtask 5.2 Train local project staff in proper techniques

All research team members are equipped with CITI training in human subjects research, and the global team will continue to provide capacity-building through trainings and workshops on subjects integral to this project and to future public health work, including best practices regarding research and data security, survey tool development, and risk communication.

Figure 6. First and second days of virtual first annual project training workshop

- The first annual project training workshop took place over the course of three days, and was attended by team members, including university students. The first and second day of the workshop was held virtually, and the third day of the workshop was held in person.

- The sessions held during the two-day virtual workshop included training on:
    - Data management use and storage - facilitated by Jamie Cooksey and Dr. Whitney Bagge
    - Ethical human subject research - facilitated by Emily Hagan and Stephanie Martinez
    - Ethical animal subject research - facilitated by Hani Talafha
    - Questionnaire administration - facilitated by Emily Hagan and Stephanie Martinez
    - Safe human and animal sampling - facilitated by Dr. Basil Amarneh and Dr. Zaidoun Hijazeen

- The third day of the workshop (May 27th, 2021) included training on basic laboratory safety: biosafety and biosecurity, facilitated by Dr. Mustafa Ababneh, and cold chain implementation, facilitated by Dr. Borhan Al-Zghoul.
    - Due to the COVID-19 group limitation, 7 people attended the third in-person workshop:
        - Dr. Mustafa Ababneh (JUST)
        - Dr. Borhan Al-Zghoul (JUST)
        - Yasmin Issa Daradkeh (graduate student, JUST)
        - Farah Al. Nabulsi (graduate student, JUST)
        - Abed Elrahman Talfha (undergraduate student, JUST)
        - Leen Al-Bayari (undergraduate student, JUST)
        - Dr. Omar Al-Omari, MD

Figure 7. In-person workshop on basic laboratory safety

- March 29, 2021: Dr. Ehab Abu-Basha reviewed the diagnostic laboratories in Al-Karak and Ma'an to determine the limitations and status of veterinary services in the south of Jordan (the report was a follow up to previous visits in 2017 and 2019).
    - Recommendations are as follows:
        - Complete laboratory building infrastructure with suitable benches, sinks, and cabinets (Karak Lab).
        - Hire adequately trained veterinarians and laboratory technicians to the laboratories.
        - Provide adequate training on safety, proper use, and maintenance of laboratory equipment and chemicals.
        - Provide adequate amount of laboratory diagnostic chemicals, supplies and kits.
        - MOA should recruit staff to Ma'an and provide incentives for relocation.

Subtask 5.6 Data Management

- The project staff have finalized data management tools and decided to use ODK Connect servers to securely store survey data and Airtable servers for human and animal lab data. Only the specific app users for each of the servers can access the secure data.
- Training for the data management systems was completed in the project training workshop.

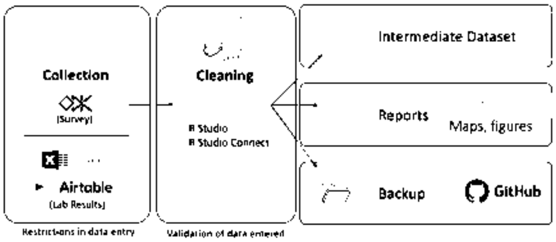


Figure 8. Data management system, from collection to cleaning and reporting results.

- Incorporated the Arabic version of surveys to ODK.
- The project team developed field data sheets and input into the Airtable data management software, and reviewed accessibility and overall design for improvements in conjunction with their review of the field and laboratory protocols.
- The project team has created specific QR codes on ODK Collect for each of the team members to access their own survey to practice using the tablets for when sampling begins.
- For real-time quality control of data collection and entry, the project team has begun coding and developing a series of automated reports using R Studio Connect to be in place for when data collection begins. The intention is that field and laboratory staff serve an active role in data cleaning as they can review data on a biweekly basis and work with EHA data management staff to identify any issues in real time.

Figure 9. A mock example of the QR codes that each team member received.

- The data management team has developed a draft project dashboard for full project progress, to be shared amongst partners to share team and project progress at-a-glance. The dashboard ensures the full team can see the project on all fronts – laboratory, surveys, and human and animal sampling. The dashboard differs from the automated sampling reports, in that the sampling reports are highly detailed accounts of each effort tailored to the sub-team doing that sampling for data cleaning purposes, while the dashboard summarizes the full team effort.

Figure 10. Project Dashboard with mock data.

Subtask 5.7 Conduct presentations/meetings at times and places specified

- Project kick off for HDTRA1-20-1-0029 – Jordan was held on January 13th, 2021. The kick-off meeting was a success and the team had a positive collaboration with DTRA and Jordan partners.
- Project staff also attended a meeting on March 7th at Jordan Armed Forces GHQ (JAF) with LTC. Mohammad Malkawi, Arms Control & International Organizations branch, Directorate of Planning & Organization (DPO), JAF followed-up with letters to the Ministry of Agriculture, Ministry of Health, and Ministry of Environment to form a Focal point committee to the project. Letters were also sent to RSS, Badia Fund, WHO, FAO, USAID, AOAD, and RVC to join the committee. This committee will be updated as part of our projects team ensuring a One Health approach is successfully employed.

- Focal Point Meeting

  The Focal Point meeting took place in Amman, Jordan on April 6, 2021. Dr. Ehab Abu-Basha presented an overview of the project. This event provided an opportunity to clearly establish the role of the Ministry of Agriculture in the context of the project and to discuss upcoming lab visits in the south of Jordan. Follow-up meetings will be conducted online due to COVID-19 regulations.

Figure 11. Focal point meeting in Jordan.

- In attendance at the focal point meeting:
    - Dr. Ehab Abu-Basha, JUST
    - Dr. Zaidoun Hijazeen, JUST
    - Dr. Yasmin Daradkeh, JUST
    - Dr. Laura Sawalha, WHO
    - Dr. Hussein Zyoud, Head of Animal Health Labs, MoA
    - Dr. Essam Hawwa, CVO, MoA
    - Colonel Oday Mrayat, Jordan Armed Forces

- Jordan Team Meeting
    - The Jordan in-country team held a meeting that discussed training and workshops, the human questionnaire, and purchasing activities in preparation for the beginning of data collection on May 10, 2021. The Jordan team is purchasing lab and field materials and establishing and reviewing standard operating procedure (SOPs) for animal and human sampling, questionnaire administration, and laboratory procedures.

Future Subtasks

Subtask 5.3 Host annual partners and stakeholders meeting

Subtask 5.4 Complete annual report and share with partners and stakeholders

Subtask 5.5 Conduct local-regional training workshops

- COVID-19 restrictions have limited in-person workshops, but as the restrictions begin to ease, we are hopeful that we will be able to set a date for the local-regional training workshop, with Human Link Lab at the National Research Centre, Egypt, in August. The team looks forward to engaging with our regional stakeholder to further serve the regional biosecurity and capacity-building objectives of the project.

Tasks to be initiated after Year 1:

Task 6. Identify specific modifiable risk factors for human infection with these zoonoses

Samples and Laboratory Techniques

Samples:

Sample collection will be performed by the JUST field team, under supervision of the Country PI, Dr. Ehab Abu-Basha. This project is conducted by a large group of scientists, researchers and trained field personnel from Jordan University of Science and Technology and Princess Haya Biotechnology Center. Several graduate students are included in the research team where they will receive intensive training on laboratory techniques including serology such as ELISA, complement fixation test, antibody neutralization test as well as molecular diagnostic techniques including DNA isolation, cDNA, PCR, and sequencing. This group of young researchers will continue to provide research and diagnostic services in various locations in the country. Therefore, the project will not only help us be part of a global initiative for the surveillance of major emerging and remerging viral infections of both human and animal origins, but also will provide a nidus for continued national development of capacity in the surveillance and diagnosis of these diseases in Jordan. Furthermore, the project will help provide animal care takers, farmers, and the public at large with valuable data and unique educational opportunities about the occurrence, recognition, and prevention of important zoonotic diseases.

Laboratory or Clinical Techniques:

The pseudo-particle neutralization (ppNT) assay is technique new to JUST and Jordan. Human serum will be tested for MERS-CoV antibodies at the Princess Haya Biotechnology Center and Molecular & Virology Laboratory at JUST. Co-I Kayali from Human Link will be training the JUST team to implement this method.

Many molecular and diagnostic assays by a group of well trained, national scientists and young graduate students and technicians will be performed according to the latest scientific standards. Highly advanced molecular diagnostic assays such as cloning, preparing different PCR products for sequencing, sequence analysis, and utilizing data entry will be performed and routinely used in this laboratory. This will reduce the running time to obtain valuable diagnostic results at a significantly lower cost since scientists and researchers from Jordan used to send such samples to international specialized laboratories around the world for cloning and sequencing.

In Jordan, the molecular and virology laboratory is expected to be an important hub for training and preparing future scientists as many graduate students are being trained in the laboratory to perform various techniques from sample handling to DNA extraction, cDNA synthesis, performing different PCR protocols, cloning, plasmid purification, and sequencing analysis. Several Graduate and undergraduate students will be trained during project time.

Opportunities for training and professional development:

Training

The Jordan Training Workshop 1 provided an opportunity for the team to have in-depth conversations about ethics in human subjects research with particular attention paid to informed consent, recruitment, and safe data handling. Our project's strong focus on tailoring tools and approaches to be reflective of our communities of interest and their protections ensures that team members are fully prepared to work with communities in a manner that is respectful, robust, and able to generate nuanced and important insights. This is an asset to this project, and to the team's future research projects.

In addition to the Jordan Training Workshop 1, all personnel who will be working with human subjects data have completed CITI training in Social-Behavioral-Educational Research and Biomedical Research.

Two graduate and two undergraduate students are being trained as part of this project, including:

- Yasmin Issa Daradkeh (graduate student, JUST)
- Farah Al Nabulsi (graduate student, JUST)
- Abed Elrahman Talfha (undergraduate student, JUST)
- Leen Al-Bayari (undergraduate student, JUST)

During the summer months (July through September), the students will have hands on training for 10 weeks on molecular biology techniques: RNA and DNA extraction, RNA and DNA quantification, cDNA synthesis, conventional and real-time PCR. They will also be trained on how to use an Eliza for serology. Once field work begins, the students will also have the opportunity to participate with the animal and human sampling.

Dissemination of results to communities of interest:

The team developed a 2-page project summary to share with stakeholders on project overview, goals, and intended outputs. This document was shared with the Ministry of Agriculture, Ministry of Health, Ministry of Environment, World Health Organization (WHO)-Jordan, Royal Scientific Society (RSS), Jordan Army Forces (JAF), Food & Agriculture Organization of The United Nation (FAO), and Badia Fund.

A focal point Steering Committee was established to regularly to update all partners about our project and help in implementation of One Health Approach with WHO. Our partners on this committee are the Ministry of Agriculture (MOA), Ministry of Health (MOH), Ministry of Environment (MOE), World Health Organization (WHO), Food and Agriculture Organization (FAO), Royal Scientific Society (RRS), and Badia Fund. Each organization has identified its' representative and are now fully engaged in the project.

Change in plan for the next reporting period to accomplish the goals:

Task 1: Determine the presence of MERS-CoV, AI, and other zoonoses among livestock and/or poultry in Jordan

1.3 Conduct biological sampling in animals within the study area
1.4 Conduct lab testing for AI. MERS-CoV, brucellosis and leptospirosis
- These tasks were scheduled to begin in Q3 of Project Year Y1 but due to both the COVID-19 pandemic and pending HRPO approval, we anticipate to begin sampling in Q4 of Project Year Y1.

Task 2: Determine whether (and if so, the extent to which) humans at human-livestock/poultry interfaces display evidence of infection

2.3 Conduct biological sampling
2.4 Conduct testing for AI. MERS-CoV, brucellosis and leptospirosis
- Same as above, we anticipate to begin sampling in Q4 of Project Year Y1.

Task 3: Characterize causal factors in animal-to-human transmission of these zoonoses
3.2 Conduct behavioral risk factor surveys in people

3.3 Analyze epi causal inference to identify modifiable risk factors
- Same as above, we anticipate to begin sampling in Q4 of Project Year Y1 and preliminary analysis will shortly follow.

Task 4: Produce geospatial maps of zoonoses in livestock and poultry and of human zoonotic transmission risk

4.1 Generate maps of laboratory results and share with partners
4.2 Generate risk maps with human behavior risk data and share with partners
- We anticipate to begin sampling in Q4 of Project Year Y1 and to generate the geospatial maps for the following quarter, Q1, Y2.

Task 5: Strengthen local capacity for detection and reporting of MERS-CoV. AI, and other zoonoses in Jordan, Iraq, and Lebanon

5.3 Host annual partners and stakeholders meeting
- No Change.

5.4 Complete annual report and share with partners and stakeholders
- No Change.

5.5 Conduct local/regional training workshops
- Regional trainings will be conducted considering team safety and regional restrictions on travel. However, we anticipate still holding the training at Human Link in Q4 of Project Year 1 as planned.

5.6 Data management
- No Change.

5.7 Conduct presentations/meetings at times and places specified
- No Change.

Grant Training DCP Matrix

	DOMAINS											
	Domain 1		Domain 2			Domain 3				Domain 4		
	COMPETENCIES											
Training Task	1.1.1	1.1.2	2.1.1	2.1.2	2.1.3	3.1.1	3.1.2	3.1.3	3.1.4	4.1.1	4.1.2	4.1.3
Task 5.5.1 Conduct local-regional training workshops			X	X		X	X	X				

	DOMAINS													
	Domain 5					Domain 6			Domain 7			Domain 8		
	COMPETENCIES													
Training Task	5.1.1	5.1.2	5.1.3	5.1.4	5.1.5	6.1.1	6.1.2	6.1.3	7.1.1	7.1.2	7.1.3	8.1.1	8.1.2	8.1.3
Task 5.5.1 Conduct local-regional training workshops														

Grant Training DCP Matrix

Instructions: *this matrix will help track and capture the alignment of BAA research training and professional development activities to BTRP's Domains, Competencies, and Proficiencies Framework. Please note: alignment is only required to the* ***competency level definitions shown below****.*

1. *in the left-hand column of the above chart, list every training activity to be performed on a separate line, using their task or sub-task number (ex. Task 2; subtask 2.1; subtask 2.1.1)*
2. *place an x or tally against the competencies that align to the training activity. Competency decisions can be made by determining using the definitions listed below and determining if a) the training subject matter corresponds to the defined competency or b) if the training outcome corresponds to the defined competency. Please note: training activities can align to multiple competencies across the 8 domains. (Note: if completing an annual report, stop at step 2; if drafting a Full Proposal, continue to step 3)*
3. *once completed, list the aligned competencies under its corresponding training activities in the grant proposal.*

Domain	**Domain Definition**	**Competency**	**Competency Definition**
1. Disease recognition and prevention of spread	**1.1** Understanding of emerging and high-consequence pathogens (EHCP) in the following realms: morbidity, mortality, transmission, control, disease presentation and distribution, and impact.	**1.1.1** Disease characteristics and impact	Disease characteristics and epidemiology of especially high consequence pathogens (EHCPs) and the diseases they cause, including etiology, signs and symptoms, morbidity, mortality, risk factors, incubation period, period of communicability, mode of transmission, clinical presentation, mechanisms of spillover, reservoir species, spatiotemporal and geographic distributions of affected populations, and demographic characteristics of affected populations (species/age/sex/occupational status/ etc.), including outcomes on population health.

Grant Training DCP Matrix

		1.1.2 Clinical Infection control and animal health biosecurity	Understanding of basic infection prevention and control procedures related to especially high consequence pathogens (EHCPs) for human and animal clinical settings in line with GHSA and IHR milestones (when applicable), including standard precautions (PPE use; disinfection; sterilization); environmental infection control; laboratory testing; nosocomial infections, including AMR; and animal health biosecurity principles, procedures.)
2. Disease identification, detection, confirmation, and reporting	**2.1** Positive identification of emerging and high consequence pathogens (EHCP) and reporting to appropriate authorities.	**2.1.1** Sample collection	Knowledge, understanding and proficiency with procedures for safely and securely collecting appropriate specimens/samples for testing of pathogens (human; animal; environmental), especially EHCPs, and handling and packaging of samples for transport to diagnostic testing laboratories, based on national and international guidelines and best practices, while ensuring specimens will are maintained in condition required for testing (cold chain and or fixation, etc.)
		2.1.2 Test procedures (presumptive/confirmatory)	Knowledge, understanding and proficiency with procedures for conducting screening, diagnostic, and confirmatory testing and interpreting test results for ECHPs from different types of samples using different types of tests (ELISA, PCR, etc.) for high consequence pathogens, including test accuracy, reliability, specificity, and sensitivity and quality control/quality assurance (QA/QC) measures needed to validate testing results.
		2.1.3 Reporting	Knowledge, understanding and proficiency in

			policies and procedures for disease notification and/or bi-directional reporting of surveillance and laboratory data through national information-sharing systems, or to notify regional/international authorities such as WHO/OIE/FAO of a disease, other significant epidemiological event, or potential public health emergency of international concern (as appropriate to roles and responsibilities at each operational level).
3. Analytics, assessment, and research	**3.1** Appropriate study design, data analysis, and implementation of processes, as applies to each discipline.	**3.1.1** Study design and ethics	Knowledge and understanding of scientific methodologies and study design principles (hypothesis development, research plan development, sampling design, strategy for data collection and analysis) and application of research ethics to responsibly address safety, security, and ethical issues related to the research aims and hypotheses, including understanding of issues around dual-use research of concern.
		3.1.2 Methodologies and analysis	Knowledge, understanding and proficiency in the use of statistical and other relevant methodologies for scientific research analyses including practices and approaches for data collection, use and interpretation of statistical data analyses, data visualization, and use of statistical data software tools.
		3.1.3 Dissemination of findings and outreach to stakeholders	Knowledge, understanding and proficiency in the dissemination of research findings through peer-reviewed scientific journal publications, conference presentations and public outreach

Grant Training DCP Matrix

			activities, including engagement with appropriate stakeholders and partners at national, regional, and international levels.
		3.1.4 Resource mobilization and management	Knowledge, understanding and proficiency in the planning, acquisition, mobilization, allocation, management and tracking of financial and non-financial resources for research projects, including proposal development and grant writing.
4. Management, leadership, and advocacy	**4.1** Critical skills, knowledge and behaviors necessary to effectively manage projects and programs, lead teams, champion solutions, inspire action, and sustain programs.	**4.1.1** Plan, implements, and evaluates a project or program	Knowledge, understanding and proficiency in program planning, implementation, monitoring and evaluation, including development and measurement of appropriate indicators, and advocacy, or management/oversight of the process.
		4.1.2 Apply program management techniques throughout the project or program	Knowledge, understanding and proficiency in program management, including timeline and deliverables management, team building, and generating high-level stakeholder support.
		4.1.3 Lead culturally diverse teams to complete a project or program	Knowledge, understanding and proficiency in developing and leading culturally diverse teams, ensuring collaboration among team members, and mentorship of future team leaders.

Grant Training DCP Matrix

5. Quality management systems	**5.1** Knowledge, skills, and abilities required for developing a culture of quality. Operations, services, and infrastructure integrated in a system that meets applicable standards, professional guidelines, and customer requirements for ensuring and maintaining quality and continually improving services.	**5.1.1** Physical environment and equipment	Knowledge, understanding and proficiency with facility and equipment operations and maintenance, and facility management policies and procedures, in support of establishing a culture regarding physical environment and equipment necessary for EHCP detection, management, and control, or management/oversight of these operations, in a system that meets applicable standards, professional guidelines, and customer requirements for ensuring and maintaining quality and continually improving services.
		5.1.2 Qualified, well-trained, and competent workforce	Knowledge, understanding and proficiency with the principles, processes, and methodologies for workforce development and sustainment in relation to EHCP detection, management, and control, including workforce planning, training, refresher training, continuing education, and/or professional development, in a system that meets applicable standards, professional guidelines, and national licensing requirements where applicable.
		5.1.3 Materiel resource management	Knowledge, understanding and proficiency with procedures and policies for procurement and inventory management of materiel resources, including supply chain systems, operations, and infrastructure, or management/oversight of these processes.

		5.1.4 Quality review practices and procedures	Knowledge, understanding and proficiency with quality assurance, quality control, and/or quality management review practices and procedures, based on national or international best practices.
		5.1.5 Document management	Knowledge, understanding and proficiency with document and information management policies and procedures, and program documentation and records/archival management processes.
6. Outbreak preparedness and surveillance	**6.1** Use of operational guidelines, identification and analysis of outbreak situations, and effective communication with stakeholders.	**6.1.1** Operational guidelines	Knowledge, understanding and proficiency with development and implementation of outbreak preparedness, surveillance, investigation, laboratory practices, and response planning and operations guidelines, including case definitions, and demonstrated ability to use related operational tools such as emergency preparedness and response plans, contingency plans, SOPs, and job aids when available. Special note and care should be given to documents designed for health care workers directly combatting an outbreak.
		6.1.2 Identification and analysis	Knowledge and proficiency with principles and processes for developing and maintaining disease outbreak situational awareness capabilities, including coordination and

			communication or reporting across surveillance, laboratory, and other data sources, epidemic intelligence, data analysis, and field epidemiological and outbreak investigation techniques, such as contact tracing, and decision-making in support of these activities.
		6.1.3 Communication systems	Knowledge and proficiency with development, implementation, and sustainment of communications systems for outbreak situational awareness and response, including multisectoral and intrasectoral coordination (including via emergency operations centers or equivalent assets), operational risk communication, and public risk communication.
7. Biosafety	**7.1** The application of knowledge, techniques, and equipment to prevent accidental exposure to and release of emerging and high consequence pathogens (EHCP).	**7.1.1** Biohazard Identification and classification	Knowledge, understanding and proficiency with identification and classification of biohazards associated with EHCPs, for laboratories, hospitals, other biomedical and clinical facilities, and the community, including biohazard risk assessment and characterization, and biohazard identification policies and compliance procedures.
		7.1.2 Biohazard Control Measures (e.g., personal protective equipment, safety practices and equipment, facility design, and administrative controls).	Knowledge, understanding and proficiency with development and implementation of international best practices and procedures for EHCP biosafety and biohazard control measures (substitution, elimination, mitigation) for personnel, equipment, facilities (laboratories, hospitals, and other biomedical and clinical facilities) and the community.

		7.1.3 Biohazard Incident Management	Knowledge, understanding and proficiency with development and implementation of policies, procedures, and operational guidelines, including emergency operation communications systems, for Biohazard Incident Management for EHCP outbreaks, releases or exposures.
8. Laboratory biosecurity	**8.1** Prevent theft, misuse, loss, or deliberate release of emerging and high consequence pathogens (EHCP).	**8.1.1** Biosecurity Risk Identification	Knowledge, understanding and proficiency with principles and procedures for Biosecurity Risk identification, risk assessments, characterization and compliance with recommended international standards and best practices to prevent the loss, theft, or misuse of biological organisms and laboratory/research technologies.
		8.1.2 Biosecurity Risk Mitigation	Knowledge, understanding and proficiency with international best practices for Biosecurity Risk Mitigation, and related risk reduction approaches to enhance physical security, personnel reliability, material control and accountability, transport security, and information security/cybersecurity, and the development and implementation of Biosecurity Risk Mitigation strategies for laboratories, facilities, and personnel to prevent the loss, theft, or misuse of biological organisms, especially EHCPs, and laboratory/research technologies.
		8.1.3 Biosecurity Incident Management	Knowledge, understanding and proficiency with international best practices for Biosecurity Incident Management, and development and implementation of

Grant Training DCP Matrix

			Biosecurity incident management policies and procedures for suspected or confirmed illicit access to pathogens, intruder alerts, and other biosecurity incidents.

Please fill out the requested information on all tabs (click on each bottom colored tab or sheet) labeled Cover Page, Personnel, Publications, Presentations, Impacts, Intellectual Property, and Transitions. For annual reports, please only describe DTRA funded work for the reporting period (July 1, 2019 - June 30, 2020).

Tab	Description
Cover Page	
	Providing information about the project participants and collaborating organizations allows an assessment of performance in promoting partnerships and collaborations.
Publications	The products from an effort demonstrate the excellence of the research and efficacy with which the results are being communicated to colleagues, potential users, and the public. Publications are the characteristic product of research. If there is nothing to report during this reporting period, the awardee shall state "Nothing to Report".
Presentations	The products from an effort demonstrate the excellence of the research and efficacy with which the results are being communicated to colleagues, potential users, and the public. Many projects (thought not all) may develop products other than publications. In all cases, if there is nothing to report during this reporting period, the awardee shall state "Nothing to Report".
Impacts	knowledge, enlarges the pool of people trained to develop that knowledge and techniques or put it to use, and improves the physical, institutional, and information resources that enable those people to get their training and perform their functions. In all cases, if there is nothing significant to report during this reporting period, the awardee shall state "Nothing to Report".
Intellectual Property	Information on any intellectual property demonstrates the value of protectable innovative ideas resulting from sponsored research and includes patents, inventions, and licenses. Submission of this information is not a substitute for other invention reporting requirements under the awards terms and conditions. In all cases, if there is nothing significant to report during this reporting period, the awardee shall state "Nothing to Report".
Transitions	Refers to cases where knowledge resulting from your DTRA sponsored effort will be further developed for, or will be used in, a technology application. Transition sponsors can be entities in DoD, other federal agencies, or industry.

SHADED FIELDS ARE REQUIRED

Report Submitted to	**Defense Threat Reduction Agency**	
Grant/Award #	HDTRA1-20-1-0029	
Organization/Institution	EcoHealth Alliance	
Project Title	Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan & Strengthening Regional Disease Surveillance Capacity	
Name of Submitting Official	Dr. William B. Karesh	
Title of Submitting Official	Executive Vice President for Health and Policy	
Email Address	karesh@ecohealthalliance.org	
Phone Number	212-380-4463	
Submission Date	7/1/2021	
Reporting Period End Date	**June 30th, 2021**	
Reporting Period	Annual	
	Foreign Spending Country	**Foreign Spending ($)**
Country 1	Jordan	$ 201,514.72
Country 2		
Country 3		

Proceed to Personnel

Enter the principle investigator (PI) and all other personnel that have worked at least one person month (~160 hours) on this DTRA project during the reporting period, regardless of the source of compensation.

Instructions	Select the appropriate personnel type from the drop down list.			Enter Suffix (e.g. Jr., Sr., III)	Enter the number of months worked rounded to the nearest month	Enter the FULL name of the university, organization, or institution.	Enter the Hirsch index for PI and Co-PI(s). Single whole number only.	Select whether a student has graduated or not.	Enter a graduation or anticipated graduation date for student in Month Year format.
Award #	**Personnel Type**	**Last name**	**First name**	**Suffix**	**Person Months Worked**	**Organization/Institution**	**Hirsh Index**	**Graduated**	**Graduation date (students)**
Example	*Post-Doc*	*Smith*	*John*	*Jr.*	3	*State University*			
HDTRA1-20-1-0029	PI	Karesh	William		2	EcoHealth Alliance	42		
HDTRA1-20-1-0029	Research Associate/Scientist	Bagge	Whitney		4	EcoHealth Alliance			
HDTRA1-20-1-0029	Research Associate/Scientist	Hagan	Emily		2	EcoHealth Alliance			
HDTRA1-20-1-0029	Research Associate/Scientist	Martinez	Stephanie		2	Ecohealth Alliance			
HDTRA1-20-1-0029	Research Associate/Scientist	Cooksey	Jamie		7	Ecohealth Alliance			
HDTRA1-20-1-0029	Research Associate/Scientist	Abu-Basha	Ehab		9	JUST			
HDTRA1-20-1-0029	Research Associate/Scientist	Hijazeen	Zaidoun		6	JUST			
HDTRA1-20-1-0029	Research Associate/Scientist	Talafha	Hani		8	JUST			
HDTRA1-20-1-0029	Research Associate/Scientist	Ababneh	Mustafa		5	JUST			
HDTRA1-20-1-0029	Research Associate/Scientist	Malkawi	Zuhair		6	JUST			
HDTRA1-20-1-0029	Research Associate/Scientist	AL-Zoghoul	Borhan		5	JUST			
HDTRA1-20-1-0029	Research Associate/Scientist	Al-Omari	Bilal		5	JUST			
HDTRA1-20-1-0029									
HDTRA1-20-1-0029	Research Associate/Scientist	Gharaibeh	Saad		1	JUST			
HDTRA1-20-1-0029	Graduate Student	Daradkeh	Yasmin		5	JUST		No	Jan-22
HDTRA1-20-1-0029	Graduate Student	Al Nabulsi	Farah		5	JUST		Yes	Sep-20
HDTRA1-20-1-0029	Undergraduate Student	Elrahman Talfha	Abed		5	JUST		No	Jul-23
HDTRA1-20-1-0029	Undergraduate Student	Al-Bayari	Leen		5	JUST		No	Jul-24
HDTRA1-20-1-0029	Technician	Aahmawi	Alaa		1	JUST			
HDTRA1-20-1-0029	Technician	Al-Hanandeh	Sief		5	JUST			
HDTRA1-20-1-0029	Technician	Hammdeh	Mohammad		5	JUST			
HDTRA1-20-1-0029	Research Associate/Scientist	Amarneh	Basil		2	JUST			
HDTRA1-20-1-0029	Research Associate/Scientist	Al-Omari	Omar		2	JUST			
HDTRA1-20-1-0029	Research Associate/Scientist	Jaradat	Saied		1	JUST			
HDTRA1-20-1-0029	Technician	Andre	Amanda		2	Ecohealth Alliance			
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Proceed to Publications

Enter all publications (Journal Articles, Books, Book Chapters, Conference Papers, and Theses/Dissertations) resulting from this DTRA project during this reporting period.
DO NOT include publications that have not yet been submitted.

Award #	Publication Type	Author	Journal (Book Title)	Article Title (Chapter Title)	Volume	Issue	Publication Year	Page	Status	Publication Identifier Type	Publication Identifier	Acknowledgement of DTRA Support	Peer Reviewed	Editors (Book)	Collection (Book)	Publisher (Book)	Publication Location (book)	Media Type (Book)	Edition (Book)
Instructions	Select the appropriate publication type from the drop down list. Select "nothing to report" if there were no publications.	Enter the full name of all authors	Select the Journal from the drop down list or enter the FULL name of the journal (book)	Enter the FULL name of the article title (chapter title if book)				Enter the first page number of the article or chapter	Select the publication status from the drop down list (e.g. Published, Submitted)	Select the publication identifier type (i.e. DOI, ISBN, ISSN)	Enter the publication identifier number for the type selected in the previous column	Select whether or not an acknowledgement of DTRA support was provided to the publisher	Select whether or not a journal article or conference paper has gone through the peer review process						
Example	*Journal Article*	*John Smith and Jane Doe*	*Journal of Applied Physics*	*Trace chemical analysis using Coherent Anti Stokes Raman Spectroscopy*	*3*	*1*	*2019*	*112*	*Published*	*DOI*	*10.1021/jp123456x*	*Yes*	*Yes*						
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Proceed to Presentations

Enter all presentations (poster or oral) given during the reporting period that resulted from this DTRA project or contained significant results from this DTRA project.

Instructions	Select the presentation type from the drop down list. Select "Nothing to Report" if there were no presentations.	Enter the FULL title of the presentation.	Enter the date of the presentation in month/day/year format.	Enter the FULL name of the presentation sponsor (e.g. conference, professional society, or university).	Enter the location of the presentation (conference) as City, State for domestic meetings or City, Country for international meetings.		Select from the drop down list the personnel type for the presenter.	Select whether or not an acknowledgement of DTRA support was included in the presentation.
Award #	**Presentation Type**	**Presentation (Paper) Title**	**Conference Date**	**Conference Name**	**Conference Location City, State**	**Author(s)**	**Personnel Type**	**Acknowledgement of DTRA Support**
Example	*Oral Keynote*	*Infrared Spectroscopy of Metal Carbonyls*	*8/1/2015*	*Materials Research Society Fall Meeting*	*Boston, MA*	*John Smith*	*Graduate Student*	*yes*
HDTRA1-20-1-0029	Oral Invited	One Health in the Pander	6/24/2021	Walter Reed Army Insti	Online		PI	Yes
HDTRA1-20-1-0029	Oral Invited	Preventing the Next Pand	6/7/2021	American Association o	Online		Associate/Scientist	Yes
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Proceed to Impacts

Enter awards, honors, promotions, or graduations that occurred during the reporting period for the personnel contributing to this DTRA project.

Instructions	Select the impact (honor) type from the drop down list. Select "Nothing to Report" if there were no impacts.		Select the personnel type for the individual who received the award or honor.	Enter the FULL name of the individual who received the award.	Enter the date the award or honor was received in month/day/year format.	
Award #	**Impact Type**	**Impact Description**	**Personnel Type**	**Awardee Name**	**Impact Date**	**Impact Details/Website**
Example	*Best Poster*	*Best Graduate Student Poster at the American Physical Society winter conference*	*Graduate Student*	*John Smith*	*9/20/2019*	
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Proceed to Intellectual Property

Enter all patents, invention disclosures, and licenses resulting from this DTRA award that were awarded or applied for during the reporting period.
Reporting here does NOT replace the reporting requirements for patents and invention disclosures in the terms and conditions of the award.

Award #	Intellectual Property Type	Title	Number	Country	Application Date	Date Issued	Abstract or Description	Inventors	Status
Instructions	Select the intellectual property type from the drop down list (i.e. patent, license, or invention). Select "Nothing to Report" if there was no intellectual property.	Enter the FULL title of the intellectual property.	Enter the relevant number for the patent, application, etc.	Enter the country or region in which the patent, invention, or license resides.	Enter the application date in month/day/year format.	Enter the issue date in month/day/year format.		Enter the name(s) of the inventor(s).	Select the status of the patent or application from the drop down list.
Example	*Invention*	*Accelerator Device to Detect WMDs*	*123456*	*USA*		*8/7/2019*	*Invention report submitted to State University for an accelerator to detect heavily shielded WMDs*	*John Smith and Jane Anybody*	*Submitted*
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Proceed to Transitions

Enter transitions of the research or technology from this DTRA project.

Instructions	Enter a text description of the transitioned research or technology. Enter "nothing to report" if there were no transitions.	Enter the year that the transition started.	Enter the organization, company, or government agency to the which this work has (is) transitioning.
Award #	**Transition Description**	**Year**	**Transitioned to**
Example	*The accelerator technology for detection of WMDs transitioned to funding from other US government agency for further development*	*2020*	*USGOV Contract # 12-34-5678*
HDTRA1-20-1-0029	Nothing to report		
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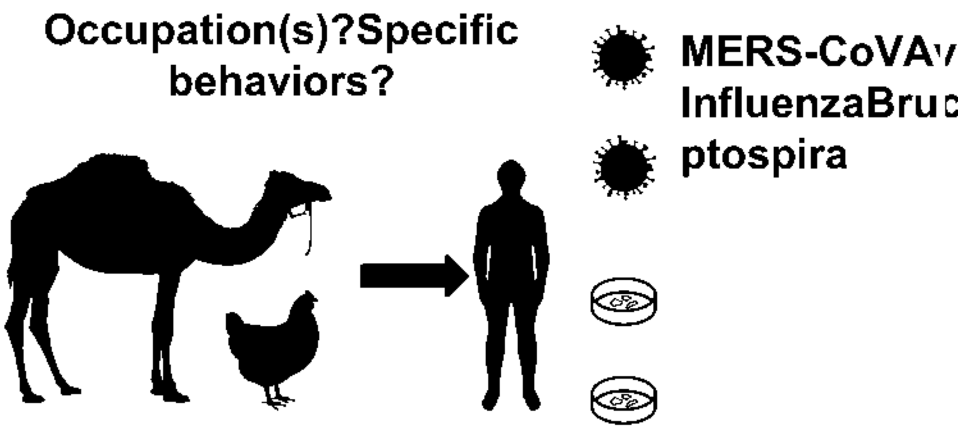
Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan, PI: William B. Karesh, EcoHealth Alliance, HDTRA1-20-1-0029

Objective: Work with government and private sector partners to characterize causal factors in animal-to-human transmission of MERS, AI, and other zoonoses in Jordan, implement serological technology for enhanced diagnostic and detection capabilities, and strengthen regional detection and reporting capacity to reduce biological threats.Threat Reduction Impact: Establishing laboratory and field SOPs to assist partners in detecting presence and exposure to high-consequence zoonotic pathogens. Capacity/Capability Building: Pseudoparticle neutralization assay technology transfer from Human Link to JUST, training of graduate and undergraduate students, site selection and sampling design,methods, human behavioral risk survey development

Status of effort: Animal sampling approval obtained, HRPO approval pending, field and laboratory teams prepping for field work and sample testing. Personnel Supported: This project is supporting 7 faculty, 6 other scientists, 2 graduate students, 2 undergraduate studentsPublications & Meetings: 13 workshop participants



Occupation(s)?Specific behaviors?

MERS-CoVAv
InfluenzaBruc
ptospira

Major Goals and Milestones:Determine evidence of MERS, AI, and other zoonoses in humans, livestock and poultry in Jordan (Y1-OY2)Identify risk factors and modifiable behaviors for threat reduction (Y1-OY2)Improve knowledge and diagnostic capacity (Y1-OY2)Funding Profile Year 1 09/2020-09/2021: $984,351, Year 2 09/2021-09/2022: $981,695, Year 3 09/2023-09/2024: $991,118Contact information PI: Dr. William B. Karesh,

212-380-4463 Karesh@ecohealthalliance.org

Biological Threats Reduction Program
PROJECT QUARTERLY REPORT

PROJECT INFORMATION		
Project and Title:	HDTRA12010029 - Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan & Strengthening Regional Disease Surveillance Capacity	
Quarter and Dates:	Y1, Q1	(9/29/20 - 12/28/20)
Prepared by:	Dr. William B. Karesh	

OVERALL PROJECT SUMMARY AND OBJECTIVES

Project Objective

Utilizing an international consortium of partners, this effort is a multi-disciplinary One Health research project to identify causal factors in the transmission of MERS-CoV, AI, and other zoonoses in Jordan, while simultaneously strengthening local capacity for prevention, detection, and reporting of these zoonoses in Jordan, Iraq, and Lebanon. Our proposed project will rigorously test the following initial hypotheses: 1) That livestock species and poultry in Jordan show evidence of infection with MERS-CoV, AI, respectively and/or other zoonoses. 2) That people regularly exposed to livestock and/or poultry or their living areas have a greater risk of infection with MERS-CoV, AI, and/or other zoonoses compared to other community members in Jordan. 3) That some specific practices may promote exposure to specific animal biohazards (e.g., blood, urine, feces, and/or nasal secretions) and pose a greater risk of infection with MERS-CoV, AI, and other zoonoses compared to others. This study involves interviews and longitudinal sampling of humans, livestock, and poultry at animal markets and farms for MERS-CoV, *Brucella* spp., and *Leptospira* spp. (people/livestock) and for AI subtypes (people/poultry). Partner laboratories in Jordan will screen and characterize these zoonotic pathogens, and capacity-building cross-trainings will be conducted with visiting laboratory scientists from Iraq and Lebanon. This multifaceted One Health approach will advance scientific knowledge on the risk of MERS-CoV, AI, and other zoonoses in Jordan, strengthen local zoonotic disease surveillance capabilities, and enhance scientific partnerships in Jordan, Iraq and Lebanon to prevent, detect, and report biological threats.

YEAR 1, QUARTER 1 PROGRESS UPDATES FOR EACH TASK

Task 1: Determine the presence of MERS-CoV, AI, and other zoonoses among livestock and poultry in Jordan.

Subtask 1.1 Identify sites for project study

Activities and results this quarter:

- Project staff reviewed site selection criteria within the 5 project sites; final site selection to occur prior to commencing sampling in Q3.

Subtask 1.2 Obtain local permissions and approvals to work with animals

Activities and results this quarter:

- JUST IACUC for research with animal subjects was submitted and full approval was obtained.
- IACUC for research with animal subjects was submitted for pre-review, comments were addressed from pre-review, and the subsequent amended application was submitted for full review to Tufts University.
- Drafted animal owner consent form.

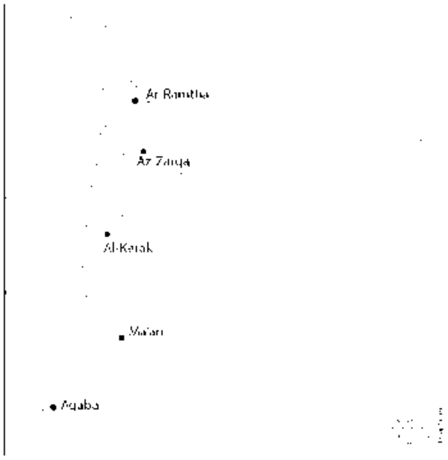


Figure 1. Map of the 5 sites for project study in Jordan.

Future Tasks

Subtask 1.3 Conduct biological sampling of animals in the study areas

Subtask 1.4 Conduct lab testing for AI, MERS-CoV, brucellosis and leptospirosis.

Task 2: Determine whether (and if so, the extent to which) humans at human-livestock/poultry interfaces display evidence of infection.

Subtask 2.1 Identify sites and conduct enrollment for human study component

Activities and results this quarter:

- Project staff reviewed site selection criteria within the 5 project sites; final site selection to occur prior to commencing sampling in Q3.

Subtask 2.2 Obtain local permissions and approvals to work with human subjects

Activities and results this quarter:

- Compiled materials for local JUST and HML IRBs, finalized human questionnaire.

Figure 2. Virtual meeting to discuss the project questionnaire

Future Tasks
Subtask 2.3 Conduct biological sampling
Subtask 2.4 Conduct testing for AI, MERS-CoV, brucellosis and leptospirosis

Task 3: Characterize causal factors in animal-to-human transmission of these zoonoses.

Subtask 3.1 Obtain local permissions and approvals to work with human subjects
Activities and results this quarter:

- Compiled materials for local JUST and HML IRBs. The Jordanian team and EHA behavioral risk scientists collaboratively built and finalized the human questionnaire and site characterization form.

Subtask 3.3 Analyze epi causal inference to identify modifiable risk factors
Activities and results this quarter:

- Project staff reviewed data analysis plan using causal inference framework to identify all data needed for the models that will be produced to test study hypotheses. All proposed model variables were mapped onto specific questions to be asked in the questionnaire. The questionnaire was then arranged according to logical conversational flow in light of how it will be administered.
- Examined socio-economic factors that could affect vulnerability to both risks and impacts, including household wealth indicators used in prior surveys (e.g. for comparability with World Bank reports). These will be relevant for economic context and policy recommendations for biothreat reduction.
- Project staff investigated the literature for risk factors and confounders associated with leptospirosis, brucellosis, AI, and MERS-COV.

Future Subtask(s)
Subtask 3.2 Conduct behavioral risk factor surveys in people

Task 4: Produce geospatial maps of zoonoses in livestock and poultry and of human zoonotic transmission risk.

Subtask 4.1 Generate maps of laboratory results
Activities and results this quarter:

- The project staff identified the workflow and mock-ups for generation of these maps for quarterly reporting.

Subtask 4.2 Generate risk maps with human behavioral risk factors
Activities and results this quarter:

- The project staff identified which exposures would be best to map for inclusion in the questionnaire.

Task 5. Strengthen local capacity for detection and reporting of MERS-CoV, AI, and other zoonoses in Jordan, Iraq, and Lebanon

Subtask 5.1 Conduct project kick-off meeting in Amman with local stakeholders
Activities and results this quarter:

- A date and preliminary schedule for the kick-off meeting was set.
- Coordinated with the Jordan Armed Forces health official, including organizing an upcoming briefing meeting on the project. We anticipate this will be a positive collaboration for the project, expanding key stakeholders to promote synergies with existing biodefense/health security activities and provide a forum to share One Health approaches that could potentially be sustained by Ministry of Health.

Subtask 5.6 Data Management

- Software, systems, and workflow was determined for data management (see Figure 3). These will be tailored to outputs for Jordanian partners (e.g., reports that can be shared at the monthly national One Health platform meeting convened by Ministry of Health, as relevant).

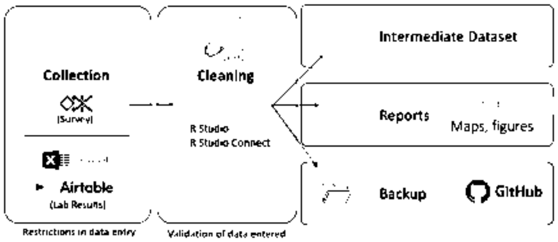


Figure 3. Summary of data management software and data flow for this project.

Future Tasks

Subtask 5.2 Train local project staff in proper techniques

- *All team members will be equipped with CITI training and the team will continue planning future training to understand research and data security, and survey tool development.*

Subtask 5.3 Host annual partners and stakeholders meeting

Subtask 5.4 Complete annual report and share with partners and stakeholders

Subtask 5.5 Conduct local-regional training workshops

Subtask 5.7 Conduct presentations/meetings at times and places specified

Tasks to be initiated after Year 1:

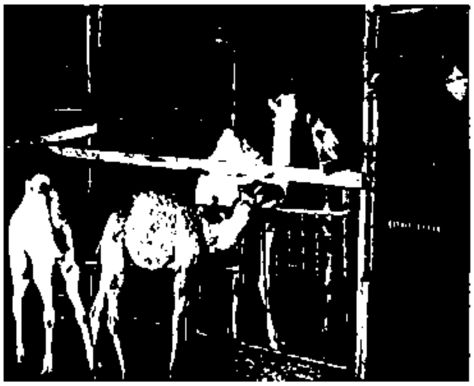
<u>Task 6. Identify specific modifiable risk factors for human infection with these zoonoses</u>

Presentations and Publications

1. **Presentations and Other Conference Submissions: All Institutes**
    - Developed slide set to present project concept for wider awareness of an applied One Health approach for threat reduction.
2. **Publications: All Institutes**

No project scientific publications to report as of yet. However, the project team developed a project summary sheet for outreach to stakeholders in Jordan (as shown below).

Reducing the Threat of MERS-CoV and AI in Jordan & Strengthening Regional Disease Surveillance Capacity



Jordan has experienced several important zoonotic diseases in the few past years including avian influenza A (AI) strains H1N1 and H5N1 and Middle East Respiratory Syndrome Coronavirus (MERS-CoV). High-consequence zoonotic pathogens in the Middle East have resulted in disease epidemics of international importance, raising the need for health security enhancements to strengthen the region's ability to prevent, detect and respond to multiple zoonotic disease threats. MERS-CoV is recognized as a threat to global health security, with designation as a priority disease under the World Health Organization (WHO) Research and Development Blueprint. Although most cases have been reported in the Kingdom of Saudi Arabia (KSA), the first known human infections occurred in Jordan in 2012.

Camels are the presumptive source of primary human MERS-CoV infections; however, the exact mechanisms of transmission and the possible role of other livestock species are unclear. These uncertainties highlight the need to better understand the causal factors of primary human infection with MERS-CoV at human-livestock interfaces given the high livestock-human contact in camel production systems in Jordan. Avian influenza viruses are widely distributed all over the world. In Jordan, the first outbreak of AI strain H5N1 was reported in 2006. The development and wide spread circulation of a new and highly pathogenic strain of AI could present a serious risk to both animal and humans and could result in major socio-economic losses. In fact, there has been a rapid expansion of the poultry industry in Jordan in recent years due to increased demand which increases the risk of AI to public health, locally as well as regionally and globally. Therefore, identification and characterization of AI subtypes circulating among poultry across Jordan will provide critical information needed to understand baseline activity and risks.

HumanLink

Utilizing an international consortium of partners, we are conducting a multi-disciplinary One Health research project to identify causal factors in the transmission of MERS-CoV, AI, and other zoonoses in Jordan, while simultaneously strengthening local capacity for prevention, detection, and reporting of these zoonoses in Jordan, Iraq, and Lebanon. Our proposed project will rigorously test the following initial hypotheses:

1) That livestock species and poultry in Jordan show evidence of infection with MERS-CoV, AI, respectively and/or other zoonoses.

2) That people regularly exposed to livestock and/or poultry or their living areas have a greater risk of infection with MERS-CoV, AI, and/or other zoonoses compared to other community members in Jordan.

3) That some specific practices may promote exposure to specific animal biohazards (e.g., blood, urine, feces, and/or nasal secretions) and pose a greater risk of infection with MERS-CoV, AI, and other zoonoses compared to others.

This study involves interviews and longitudinal sampling of humans, livestock, and poultry at animal markets and farms for MERS-CoV, *Brucella* spp., and *Leptospira* spp. (people/livestock) and for AI subtypes (people/poultry). Partner laboratories in Jordan will screen and characterize these zoonotic pathogens, and capacity-building cross-trainings will be conducted with visiting laboratory scientists from Iraq and Lebanon. This multifaceted One Health approach will advance scientific knowledge on the risk of MERS-CoV, AI, and other zoonoses in Jordan, strengthen local zoonotic disease surveillance capabilities, and enhance scientific partnerships in Jordan, Iraq and Lebanon to prevent, detect, and report biological threats.

The project is supported by the U.S. DoD Defense Threat Reduction Agency's Biological Threats Reduction Program.

Biological Threats Reduction Program
PROJECT QUARTERLY REPORT

PROJECT INFORMATION		
Project and Title:	HDTRA12010029 - Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan & Strengthening Regional Disease Surveillance Capacity	
Quarter and Dates:	Y1, Q2	(12/29/20 - 03/28/21)
Prepared by:	Dr. William B. Karesh	

OVERALL PROJECT SUMMARY AND OBJECTIVES

Project Objective

Utilizing an international consortium of partners, this effort is a multi-disciplinary One Health research project to identify causal factors in the transmission of MERS-CoV, AI, and other zoonoses in Jordan, while simultaneously strengthening local capacity for prevention, detection, and reporting of these zoonoses in Jordan, Iraq, and Lebanon. Our proposed project will rigorously test the following initial hypotheses: 1) That livestock species and poultry in Jordan show evidence of infection with MERS-CoV or AI, respectively and/or other zoonoses. 2) That people regularly exposed to livestock and/or poultry or their living areas have a greater risk of infection with MERS-CoV, AI, and/or other zoonoses compared to other community members in Jordan. 3) That some specific practices may promote exposure to specific animal biohazards (e.g., blood, urine, feces, and/or nasal secretions) and pose a greater risk of infection with MERS-CoV, AI, and other zoonoses compared to others. This study involves interviews and longitudinal sampling of humans, livestock, and poultry at animal markets and farms for MERS-CoV, *Brucella* spp., and *Leptospira* spp. (people/livestock) and for AI subtypes (people/poultry). Partner laboratories in Jordan will screen and characterize these zoonotic pathogens, and capacity-building cross-trainings will be conducted with visiting laboratory scientists from Iraq and Lebanon. This multifaceted One Health approach will advance scientific knowledge on the risk of MERS-CoV, AI, and other zoonoses in Jordan, strengthen local zoonotic disease surveillance capabilities, and enhance scientific partnerships in Jordan, Iraq and Lebanon to prevent, detect, and report biological threats.

YEAR 1, QUARTER 1 PROGRESS UPDATES FOR EACH TASK

Task 1: Determine the presence of MERS-CoV, AI, and other zoonoses among livestock and poultry in Jordan.

Subtask 1.1 Identify sites for project study

Activities and results this quarter:

- Project staff reviewed site selection criteria and collaborated with the team to produce a solution for spatial sampling using a "Shiny App." This novel app will be used to randomly select sampling sites in Jordan.
- The Site Characterization form has been drafted and coded with Open Data Kit (ODK). ODK is software that allows for the creation of survey tools and the collection, management, and usage of data in low-bandwidth environments.

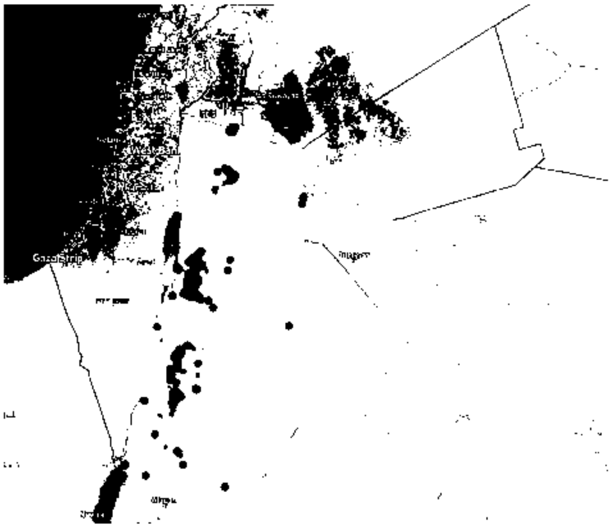
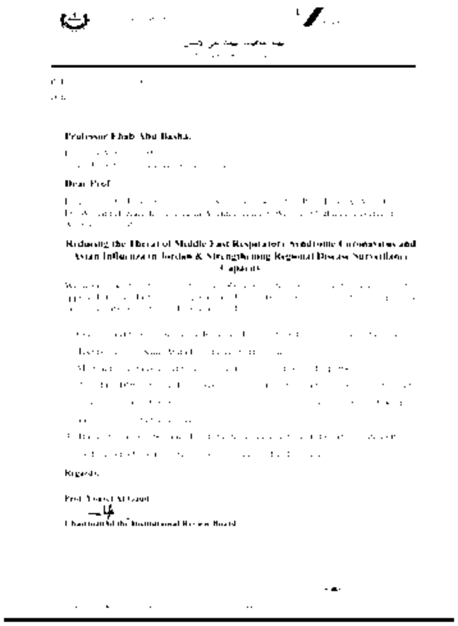


Figure 1. An example of the Shiny App randomly selecting sites (the red dots).

Subtask 1.2 Obtain local permissions and approvals to work with animals

Activities and results this quarter:

- The animal owner consent forms were finalized with input from local subject matter experts (SMEs) familiar with sampling communities.
- Jordan University Science and Technology (JUST) IACUC for research with animal subjects was submitted and full approval was obtained.
- JUST approval for use of the animal owner consent forms was obtained.
- ACURO approved the animal IACUC and determined the projects protocol was a surveillance project. No further action is required.
- The first draft of the animal sampling protocol has been completed and is currently being reviewed by partners.



Professor Ehab Abu Basha,

Dear Prof

Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan & Strengthening Regional Disease Surveillance Capacity

Regards,

Chairman of the Institutional Review Board

Figure 2. Approval letter from Jordan's IRB committee.

Future Tasks

Subtask 1.3 Conduct biological sampling of animals in the study areas

Subtask 1.4 Conduct lab testing for AI, MERS-CoV, brucellosis and leptospirosis.

Task 2: Determine whether (and if so, the extent to which) humans at human-livestock/poultry interfaces display evidence of infection.

Subtask 2.1 Identify sites and conduct enrollment for human study component
Activities and results this quarter:

- The project staff determined that it is likely that there will be a higher rate of loss to follow-up than initially projected. To account for an increased loss to follow-up, the target number for human enrollment for the first year will be increased to 100 people at each site for a total of 500 people for the first year. Protocol documents have been updated as appropriate.

Subtask 2.2 Obtain local permissions and approvals to work with human subjects
Activities and results this quarter:

- Obtained human subjects research approval from the local ethics review board at JUST (2/23/21). The human subjects research and human sampling protocol will now be submitted to Health Media Lab IRB Research and Ethics (HML) for domestic approval.
- Prior to purchasing equipment, the team needs to acquire a tax exemption letter from the Jordanian government.
- Supported JUST in their application for a Federal Wide Assurance number.

Future Tasks
Subtask 2.3 Conduct biological sampling
Subtask 2.4 Conduct testing for AI, MERS-CoV, brucellosis and leptospirosis

Task 3: Characterize causal factors in animal-to-human transmission of these zoonoses.

Subtask 3.1 Obtain local permissions and approvals to work with human subjects
Activities and results this quarter:

- The Jordanian team and EcoHealth Alliance (EHA) behavioral risk scientists collaboratively built and finalized the Animal History Form, Field Data Sheet, Human Questionnaire, and Site Characterization Form.
- Local JUST IRB approval obtained.
- The Human questionnaire, Site Characterization Form, and Animal History Form have been drafted and coded for Open Data Kit (ODK). Tablets were purchased for the Jordan team.

Subtask 3.3 Analyze epi causal inference to identify modifiable risk factors
Activities and results this quarter:

- Worked with the project staff and SMEs to compile a list of epidemiological risk factors, behaviors, and general exposure risk factors to be used in data analysis.
- During the human subjects research workshop, worked to collaboratively fill-out a survey guide to provide clarity of question purpose and application for field staff. In scenarios where subjects might need support in understanding questions, ensuring that field staff understand the risk factors being analyzed in each question will support survey strength.

Future Subtask(s)
Subtask 3.2 Conduct behavioral risk factor surveys in people

Task 4: Produce geospatial maps of zoonoses in livestock and poultry and of human zoonotic transmission risk.

Future Subtask(s):
Subtask 4.1 Generate maps of laboratory results
Subtask 4.2 Generate risk maps with human behavioral risk factors

Task 5. Strengthen local capacity for detection and reporting of MERS-CoV, AI, and other zoonoses in Jordan, Iraq, and Lebanon

Subtask 5.1 Conduct project kick-off meeting in Amman with local stakeholders
Activities and results this quarter:

- The Jordan MERS/AI project launch meeting was held on January 27th, 2021. In order to adhere to COVID-19 safety guidelines, the meeting was held virtually using a password-protected system. The launch meeting was a success and highlighted the centrality and investment in collaboration for this project. The launch was also an opportunity to engage additional key stakeholders to promote synergies with existing biodefense/health security activities, and provided a forum to share One Health approaches that could potentially be sustained by the Ministry of Health.

Subtask 5.2 Train local project staff in proper techniques

- All research team members are equipped with CITI training in human subjects research, the team will continue to provide capacity-building through trainings and workshops on subjects integral to this project and to future public health research, including best practices regarding research and data security, and survey tool development.
    - The first annual project training workshop took place over the course of three days, and was attended by all team members, including senior scientist and university students. The first and second day of the workshop was held virtually and the third day of the workshop will be held in person. The date of the third workshop will be determined soon, depending on local regulations and will include safety measures in place for COVID-19.
    - The third day of the workshop will include training on basic laboratory safety: biosafety and biosecurity, facilitated by Dr. Mustafa Ababneh, and cold chain implementation, facilitated by Dr. Borhan Al-Zghoul.
- The sessions held during the two-day virtual workshop included training on:
    - Data management use and storage - facilitated by Jamie Cooksey and Dr. Whitney Bagge
    - Ethical human subject research - Emily Hagan and Stephanie Martinez
    - Ethical animal subject research- Hani Talafha
    - Questionnaire administration - facilitated by Emily Hagan and Stephanie Martinez

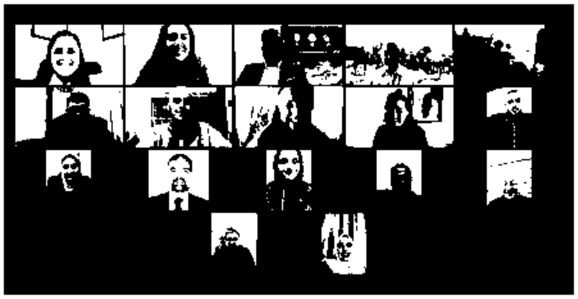


Figure 3. First day of the virtual first annual project training workshop.

- Safe human and animal sampling - led by Dr. Basil Amarneh and Dr. Zaidoun Jijazeen

Subtask 5.6 Data Management

- The project staff have finalized data management tools and decided to use ODK connect servers to securely store survey data and Airtable servers for human and animal lab data. Only the specific app users for each of the servers can access the secure data.
- Training for the data management systems was completed in the project training workshop.

Figure 4. Second virtual day: first annual project training workshop.

Subtask 5.7 Conduct presentations/meetings at times and places specified

- Project kick off for HDTRA1-20-1-0029 Jordan was held on January 13th, 2021. The kick-off meeting was a success and the team had a positive collaboration with DTRA, and Jordan partners.
- Meeting on March 7th at Jordan Armed Forces GHQ (JAF) with LTC. Mohammad Malkawi, Arms Control & International Organizations branch, Directorate of Planning & Organization (DPO), JAF to follow up with letters send to Ministry of Agriculture, Ministry of Health and Ministry of Environment to form a Focal point committee to the project. Letters are also sent to RSS, Badia Fund, WHO, FAO, USAID, AOAD and RVC to join the committee. This committee will follow up on One Health approach as well.

Future Tasks

Subtask 5.3 Host annual partners and stakeholders meeting

Subtask 5.4 Complete annual report and share with partners and stakeholders

Subtask 5.5 Conduct local-regional training workshops

- A proposed date has been set for the training at the Human Link Lab at the National Research Centre, Egypt. While details remain to be confirmed due to considerations for COVID-19, the team looks forward to engaging with our regional stakeholder to further serve the regional biosecurity and capacity-building objectives of the project.

Tasks to be initiated after Year 1:

Task 6. Identify specific modifiable risk factors for human infection with these zoonoses

Presentations and Publications

1. Presentations and Other Conference Submissions: All Institutes
    - Developed slide set to present project concept for wider awareness of an applied One Health approach for threat reduction.
2. Publications: All Institutes

No project scientific publications to report as of yet.

Biological Threats Reduction Program
PROJECT QUARTERLY REPORT

PROJECT INFORMATION		
Project and Title:	HDTRA12010029 - Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan & Strengthening Regional Disease Surveillance Capacity	
Quarter and Dates:	Y1, Q3	(03/29/21- 6/29/21)
Prepared by:	Dr. William B. Karesh	

OVERALL PROJECT SUMMARY AND OBJECTIVES

Project Objective

Utilizing an international consortium of partners, this effort is a multi-disciplinary One Health research project to identify causal factors in the transmission of Middle East Respiratory Syndrome Coronavirus (MERS-CoV), Avian Influenza (AI), and other zoonoses in Jordan, while simultaneously strengthening local capacity for prevention, detection, and reporting of these zoonoses in Jordan, Iraq, and Lebanon. Our proposed project will rigorously test the following initial hypotheses: 1) That livestock species and poultry in Jordan show evidence of infection with MERS-CoV or AI, and/or other zoonoses. 2) That people regularly exposed to livestock and/or poultry or their living areas have a greater risk of infection with MERS-CoV, AI, and/or other zoonoses compared to other community members in Jordan. 3) That some specific practices may promote exposure to specific animal biohazards (e.g., blood, urine, feces, and/or nasal secretions) and pose a greater risk of infection with MERS-CoV, AI, and other zoonoses compared to others. This study involves interviews and longitudinal sampling of humans, livestock, and poultry at animal markets and farms for MERS-CoV, *Brucella* spp., *Leptospira* spp. (people/livestock), and for AI subtypes (people/poultry). Partner laboratories in Jordan will screen and characterize these zoonotic pathogens, and capacity-building cross-trainings will be conducted with visiting laboratory scientists from Iraq and Lebanon. This multifaceted One Health approach will advance scientific knowledge on the risk of MERS-CoV, AI, and other zoonoses in Jordan, strengthen local zoonotic disease surveillance capabilities, and enhance scientific partnerships in Jordan, Iraq, and Lebanon to prevent, detect, and report biological threats.

YEAR 1, QUARTER 1 PROGRESS UPDATES FOR EACH TASK

Task 1: Determine the presence of MERS-CoV, AI, and other zoonoses among livestock and poultry in Jordan.

Subtask 1.1 Identify sites for project study

Activities and results this quarter:

- Project staff reviewed site selection criteria and with input from local subject matter experts (SMEs), the list of sites was narrowed down to include villages with the three interface sites represented and sufficient human population. From this list of thirteen potential sites, the Shiny App, was used to randomly generate the final five sites in Jordan to be used for the field study components of the project. Jordian project partners participated throughout the process and learned the methodology and rationale for randomizing site selection.

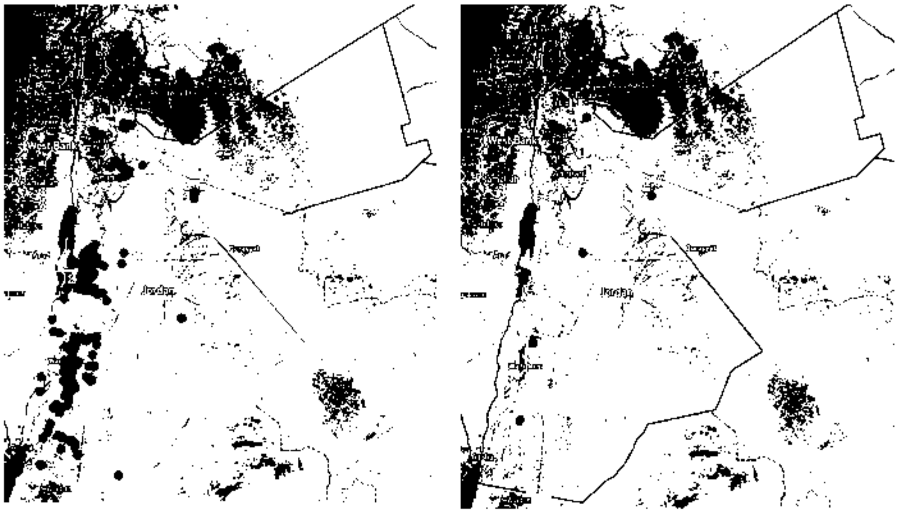


Figure 1. Sites selected using spatial sampling "Shiny App" (red points). Left image contains every point prior to SME local input and the right image contains the randomly selected points.

Subtask 1.2 Obtain local permissions and approvals to work with animals

Activities and results this quarter:

- Jordan ACUC and Tufts IACUC approvals and ACURO surveillance project determination were obtained in previous quarters. No further action is required.

Future Subtask(s)

Subtask 1.3 Conduct biological sampling of animals in the study areas

Subtask 1.4 Conduct lab testing for AI, MERS-CoV,
brucellosis and leptospirosis.

Task 2: Determine whether (and if so, the extent to which) humans at human-livestock/poultry interfaces display evidence of infection.

Subtask 2.1 Identify sites and conduct enrollment for human study component

Activities and results this quarter:

- The project staff have selected the villages below for sampling:
  1. WC34+58 Dabet Hanut, Quaira, Aqaba
  2. HHF4+55 Al-Mansoura, Shoabak, Ma`an
  3. 8G3R83WF+5G Al Damkhi, Karak
  4. RRM8+8F Azraq, Zarqa
  5. F4PG+QH, Hosha Sub-District, Ramtha, Irbid
- The team developed a draft Human and Animal sampling protocol in preparation for enrollment of human and animal participants.

Subtask 2.2 Obtain local permissions and approvals to work with human subjects

Activities and results this quarter:

- The project team submitted the study protocol to Health Media Lab IRB Research and Ethics (HML) for U.S. IRB approval. Approval was obtained (4/23/21).
- The project team submitted an amendment to the local ethics review board at JUST and approval was given (4/26/21).
- The human subjects research and human sampling protocol was submitted to the Human Research Protection Office (HRPO) (5/4/21).

Subtask 2.3 Conduct biological sampling

- Equipment purchased
  - Field Vehicle: 2021 MGRX8, delivery pending completion of tax exemption approval

Subtask 2.4 Conduct testing for AI, MERS-CoV, brucellosis and leptospirosis

- Equipment purchased
  - Synergy HTX Multi-Mode microplate reader and PC

Task 3: Characterize causal factors in animal-to-human transmission of these zoonoses.

Subtask 3.1 Obtain local permissions and approvals to work with human subjects

Activities and results this quarter:

- The JUST IRB approved an amendment for the human subjects research.
- HML IRB approved the protocol for U.S.-based IRB approval.
- The human subjects research and human sampling protocol were submitted to HRPO.

Future Subtask(s)

Subtask 3.2 Conduct behavioral risk factor surveys in people

Subtask 3.3 Analyze epi causal inference to identify modifiable risk factors

Task 4: Produce geospatial maps of zoonoses in livestock and poultry and of human zoonotic transmission risk.

Subtask 4.1 Generate maps of laboratory results

Activities and results this quarter:

- The project staff created an R Markdown document in RStudio for future stakeholder meetings that includes maps to demonstrate the percentage of positive tests over the total amount of humans and animals tested for the four zoonotic pathogens of interest in Jordan for this project.

Future Subtask(s):
Subtask 4.2 Generate risk maps with human behavioral risk factors

Task 5. Strengthen local capacity for detection and reporting of MERS-CoV, AI, and other zoonoses in Jordan, Iraq, and Lebanon

Subtask 5.2 Train local project staff in proper techniques

- Due to an increase in COVID-19 cases in Jordan, the third date for the in-person workshop was finalized for May 27th, 2021. The workshop included training on basic laboratory safety: biosafety and biosecurity, facilitated by Dr. Mustafa Ababneh, and cold chain implementation, facilitated by Dr. Borhan Al-Zghoul.
  - Due to the COVID-19 group limitation, 7 people attended the third in-person workshop:
    - Dr. Mustafa Ababneh (JUST)
    - Dr. Borhan Al-Zghoul (JUST)
    - Yasmin Issa Daradkeh (graduate student, JUST)
    - Farah AlNabulsi (graduate student, JUST)
    - Abed Elrahman Talfha (undergraduate student, JUST)
    - Leen Al-Bayari (undergraduate student, JUST)
    - Dr. Omar Al-Omari, MD

Figure 2. In-person workshop on basic laboratory safety.

- March 29, 2021: Dr. Ehab Abu-Basha reviewed the diagnostic laboratories in Al-Karak and Ma'an to determine the limitations and status of veterinary services in the south of Jordan (the report was a follow up to previous visits in 2017 and 2019).
  - Recommendations are as followed:
    - Complete laboratory building infrastructure with suitable benches, sinks, and cabinets (Karak Lab)
    - Hire adequately trained veterinarians and laboratory technicians to the laboratories
    - Provide adequate training on safety, proper use and maintenance of laboratory equipment and chemicals.
    - Provide adequate amount of laboratory diagnostic chemicals, supplies and kits.
    - MOA should recruit staff to Ma'an and provide incentives for relocation.

Subtask 5.6 Data Management

Incorporated the Arabic translations of the surveys into ODK.

- The project team developed field data sheets and input into the AirTable data management software, and reviewed accessibility and overall design for improvements in conjunction with their review of the field and laboratory protocols.
- The project team has created specific QR codes on ODK Collect for each of the team members to access their own survey to practice using the tablets for when sampling begins.
- For real-time quality control of data collection and entry, the project team has coded and developed a series of automated reports using R Studio Connect to be in place for when data collection begins. The intention is that field and laboratory staff serve an active role in data cleaning as they can review data on a biweekly basis and work with EHA data management staff to identify any issues in real time
    - The ODK validation report has been coded for the purpose of real-time quality control for the surveys that are delivered by field team members.
- The data management team developed a draft project dashboard for full project progress monitoring, to be shared among partners to share team and project progress at-a-glance. The dashboard ensures the full team can see project activities on all fronts laboratory, surveys, human and animal sampling. The dashboard differs from the automated sampling reports, in that the sampling reports are highly detailed accounts of each effort tailored to the sub-team doing that sampling for data cleaning purposes, while the dashboard summarizes the full team effort.

Figure 3. A mock example of the QR codes that each individual team member

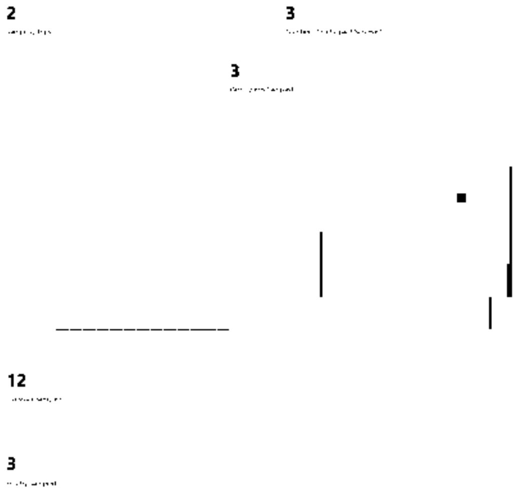


Figure 4. An example of the dashboard demonstrating how data will be summarized.

Subtask 5.7 Conduct presentations/meetings at times and places specified

Activities and results this quarter:

- Focal Point Meeting

Figure 5. Focal point meeting in Jordan.

  - April 6, 2021: The focal point meeting took place in Amman, Jordan, in April. Dr. Ehab Abu Basha gave a brief description of the project. This event provided an opportunity to clearly establish the role of the Ministry of Agriculture in the context of the project and to discuss upcoming lab visits in the south of Jordan. Follow-up meetings will be conducted online due to COVID-19 regulations.
  - In attendance to the focal point meeting:
    - Dr. Ehab Abu Basha, JUST
    - Dr. Zaidoun Hijazeen, JUST
    - Dr. Yasmin Daradkeh, JUST
    - Dr. Laura Sawalha, WHO
    - Dr. Hussein Zyoud, Head of Animal Health Labs, MoA
    - Dr. Essam Hawwa, CVO, MoA
    - Colonel Oday Mrayat, Jordan Armed Forces

- Jordan Team Meeting
  - May 10, 2021: The Jordan in-country team held a meeting to discuss training and workshops, the human questionnaire, and purchasing activities in preparation for the beginning of data collection. The Jordan team will purchase lab and field materials and establish and review standard operating procedure (SOPs) for animal and human sampling, questionnaire administration, and laboratory procedures.

Future Subtask(s)

Subtask 5.1 Conduct project kick-off meeting in Amman with local stakeholders
Subtask 5.3 Host annual partners and stakeholders meeting
Subtask 5.4 Complete annual report and share with partners and stakeholders
Subtask 5.5 Conduct local-regional training workshops

- COVID-19 restrictions have limited in-person workshop, but as the restrictions begin to ease, we are hopeful that we will be able to set a date for the local-regional training workshop, with Human Link Lab at the National Research Centre, Egypt, in August. The team looks forward to engaging with our regional stakeholder to further serve the regional biosecurity and capacity-building objectives of the project.

Tasks to be initiated after Year 1:

<u>Task 6. Identify specific modifiable risk factors for human infection with these zoonoses</u>

Presentations and Publications

1. <u>Presentations and Other Conference Submissions: All Institutes</u>
    - June 7, 2021: Dr. Whitney Bagge presented to the American Association of University Women (AAUW) on "Preventing the Next Pandemic: Science and Capacity Building.
    - June 24, 2021: Dr. William Karesh presented a webinar for the Walter Reed Army Institute of Research (WRAIR) One Health Branch, including AFRIMS and other overseas labs on "One Health in the Pandemic Era" and discussed DTRA BTRP projects including this one in Jordan.

2. <u>Publications: All Institutes</u>

No project scientific publications to report as of yet.

Biological Threats Reduction Program
PROJECT QUARTERLY REPORT

PROJECT INFORMATION		
Project and Title:	HDTRA12010029 - Reducing the Threat of Middle East Respiratory Syndrome Coronavirus and Avian Influenza in Jordan & Strengthening Regional Disease Surveillance Capacity	
Quarter and Dates:	Y1, Q4	(06/30/21- 9/29/21)
Prepared by:	Dr. William B. Karesh	

OVERALL PROJECT SUMMARY AND OBJECTIVES

Project Objective

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YEAR 1, QUARTER 4 PROGRESS UPDATES FOR EACH TASK

Task 1: Determine the presence of MERS-CoV, AI, and other zoonoses among livestock and poultry in Jordan.

Subtask 1.1 Identify sites for project study

Activities and results this quarter:

- Four project staff from Ecohealth Alliance traveled to Amman, Jordan from August 6th - 14th to provide a two-day workshop and an investigation of selected study sites. During the trip the project staff visited four different potential human-animal interface sites. Two of the were located in the Tura subdistrict in Al-Ramtha and the other two sites were located in the Hmeimeh and the Al-Dissi subdistricts in Quaira, Aqaba.

Figure 1. A camel interface site in the Tura subdistrict in Al-Ramtha in the north of Jordan.

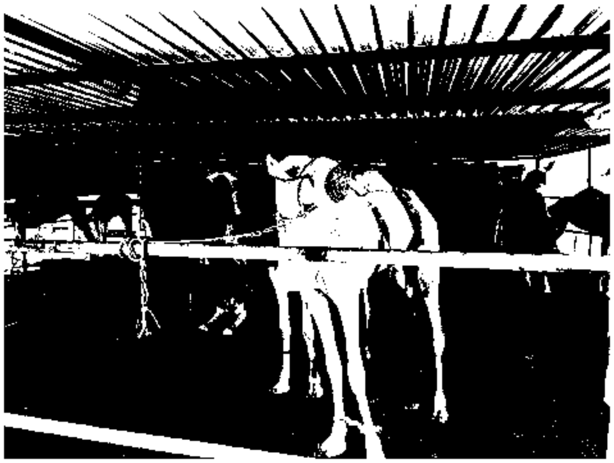


Figure 2. A camel interface site in Al-Dissi, Quaira, Aqaba in south of Jordan.

Subtask 1.2 Obtain local permissions and approvals to work with animals

Activities and results this quarter:

- All required approvals for animal work have been obtained. The team is still awaiting approval from the Office for Human Research Protections (HRPO) so that human and animal work can be conducted simultaneously (One Heath approach).

Future Subtask(s)

Subtask 1.3 Conduct biological sampling of animals in the study areas
Subtask 1.4 Conduct lab testing for AI, MERS-CoV,
brucellosis and leptospirosis.

Task 2: Determine whether (and if so, the extent to which) humans at human-livestock/poultry interfaces display evidence of infection.

Subtask 2.1 Identify sites and conduct enrollment for human study component

Activities and results this quarter:

- During the August 6th to 14th trip to Jordan, the project staff investigated the sites that were randomly chosen for the project. They communicated and discussed the project's objectives with the people who lived/worked with the camels at four different interface sites. These sites were located in the Hmeimeh and the Al-Dissi subdistricts in Quaira, Aqaba, and the Tura subdistrict in Al-Ramtha, Irbid.


[redacted]

Figure 3. Meeting with the four families from a camel interface site in Hmeimeh subdistrict in Quaira, Aqaba.

Figure 4. Discussing the project with the head of the household at a camel interface site in the Tura subdistrict in Al-Ramtha, Irbid.

Subtask 2.3 Conduct biological sampling

- Equipment purchased
    - Field Vehicle: 2021 MGRX8 was delivered and is currently with the in-country team.
    - Lab supplies were purchased for the project. These supplies include PCR testing kits, direct RNA sequencing kits, tubes and caps, pipettes, probes, and etc.
    - The JUST team created a purchasing committee from three members that will review different vendors for product quality and price, and recommend the purchases of items accordingly. In addition, they will also follow up with products once delivered to check specifications and sign the required receipt forms as per JUST regulations.

Subtask 2.4 Conduct testing for AI, MERS-CoV, brucellosis and leptospirosis.

- During the trip to Jordan, project team members visited Jordan University of Science and Technology (JUST), and visited the laboratories that the project's lab personnel will be using to conduct testing on samples for exposure to AI, MERS-CoV, Brucella Sp. and Leptospira Sp.

Figure 5. Mohammad Hussien Alboom demonstrating how to analyse genetic sequencing results.

Figure 6. (L-R) Zaidoun Hijazeen, Jamie Cooksey, Emily Hagan, Dr. Ehab Abu-Basha, Dr. Mustafa Ababneh, Dr. Whitney Bagge, Dr. William Karesh, Dr. Borhan Al-Zghoul, and Mohammad Hussien Alboom in the molecular biology lab at JUST.

Future Subtask(s)

Subtask 2.2 Obtain local permissions and approvals to work with human subjects

- The team is still awaiting approval from the Office for Human Research Protections (HRPO).

Task 3: Characterize causal factors in animal-to-human transmission of these zoonoses.

Subtask 3.1 Obtain local permissions and approvals to work with human subjects

Activities and results this quarter:

- The team is still awaiting approval from the Office for Human Research Protections (HRPO).

Future Subtask(s)

Subtask 3.2 Conduct behavioral risk factor surveys in people

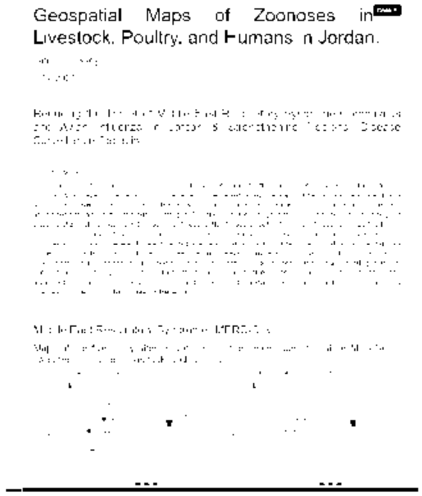
Subtask 3.3 Analyze epi causal inference to identify modifiable risk factors

Task 4: Produce geospatial maps of zoonoses in livestock and poultry and of human zoonotic transmission risk.

Subtask 4.1 Generate maps of laboratory results

Activities and results this quarter:

- Updated the original geospatial map with mock data that is connected to the project's AirTable to create updated automated reports to be sent to our project partners and stakeholders.



Geospatial Maps of Zoonoses in Livestock, Poultry, and Humans in Jordan.

Figure 7. Updated geospatial map based on laboratory results of humans, livestock, and poultry positive for the four pathogens.

Future Subtask(s):

Subtask 4.2 Generate risk maps with human behavioral risk factors

Task 5. Strengthen local capacity for detection and reporting of MERS-CoV, AI, and other zoonoses in Jordan, Iraq, and Lebanon

Subtask 5.2 Train local project staff in proper techniques

- The JUST graduate and undergraduate students working on the project train for 8 weeks in PCR techniques at the Molecular and Biology Laboratory, JUST. After training, the students may come in on their own time to practice.
- September 14, 2021, the human studies field team, graduate and undergraduate students gathered for training on how to use the tablets and give the questionnaire to the participants.
- The project staff team and the students have created a "WhatsApp" group chat for communication.

Figure 8. Dr. Basil demonstrates how to use the tablets and questionnaires to the human field team, graduate, and undergraduate students.

Subtask 5.5 Conduct local-regional training workshops

Activities and results this quarter:

- On August 10th & 11th, 2021, EHA project staff travelled to Amman, Jordan, to lead a two-day Survey Design and Risk Communications Workshop at the Grand Hyatt Amman. The workshop was a highly interactive event in which project team leaders facilitated presentations, discussions, and workbook activities designed to build skills around question and survey design and risk communications strategies. The workshop additionally included training on key tenets of ethical research with human populations. Including the project team, 48 participants attended the first day, and 37 participants attended the second day. In keeping with the One Health foundations of the project, an important component of this workshop was having a group of participants who would be representative of a diverse cross-section of government ministries and national One Health stakeholders from the public and private sector. As the participant list below illustrates, this was successfully achieved. Our esteemed participants received certificates at the close of the workshop, and the project team received positive feedback and suggestions for future trainings.

- **Objectives Day One**
  - Refresher on ethics in research with human populations
  - Review of key principles of research design and preparation
  - Discussion of strategies of how to design surveys with strong questions
- **Objectives Day Two**
  - Application of lessons learned from Day One in drafting real survey questions
  - Introduction to the concept of risk
  - Introduction to the concept of risk communication
  - Practice key message development
  - Practice risk communication skills through examples

Attendance for Day One

- Ministry of Health
  - Dr. Alaa Hamdallah
  - Dr. Saed Alnserat
  - Dr. Nizar Masouda
  - Dr. Akef Sleihat
  - Dr. Hayel El-Buriqi
  - Dr. Fatima Zerriouh
- Ministry of Agriculture
  - Dr. Esam Hawa, Chief Veterinary Officer
  - Dr. Majed Hawaosheh
  - Dr. Samer Aldwairi
  - Dr. Khaldoon Malkawi
  - Dr. Hassan Al-Husainat
  - Dr. Marwan Awabdeh
  - Dr. Sharher Abu Dalbouh
  - Dr. Haitham Athamneh
- Ministry of Environment
  - Eng. Belal Shaqarin, Director of Climate Change Direcotorate
  - Eng. Saddam Diab Al-Khawaldeh, Nature Protection Directorate
  - Eng. Nour M Alghazo, Climate Change Directorate
  - Noura Hamad Alshra'a, Climate Change Directorate
- Jordan University of Science and Technology
  - Dr. Mohammad Khalifeh, Dean of Faculty of Veterinary Medicine
  - Dr. Tareq Mukattash, Dean of Research
  - Dr. Ehab Abu-Basha, Project Lead
  - Dr. Mustafa Ababneh
  - Mr. Bilal Al-Omari
  - Dr. Mohammad Borhan Al-Zghoul
  - Dr. Basil Hameed Amarneh
  - Dr. Saied Jaradat
  - Dr. Omar Al-Omari
  - Eng. Hani Talafha
  - Alaa Fahmawi, Nurse, King Abdulla Hospital

Figure 9. Invited speakers table at opening of the workshop.

Figure 10. A 10-minute presentation on One Health in Jordan by Dr. Alaa Hamdallah from the Ministry of Health.

Figure 11. Group exercise during day one of the Survey Design and Risk Communication Workshop.

    - Ayesha Al-Kofahi, Research assistant
    - Nour Alhoda, Research assistant
    - Graduate Students
        - Dr. Yasmin Daradkeh
        - Dr. Farah Al Nabulsi
    - Undergraduate Students
        - Leen Al Bayari
        - Abdelrahman Talafha
- Royal Scientific Society
    - Dr. Ghadeer Alzghoul
    - Dr. Mu'men Alrwashdeh
- WHO
    - Dr. Lora Al-Sawalha, One Health Professional Officer
- EMPHNET
    - Dr. Moad Rahamneh
- United Animal Health Inc.
    - Dr. Nadim Amarin, marketing and Technical Manager, META
- Private Sector Veterinarians
    - Dr. Zaidoun Hijazeen
    - Dr. Brittany Crook, AUS
- DTRA
    - LTC. Todd Dahmann

Attendance for Day Two

- Ministry of Health
    - Dr. Alaa Hamdallah
    - Dr. Saed Alnserat
    - Dr. Nizar Masouda
    - Dr. Akef Sleihat
    - Dr. Hayel El-Buriqi
    - Dr. Fatima Zerriouh
    - Ministry of Agriculture
    - Dr. Esam Hawa, Chief Veterinary Officer
    - Dr. Majed Hawaosheh
    - Dr. Samer Aldwairi
    - Dr. Khaldoon Malkawi
    - Dr. Hassan Al-Husainat
    - Dr. Marwan Awabdeh
    - Dr. Haitham Athamneh
    - Dr. Safa Atoom, Head of Microbiology Unit
- Ministry of Environment
    - Eng. Nour M Alghazo, Climate Change Directorate
    - Noura Hamad Alshra'a, Climate Change Directorate
        - Abdelrahman Talafha
- Royal Scientific Society
    - Dr. Ghadeer Alzghoul
- Jordan University of Science and Technology
    - Dr. Ehab Abu-Basha, Project Lead
    - Mr. Bilal Al-Omari
    - Dr. Mohammad Borhan Al-Zghoul
    - Dr. Omar Al-Omari
    - Eng. Hani Talafha
    - Ayesha Al-Kofahi
    - Nour Alhoda
    - Graduate Students
        - Dr. Yasmin Daradkeh
    - Undergraduate Students
        - Leen Al Bayari
        - Abdelrahman Talafha
- WHO
    - Dr. Lora Al-Sawalha, One Health Professional Officer
    - Olle Mjergura
- EMPHNET
    - Dr. Moad Rahamneh
- Private Sector Veterinarians
    - Dr. Zaidoun Hijazeen
    - Dr. Brittany Crook, AUS

Figure 12. Group photo of the participants from the August training workshop.

Figure 13. Certificates given out at the end of day two after the completion of the workshop.

Subtask 5.6 Data Management

- On August 8th, the project staff met at the Princess Haya Biotechnology Center at Jordan University of Science and Technology to review the data management system AirTable and discuss any concerns prior to starting sampling.
    - The team decided to use a general QR code and have team members select their name from a list in the administration section of the survey.
    - The team created validation reports for the field data and lab data. The data validation reports will help the field team check for extreme values or any data entry errors when the project team inputs data into AirTable or ODK surveys.

Figure 14. On August 8, 2021, the team gathered at JUST University, Jordan to discuss AirTable and data management.

Subtask 5.7 Conduct presentations/meetings at times and places specified

- On September 9, 2021, Dr. Ehab Abu-Basha conducted a meeting with both field and lab teams and the following activities were undertaken:
    - Responsibilities and tasks such as sample collection, transportation, sample identification and labeling, receiving, and processing of samples in the lab and questionnaire administration were described and identified for each member of each team.
    - SOPs previously prepared were reviewed and the human and animal team were instructed to strictly follow the SOPs. A workshop to train team members how to execute each task according to SOP is set to take place in the coming weeks.

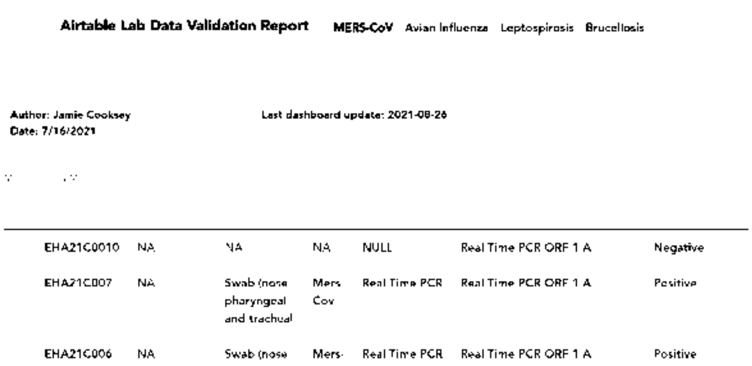
- September 14, 2021, the field and lab teams had a meeting to discuss the logistics of cold chain transport of samples from different project sites to JUST. The field team will draw a chart to summarize this process according to the agreed SOPs.
- September 16, 2021, Dr. Whitney Bagge conducted a regional planning meeting to discuss the upcoming training at Human Link Lab at the National Research Centre in Egypt.
    - Those in attendance:
        - EcoHealth: Dr. William Karesh Dr. Whitney Bagge, Jamie Cooksey, Amanda Andre, Darya Ivanova
        - JUST: Dr. Ehab Abu-Basha, Dr. Zaidoun Hijazeen, Dr. Bilal Al Omari, Yasmin Daradkeh, Farah Al. Nabulsi
        - Human Link: Ghazi Kayali
    - The meeting concluded that the training would take place for 5 days in the second half of November. Security clearance for participants to enter the lab will need to be cleared before travel to Egypt since the lab is a governmental facility.

Future Subtask(s)

Subtask 5.1 Conduct project kick-off meeting in Amman with local stakeholders

Subtask 5.3 Host annual partners and stakeholders meeting

Subtask 5.4 Complete annual report and share with partners and stakeholders



Airtable Lab Data Validation Report **MERS-CoV** Avian Influenza Leptospirosis Brucellosis

Author: Jamie Cooksey
Date: 7/16/2021

Last dashboard update: 2021-08-26

EHA21C0010	NA	NA	NA	NULL	Real Time PCR ORF 1 A	Negative
EHA21C007	NA	Swab (nose pharyngeal and trachual	Mers Cov	Real Time PCR	Real Time PCR ORF 1 A	Positive
EHA21C006	NA	Swab (nose	Mers-	Real Time PCR	Real Time PCR ORF 1 A	Positive

Figure 15. An updated version of the validation reports that will be sent to the team members that will inform of any extreme or missing values.

Tasks to be initiated after Year 1:

Task 6. Identify specific modifiable risk factors for human infection with these zoonoses

Presentations and Publications

1. <u>Presentations and Other Conference Submissions: All Institutes</u>

- Dr. Ehab Abu-Basha was invited to attend WHO 3rd Quarterly Meeting "Strengthening One Health in Jordan" which was hold on July 15th, 2021, in Amman. Dr. Abu-Basha gave a presentation about Strengthening Regional Disease Surveillance MERS CoV and AI in Jordan. He also discussed the methodology and the goals of the current project.

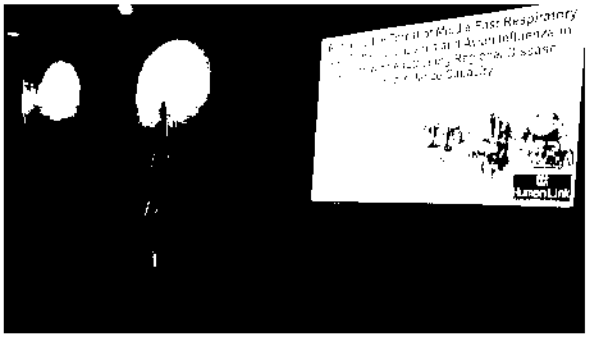


Figure 16. Dr. Ehab Abu-Basha at the WHO's 3rd Quarterly Meeting.

- Dr. Ehab Abu-Basha was invited as keynote speaker to the World Zoonoses Day 2021 on July 6th by the Turkish Veterinary Association and gave a presentation about "One Health in Action". He addressed the importance of One Health in action, strengthening collaboration for detection and surveillance of zoonotic diseases, establishment of a national One Health committee, capacity building and community trust and taising awareness.

Figure 17. World Zoonoses Day 2021 conference was virtual on Zoom.

2. <u>Publications: All Institutes</u>

No project scientific publications to report as of yet.

From: Aleksei Chmura
To: (b)(6)
Cc: Noam Ross; (b)(6)
(b)(6); Joe Riccardi
Subject: [Non-DoD Source] Re: Notification of DTRA Grant Award -- HDTRA12110023 -- "Predicting Biothreat Impacts from Early-Stage Data via Transfer Learning
Date: Monday, July 19, 2021 4:32:15 PM

All active links contained in this email were disabled. Please verify the identity of the sender, and confirm the authenticity of all links contained within the message prior to copying and pasting the address to a Web browser.

……

Daer (b)(6)

I confirm receipt and we are delighted to revive this Grant award!

Please note our address may need to be updated, since it now is:

EcoHealth Alliance
520 Eighth Avenue
Suite 1200
New York, NY 10018

Thank you!

-Aleksei

Aleksei Chmura, PhD
Chief of Staff

EcoHealth Alliance
520 Eighth Avenue, Suite 1200
New York, NY 10018-4182

+1.212.380.4473 < tel:1.212.380.4469 > (office)
(b)(6) > (mobile)
Caution-www.ecohealthalliance.org < Caution-http://www.ecohealthalliance.org >

EcoHealth Alliance develops science-based solutions to prevent pandemics and promote conservation.

On Jul 19, 2021, at 15:56, (b)(6)
Caution (b)(6) > wrote:

Dr. Ross and Dr. Chmura,

Congratulations! Attached for your records is the subject Grant award. Please let me know if you have any questions about the attached document. FYSA - also cc'ed to this email is the GOR for this effort, Dr. Batni.

Thank you,

(b)(6)
Contracting Officer
Defense Threat Reduction Agency, AL-ACR
Phone:(b)(6)
Email:

<HDTRA1-21-1-0023.pdf>

Disclaimer

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Prime 1 (Fill-in)

COST PROPOSAL

Sub 1 (Fill-in)

GENERAL INFORMATION

The purpose of the requested information in the attached worksheets is to assist government personnel in the review and evaluation of cost proposals submitted by offerors.

Options: Unpriced Options will not be accepted. Any Option that is not fully priced, will not be included in any resulting award.

Enter the proposed cost detail for the Base and each Option period (as needed) on the "Total Amount" tab.

- The formulas in this spreadsheet are based upon common business practices; however, Offerors may edit formulas as necessary (edited formulas must still be visible).
- Ensure all costs from other worksheets are correct.

Below is a summary of the proposed cost. This chart will automatically fill in from the "Total Amount" tab.

Total Direct Labor Costs	$286,937
Total Fringe Benefit Costs	$105,593
Total Labor Overhead Costs	$0
Total Subcontract Costs	$0
Total Consultant Costs	$0
Total Other Direct Costs	$22,660
Total Material Handling Costs	$0
Subtotal Costs	$420,190
Total G&A Costs	$150,596
Subtotal Costs	$570,787
Total Cost of Money	$0
Total Estimated Costs	$570,787
Fixed Fee (If proposing a CPFF contract)	$0
Total Estimated Costs Plus Fixed Fee	$570,787

Cost Proposal - Total Amount
Prime Offeror: Prime 1 (Fill-in)
Subcontractor: Sub 1 (Fill-in)

				BASE			OPTION 1			OPTION 2			OPTION 3			OPTION 4		Total	
Direct Labor (DL)				MM/YR to MM/YR			MM/YR to MM/YR			MM/YR to MM/YR			MM/YR to MM/YR			MM/YR to MM/YR			
	Offeror's Labor Category (Note 1)	**Name (Last, First)**	**Base/Hours**	**Rate**	**Extended $**	**Base/Hours**	**Rate**	**Extended $**	**Base/Hours**	**Rate**	**Extended $**	**Base/Hours**	**Rate**	**Extended $**	**Base/Hours**	**Rate**	**Extended $**	**Base/Hours**	**Extended $**
	Principal Scientist	Ross, Noam	520	$55.29	$28,750.00	520	$58.05	$30,187.50	0	$0.00	$0.00	0	$0.00	$0.00	0	$0.00	$0.00	1,040	$58,937.50
	Research Scientist	Mendelsohn, Emma	1,040	$40.87	$42,500.00	1,040	$42.91	$44,625.00	347	$42.91	$14,875.00	0	$0.00	$0.00	0	$0.00	$0.00	2,427	$101,999.99
	Senior Engineer	Young, Rob	1,040	$50.48	$52,500.00	1,040	$53.00	$55,125.00	347	$53.00	$18,375.00	0	$0.00	$0.00	0	$0.00	$0.00	2,427	$126,000.00
	Total Direct Labor Costs		**2,600**	**$146.63**	**$123,750.00**	**2,600**	**$153.97**	**$129,937.50**	**693**	**$95.91**	**$33,250.00**	**0**	**$0.00**	**$0.00**	**0**	**$0.00**	**$0.00**	**5,893**	**$286,937.49**
Fringe Benefits (F/B) (See Escalation and Indirect Rate Worksheet)																			
	Fringe Benefits	*See Labor&Ind Rates Tab*	$123,750	36.800%	$45,540.00	$129,937	36.800%	$47,817.00	$33,250	36.800%	$12,236.00	$0	0.000%	$0.00	$0	0.000%	$0.00	$286,937.49	$105,593.00
	Total Fringe Benefit Costs				**$45,540.00**			**$47,817.00**			**$12,236.00**			**$0.00**			**$0.00**		**$105,593.00**
Labor Overhead (O/H) (See Escalation and Indirect Rate Worksheet)																			
	N/A		$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	$0.00
	Total Labor Overhead Costs				**$0.00**			**$0.00**			**$0.00**			**$0.00**			**$0.00**		**$0.00**
Subcontracts/Interorganizational Transfer		**File/Tab Name or Link**																	
	N/A				$0.00			$0.00			$0.00			$0.00			$0.00		$0.00
	Total Subcontract Costs				**$0.00**			**$0.00**			**$0.00**			**$0.00**			**$0.00**		**$0.00**
Consultants																			
	N/A				$0.00			$0.00			$0.00			$0.00			$0.00		$0.00
	Total Consultant Costs				**$0.00**			**$0.00**			**$0.00**			**$0.00**			**$0.00**		**$0.00**
Other Direct Costs																			
	Materials/Supplies	*See Materials-Supplies Tab*			$4,000.00			$0.00			$0.00			$0.00			$0.00		$4,000.00
	Equipment				$0.00			$0.00			$0.00			$0.00			$0.00		$0.00
	Travel	*See Travel Tab*			$8,664.00			$5,996.00			$0.00			$0.00			$0.00		$14,660.00
	Cloud Services and Storage	*See ODC Details Tab*			$2,000.00			$2,000.00			$0.00			$0.00			$0.00		$4,000.00
	Communication and Collaboration Services and Softwar	*See ODC Details Tab*			$1,000.00			$1,000.00			$0.00			$0.00			$0.00		$2,000.00
	Publication Costs	*See ODC Details Tab*			$1,500.00			$1,500.00			$0.00			$0.00			$0.00		$3,000.00
	Total Other Direct Costs				**$17,164.00**			**$10,496.00**			**$0.00**			**$0.00**			**$0.00**		**$22,660.00**
Material Handling (M/H O/H) (See Escalation and Indirect Rate Worksheet)																			
	N/A		$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	$0.00
	Total Material Handling Costs				**$0.00**			**$0.00**			**$0.00**			**$0.00**			**$0.00**		**$0.00**
Subtotal Costs					**$186,453.99**			**$188,250.49**			**$45,486.00**			**$0.00**			**$0.00**		**$420,190.49**
General and Administrative (G&A) (See Escalation and Indirect Rate Worksheet)																			
	Institutional Overhead	*See Labor&Ind Rates Tab*	$186,454	35.840%	$66,825.11	$188,250	35.840%	$67,468.98	$45,486	35.840%	$16,302.18	$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$420,190.49	$150,596.27
	Total G&A Costs				**$66,825.11**			**$67,468.98**			**$16,302.18**			**$0.00**			**$0.00**		**$150,596.27**
Subtotal Costs					**$253,279.10**			**$255,719.47**			**$61,788.18**			**$0.00**			**$0.00**		**$570,786.76**
Facilities Cost of Money (COM) (See Escalation and Indirect Rate Worksheet)																			
	N/A		$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	$0.00
	Total Cost of Money				**$0.00**			**$0.00**			**$0.00**			**$0.00**			**$0.00**		**$0.00**
Total Estimated Costs					$253,279.10			$255,719.47			$61,788.18			$0.00			$0.00		$570,786.76
Fixed Fee (If proposing a CPFF contract)		(Note 2)	$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	0.000%	$0.00	$0.00	**$0.00**
Total Estimated Costs Plus Fixed Fee		(Note 3)			**$253,279.10**			**$255,719.47**			**$61,788.18**			**$0.00**			**$0.00**		**$570,786.76**

Instructions:

- For PR ME submission - Subcontractor Name. If there are subcontracts, list all subcontractor names
- List Principal Investigator and Key Personnel working on the project even if they receive no salary support.
- Subcontracts/Interorganizational Transfers: If appropriate, place Subcontractor name(s) or Interorganizational Name/Code in Column B
- Consultants: If appropriate, place Consultant name(s) in Column B
- Remember that the total of all Base and Option worksheets should equal the total of the Total Amount worksheet.
- Add descriptions in Column B if costs are entered in the following areas: Fringe Benefits, Labor Overhead, Other Direct Costs/other types, Material Handling, General and Administrative, and Facilities Cost of Money

Note 1: **Any proposed personnel in the technical proposal should be identified with their labor category.**
Note 2: **Profit or fee is not allowed on direct costs for travel. In addition, a DD Form 1547 (DFARS 215.404-70) will be utilized in calculating the Government objective for fee.**
Note 3: **This worksheet does not pull data from other worksheets within this Excel Spreadsheet**

=

LABOR Information	Prime 1 (Fill-in)							
		Base Period	**Option I**	**Option II**	**Option III**	**Option IV**	**Supporting Documentation**	**Supporting Rationale**
Labor Category (Note 1)	**Name**	**Direct Labor Rate**	**Escalation Rate**	**Escalation Rate**	**Escalation Rate**	**Escalation Rate**	(Note 2)	(Note 3)
Principal Scientist	Ross, Noam	$55.29	$58.05	$0.00				
Research Scientist	Mendelsohn, Emma	$40.87	$42.91	$42.91				
Senior Engineer	Young, Rob	$50.48	$53.00	$53.00				

Indirect Rates								
	Base Period	**Option I**	**Option II**	**Option III**	**Option IV**	**Basis of Rate**	**Applied Against (Note 5)**	**Supporting Documentation (Note 6)**
Rate Category	**Rate**	**Rate**	**Rate**	**Rate**	**Rate**	**(Example: FPRA, FPRP, Estimate, etc.)**		
Fringe Benefits	36.80%	36.80%	36.80%			Estimate	Direct labor costs	
Labor Overhead								
Material Handling								
General and Administrative	35.84%	35.84%	35.84%			Provisional (PROV)	Total direct costs	
Facilities Cost of Money								

Note 1: Add additional labor categories if needed.

Note 2: Provide the location (section, page) in the proposal's Cost Narrative/Supporting Documentation (BAA para 3.5.2.2.1) to support your price basis (e.g. copy of current payroll record or signed offer letter)

Note 3: Provide the location (section, page) in the proposal's Technical Basis of Estimate (BAA para 3.5.2.1.2) of the rationale for the appropriateness and necessity of the proposed labor categories and the labor hours allocated t

Note 4: Add additional indirect rates as needed.

If the offeror does not have a Forward Pricing Rate Agreement (FPRA), Forward Pricing Rate Recommendation (FPRR), or provisional billing rates; in order to assist the Government in evaluating the reasonableness of your proposed indirect rates, please provide the following information:

1. **Performance data used to develop your proposed indirect rates. This typically consists of pool costs and base costs that demonstrate how the indirect rates were derived.**
2. **Information regarding your projections for out years, including your assumptions and method for developing these estimates.**

SUBCONTRACTOR COST DATA Prime 1 (Fill-in)

Subcontracts/Interorganizational Transfers – A fully disclosed cost proposal as detailed as the Offeror's cost proposal including support documentation
In accordance with FAR 15.404-3(b) and 15.404-3(c), the prime contractor **shall** perform and provide a cost/price analysis of each subcontractor's cost

Certified cost or pricing data may be required for subcontractor proposals over $2,000,000.00, in accordance with Section 811 of the National Defense Authorization Act for Fiscal Year 2018 (Pub. L. 115-91).

Subcontractor	CAGE Code	Competitive/Sole Source	Cost/price analysis included (Y/N)	Type of Subcontract (i.e., Fixed Price, Time and Materials, etc.)	Competitive Quotes or Sole Source Documentation Included (Y/N)	Total amount exceeds $750K (Y/N)	Cost/Price Analysis (Note 1)

Note 1: Provide the location (section, page) in the proposal's Cost Narrative/Supporting Documentation (BAA para 3.5.2.2.1) of the cost/price analysis for each individual subcontractor.

Offeror:

CONSULTANTS Prime 1 (Fill-in)

Name (Note 1)	Description of effort to be performed by the Consultant or attach Consultant Statement of Work	Number of Hours	Hourly Rate	Total	Supporting Documentation (Note 2)	Supporting Rationale (Note 3)
Base						
				$0.00		
				$0.00		
				$0.00		
Option I						
				$0.00		
				$0.00		
				$0.00		
				$0.00		

Instructions: • For Prime - fill out all columns if applicable. Indicate "Not Applicable" in B5 when there is no information to include.

Note 1: **Include a separate section in the above table for the Base and each Option.**

Note 2: **Provide the location (section, page) in the proposal's Cost Narrative/Supporting Documentation (BAA para 3.5.2.2.1) used to support your price basis (e.g. copy of quote or agreement).**

Note 3: **Provide the location (section, page) in the proposal's Technical Basis of Estimate (BAA para 3.5.2.1.2) of the rationale for the necessity of the proposed consultant(s).**

MATERIALS - SUPPLIES (Note 1) Prime 1 (Fill-in)

Item (Note 2)	Description of Material (include model number)	Qty	Unit Price	Total Price	Competitive /Sole Source	Vendor/Source (If known)	Supporting Documentation (Note 3)	Supporting Rationale (Note 4)
Base								
1	Laptop computers	2	$2,000.00	$4,000.00				
Option I								

Instructions:

- Fill out all columns on the Materials/Supplies Tab for each item.
- Add additional lines if needed.
- Ensure that descriptions and vendors listed on the Materials/Supplies worksheet match information provided in the backup.

Note 1: **Material is property that may be incorporated into or attached to a deliverable end item or that may be consumed or expended in performing a contract. It includes assemblies, components, parts, raw and processed materials, and small tools and supplies that may be consumed in normal use in performing a contract. Material should be proposed separately from Equipment (see following spreadsheet and definitions).**

Note 2: **Include a separate section in the above table for the Base and each Option.**

Note 3: **Provide the location (section, page) in the proposal's Cost Narrative/Supporting Documentation (BAA para 3.5.2.2.1) of the documentation used to support your price basis (e.g. copy of quote, page from catalog, recent invoice or PO). If the supporting documentation is located on a website, then please provide a screen shot.**

Note 4: **Provide the location (section, page) in the proposal's Technical Basis of Estimate (BAA para 3.5.2.1.2) for the necessity of the proposed materials/supplies**

EQUIPMENT (NOTE 1) Prime 1 (Fill-in)

Item (Note 2)	Description of Equipment (include model number) (Note 1)	Will the equipment be included as part of a deliverable item under the award? (Y/N)	Type of Equipment (special test equipment, special tooling, general purpose equipment, or plant equipment) (Note 3)	Qty	Unit of Issue	Unit Price	Total Price	Vendor/Source	Supporting Documentation (Note 4)	Supporting Rationale (Note 5)
Base										
							$0			
							$0			
Option I										
							$0			

Instructions:

- Fill out all columns on the Equipment Tab for each item.
- Add additional lines if needed.
- Ensure that descriptions and vendors listed on the Equipment worksheet match information provided in the backup.

Note 1: **Contractors are normally required to furnish all equipment and/or facilities necessary to perform Government contracts (see FAR 45.102(a)). The Government may allow**

Note 2: **Include a separate section in the above table for the Base and each Option. Add additional lines labeled with Options if needed.**

Note 3: **Definitions:**
performing a contract. It consists of items or assemblies of equipment including standard or general purpose items or components that are interconnected and interdependent
for installing special test equipment, and which are of such a specialized nature that without substantial modification or alteration their use is limited to the development or
Plant equipment means personal property of a capital nature (including equipment, machine tools, test equipment, furniture, vehicles, and accessory and auxiliary items) for

Note 4: **Provide the location (section, page) in the proposal's Cost Narrative/Supporting Documentation (BAA para 3.5.2.2.1) used to support your price basis (e.g. copy of quote, page from catalog, recent invoice or PO).**

Note 5: **Provide the location (section, page) in the proposal's Technical Basis of Estimate (BAA para 3.5.2.1.2) of the rationale for the necessity of the proposed materials/supplies**

Prime 1 (Fill-in)

City, State	Trip Purpose	Number	Number of	Number	Air/Rail	Per Diem	Per Diem	Rental	Parking	Mileage	Taxi	Other	TOTAL	Supporting
New York, NY	**Conference Attendance**	1	2	5	$1,500.00	$155.00	$196.00	$0.00	$0.00	0	$262.50	$300.00		
Montpelier, France				**Totals**	**$3,000.00**	**$1,395.00**	**$1,568.00**	**$0.00**	**$0.00**	**$0.00**	**$525.00**	**$600.00**	**$7,088.00**	
New York, NY	**Annual Technical Review**	1	1	5	$350.00	$71.00	$161.00	$0.00	$0.00	0	$262.50	$0.00		
Alexandria, VA				**Totals**	**$350.00**	**$319.50**	**$644.00**	**$0.00**	**$0.00**	**$0.00**	**$262.50**	**$0.00**	**$1,576.00**	
New York, NY	**Conference Attendance**	1	2	5	$500.00	$55.00	$225.00	$0.00	$0.00	0	$262.50	$300.00		
Bozeman, Montana				**Totals**	**$1,000.00**	**$495.00**	**$1,800.00**	**$0.00**	**$0.00**	**$0.00**	**$525.00**	**$600.00**	**$4,420.00**	
New York, NY	**Annual Technical Review**	1	1	5	$350.00	$71.00	$161.00	$0.00	$0.00	0	$262.50	$0.00		
Alexandria, VA				**Totals**	**$350.00**	**$319.50**	**$644.00**	**$0.00**	**$0.00**	**$0.00**	**$262.50**	**$0.00**	**$1,576.00**	
TOTAL													**$14,660**	

- When completing the "From" and "To" information, enter the city and state where travel will originate and end. For example, from Seattle WA to Washington DC. Do not list airport codes.
- Include the trip purpose. It must be referred to in the Technical Proposal. Publications, conference attendance, and presentations are encouraged but must be justified to and approved by the Program Officer.
- Remember that you cannot stay overnight the same number of days that you travel. There must always be one more day than night.
- Do not combine any categories.
- For lodging and M&IE, use federal Per Diem Rates found at http://www.defensetravel.dod.mil/site/perdiemCalc.cfm.
- For M&IE, input the full rate in the white block. The gray block will automatically calculate the total to include 75% for the first and last day of travel.
- Submit backup for airfare and rental cars. Price airfare at economy rates; indicate if the airfare is refundable.

Estimates and the resultant costs claimed must conform to the applicable Federal cost principles.
Include a separate section in the above table for the base and each option
If there are miscellaneous expenses associated with the trip, provide description and rationale.

Provide the location (section, page) in the proposal's Cost Narrative/Supporting Documentation (BAA para 3.5.2.2.1) used to support your price basis (e.g. copy of quote, page from catalog, recent invoice or PO).

OTHER DIRECT COSTS (Note 1)			Prime 1 (Fill-in)	
Description (Note 2)	**Qty**	**Unit of Issue**	**Unit Price**	**Total Price**
Base				$0
Publication costs	1	Publication	$1,500	$1,500
Cloud Services and Storage	1	Annual	$2,000	$2,000
Communication and Collaboration Services &	1	Annual	$1,000	$1,000
Option I				$0
Publication costs	1	Publication	$1,500	$1,500
Cloud Services and Storage	1	Annual	$2,000	$2,000
Communication and Collaboration Services &	1	Annual	$1,000	$1,000

Instructions:

- If you have any ODC entries, be sure to fill out all columns.
- Ensure that descriptions and vendors listed on the ODC Details works

Note 1: **Examples include rental fees, shipping costs, license fees**

Note 2: **Include a separate section in the above table for the Base and each**

Attachment 1 - Statement of Work (SOW)

Project Title: Predictin Biothreat Impacts from Early-Stage Data via Transfer Learning
Document Date: February 26, 2021

Objective

The project's objectives are to determine the efficacy of machine learning (ML) techniques in predicting epidemic impacts in early-stage, data-sparse conditions, particularly novel biothreats, both intentional (e.g. novel genetically-modified pathogens) and natural (e.g. zoonotic). We define "early stage" as the initial period in an outbreak when only short time-series data are available, prior to rapid growth and geographic spread, and epidemiological parameters are not well-established. Specifically, we will answer three questions that will enable rapid decision-making based on ML models of epidemic impacts:

Q1: How much does partial-pooling improve predictions of epidemic impacts, and what information transfers best across diseases?
Q2: What variables are most predictive of epidemic impacts at early stages of an outbreak?
Q3: At what point in epidemic growth do hybrid models that incorporate mechanistic epidemiological components become more accurate than pure ML models?

This work will contribute to fundamental knowledge of properties and variables that contribute most to predictive accuracy at early-stage stages in emerging outbreak prediction and forecasting. It will enable the development of robust and deployable predictive models at early stages of outbreaks, and support informed choices for data collection and model selection.

Scope

The awardee proposes a two-year study to determine the efficacy of ML techniques in predicting epidemic impacts in early-stage, data-sparse conditions, particularly novel biothreats. The awardee team shall focus on the following major goals and milestones:

- *Year 1, Milestone 1 (0-6 months)*: Create and curate predictor database, project infrastructure, continuous integration/validation, establish data-imputation and automatic predictor workflow (Tasks 1.1-1.2).
- *Year 1, Milestone 2 (6-12 months)*: Bayesian additive regression tree (BART) model fitting and tuning, determination of variable contribution to prediction accuracy (Task 1.3). Document and validate project code and infrastructure (Task 1.4)
- *Option Year 1, Milestone 3 (12-18 months)*: Extend the database to include additional predictors, extend the BART model to ingest genetic data (Tasks 2.1-2.3)
- *Option Year, Milestone 4 (18-24 months):* Construction of hybrid ML/mechanistic model structure, comparative testing of pure and hybrid version, determination of timing when current data overtakes transfer data (Task 2.4). Document and validate project code and infrastructure (Task 2.5)
- *Option Task 1, (12-18 months):* Develop a graphical user interface (GUI) for the model, allowing users to input of early-stage outbreak data and generate predictions, uncertainty bounds, and interpretable explanations of influential variables. Document GUI and validate code.

Background

Situational awareness and risk assessment are critical at early stages of disease outbreaks, when interventions can best mitigate adverse outcomes. Yet decision-makers often face a paucity of data at these stages. Traditional modeling methods to forecast disease impact severity rely heavily on prior knowledge or assumptions about mechanisms of disease spread progression, and they frequently do not anticipate the actual mechanisms.[1-3] They also take considerable time and effort to develop.

Recent theory suggests disease dynamics are fundamentally predictable[4], and ML methods have been successfully applied in emerging disease science. ML refers to a group of methods, ranging from simple nearest-neighbor approaches to function-approximation methods such as boosted trees and penalized splines, to complex deep-learning neural networks. ML has been used to predict the likelihood of disease emergence and the zoonotic potential of various hosts and viruses[5,6], and deep-learning approaches have been used to infer viral hosts from the comparatively richer data of genetic sequences of viruses.[7,8]

ML methods are generally unstructured, flexible, and offer greater predictive power over traditional statistical approaches. However, these methods are data-intensive, and a key challenge with ML development is data paucity and/or a low signal-to-noise ratio. Surveillance data for even existing, well-studied diseases is rarely rich enough for the data scale of many modern ML techniques. For instance, a ML approach to predict impacts from a new outbreak of Ebola would draw training data from fewer than twenty previous events, each with varying levels of data coverage.

Transfer learning, or data fusion, provides a solution to data paucity issues by using data from other domains to train parts of models that are general, thus limiting new data requirements for more specific components. Hierarchical modeling, or *partial pooling*, is a transfer learning approach for partitioning out which data can be shared between models and which are only applicable to a specific case. For instance, Ebola forecasts for countries outside the historic range of the disease may be improved by calibrating against Cholera outbreaks, which have occurred both within and outside countries with Ebola outbreaks. The degree to which the disease outcomes are correlated is learned, rather than assumed.

An alternative recent development in disease forecasting is the development of hybrid models that incorporate simple mechanistic structures and predictive ML methods to learn model parameters. These approaches have demonstrated high predictive accuracy for near-term forecasting of epidemic growth and impact, particularly during the COVID-19 pandemic[9]. However, these approaches require adequate time-series of data to project forward from current conditions. Their utility in early stages and long-term forecasting accuracy has yet to be determined. In opting to apply these models, it is critical to understand these data requirements and at what point in an outbreak hybrid approaches can overtake pure ML early-stage predictions in accuracy. This project seeks to develop, apply, and compare pure and hybrid-ML techniques to enable the development of robust, rapidly usable predictions at early stages of outbreaks.

Key references (additional references can be found in the Technical Proposal):

1 MacDiarmid, S. C. *et al. Handbook On Import Risk Analysis for animals and animal products: quantitative risk assessment.* Vol. 2 (Office International des Épizooties, 2004).

2 Moura, J. A., McManus, C. M., Bernal, F. E. M. & de Melo, C. B. An analysis of the 1978 African swine fever outbreak in Brazil and its eradication. *Rev. Sci. Tech.* **29**, 549-563, doi:10.20506/rst.29.3.1992 (2010).

3 Delgado, J. *et al.* U.K. Foot and Mouth Disease: A Systemic Risk Assessment of Existing Controls. *Risk Anal.* **37**, 1768-1782, doi:10.1111/risa.12704 (2017).

4 Scarpino, S. V. & Petri, G. On the predictability of infectious disease outbreaks. *Nat. Commun.* **10**, 898, doi:10.1038/s41467-019-08616-0 (2019).

5 Olival, K. J. *et al.* Host and viral traits predict zoonotic spillover from mammals. *Nature*, doi:10.1038/nature22975 (2017).

6 Allen, T. *et al.* Global hotspots and correlates of emerging zoonotic diseases. *Nat. Commun.* **8**, 1124, doi:10.1038/s41467-017-00923-8 (2017).

7 Mock, F., Viehweger, A., Barth, E. & Marz, M. VIDHOP, viral host prediction with Deep Learning. *Bioinformatics* (2019).

8 Babayan, S. A., Orton, R. J. & Streicker, D. G. Predicting reservoir hosts and arthropod vectors from evolutionary signatures in RNA virus genomes. *Science* **362**, 577-580, doi:10.1126/science.aap9072 (2018).

9 Gu, Y. *COVID-19 Projections Using Machine Learning*, <https://covid19-projections.com/about/#historical-performance> (2020).

Data Sources

Fitting and testing models will draw from disease outbreak data (counts, timing, and geography) and predictor data including pathogen traits (disease symptoms, pathogen traits, modes of transmission), pathogen sources (point of origin, geographic range of potential natural hosts), environmental context (climatic conditions, ecosystem traits), and socioeconomic context (local population densities, demographics, transportation networks, healthcare systems). Please see the Technical Proposal for available data sources.

Tasks/Scientific Goals (Format: Year.Task.Subtask)

YEAR 1

Task 1.1 – Develop and deploy project infrastructure

The awardee shall develop a computational environment that enables continuous model development and testing and allows for research and models to be reproduced and extended by external teams. The computational environment will include continuous maintenance and documentation of project codebase.

Subtasks

1.1.1 Layout a provision internal project network
1.1.2 Set up continuous integration pipelines
1.1.3 Implement backup and data verification jobs
1.1.4 Implement differential privacy testing

Task 1.2 – Engineer project database

The awardee shall curate, integrate, cross-link, and validate relevant datasets from various sources into a project database, accounting for differing space and time scales, data formats, and data completeness.

Subtasks

1.2.1 Design database schema
1.2.2 Write pipelines to ingest data
1.2.3 Cross-link data sources via common ontology

1.2.4 Write quality assurance/quality control (QA/QC) tests for data and perform data cleaning
1.2.5 Create automatic extraction routines to populate relevant predictors from location information
1.2.6 Update data from live sources and clean and maintain data continuously

Task 1.3 – Machine Learning (ML) model development and testing
The awardee shall design, implement, test, and analyze performance of ML model structures and iteratively improve them.

Subtasks
1.3.1 Establish quantitative and qualitative metrics of model performance
1.3.2 Implement "practical naïve" model baseline
1.3.3 Design Bayesian additive regression tree (BART) model structure
1.3.4 Design alternative generalized additive model (GAM) structure
1.3.5 Implement within-disease, all-disease, and partial-pooled disease model versions
1.3.6 Measure variable contribution by re-fitting
1.3.7 Analyze prediction-level variable contributions and model performance
1.3.8 Iteratively update models to improve performance

Task 1.4 – Maintain and document project infrastructure
The awardee shall document the methodology for database schema, data ingestion pipelines, QA/QC tests, extraction routes, and ML models established in Tasks 1.1-1.3.

Subtasks
1.4.1 Write and maintain initial codebase documentation
1.4.2 Perform code review, testing, and validation

OPTION YEAR (OPTION I):

Task 2.1 – Extend project database
In the option year, the awardee shall extend the database to include additional predictors and continuously maintain and update to accumulate more data from upstream sources.

Subtasks
2.1.1 Extend database schema to include genetic data and auto-encoded variables
2.1.2 Write pipelines to ingest genetic data
2.1.3 Cross-link data sources via common ontologies
2.1.4Write QA/QC tests for data and perform data cleaning
2.1.5Update data from live sources and clean and maintain data continuously

Task 2.2 – Extend BART model
In the option year, the awardee shall extend the BART model to ingest genetic data and test the contribution of this data in enhancing or recapitulating pathogen trait data.

Subtasks
2.2.1Develop genetic predictor variable set via neural-network autoencoding
2.2.2 Modify BART and GAM structures to incorporate genetic variables
2.2.3 Implement within-disease, all-disease, and partial-pooled disease model versions
2.2.4 Compare performance of genetic, pathogen-trait, and combined models

Task 2.3 – Hybrid ML-mechanistic model development and testing

In the option year, the awardee shall develop the hybrid machine-learning mechanistic model, compare its performance to a pure ML model, and determine the switch-over time when the mechanistic model becomes more predictive in the course of the outbreak.

Subtasks

2.4.1 Establish quantitative and qualitative metrics of model performance
2.4.2 Design mechanistic model structure
2.4.3 Determine mechanistic model prior forms
2.4.4 Modify ML model to predict mechanistic parameters rather than outcomes
2.4.5Implement within-disease, all-disease, and partial-pooled disease model versions
2.4.6Measure variable contribution by re-fitting
2.4.7Analyze prediction-level variable contributions and model performance using criteria developed in Task 1.3
2.4.8Compare Hybrid and ML performance along outbreak time-series progression
2.4.9Iteratively update models to improve performance

Task 2.4 – Maintain and document project infrastructure

In the option year, the awardee shall document the methodology for extended database schema, and data ingestion pipelines, QA/QC tests, extraction routes, and ML models established in Tasks 2.1-2.3.

Subtasks

2.4.1 Write and maintain initial codebase documentation
2.4.2 Perform code review, testing, and validation

OPTION TASK (OPTION II):

Task 3.1 – Develop Model Graphical User Interface

As an additional optional task, the awardee shall develop a graphical user interface (GUI) for the ML model developed in task 1.3, allowing users to input of early-stage outbreak data and generate predictions, uncertainty bounds, and interpretable explanations of influential variables.

Subtasks

3.1.1 Port model into portable framework usable for standalone or web-based interaction
3.1.2 Optimize for rapid response time and application size
3.1.3 Design input interface
3.1.4 Design visualizations for predictions, uncertainty, and variable importance

Task 3.2 – Maintain and document project infrastructure

In the option task, the awardee shall document usage of the GUI, and perform code review of testing and validation of the GUI codebase created in tasks 3.1

Subtasks

3.2.1 Create GUI documentation
3.2.2 Perform code review, testing, and validation

Deliverables

- Reports and Documents
    - Monthly reports on task status
    - Monthly cost statement
    - Periodic program reviews (virtual and/or in person)
    - Annual technical report, which shall include
        - Executive Summary
        - I. Introduction/Background
        - II. Methodology
        - III. Findings
        - IV. Discussion/Future Recommendations
        - V. Conclusion
        - VI. Appendices
            - a. Snapshots of GUI/how to use
            - b. Data worksheet (summarizing list of data sources used, metadata abstracted, links, etc.)
- Source and executable software code
- Project databases
- Technical papers describing algorithm design and performance
- Conference presentations

Code Modules and Database Archives
Code and databases will be made available for download and provided electronically via DoD SAFE and/or on-disk to DTRA at the end of the period of performance.

Note: The data and information collected in this effort is funded on the condition that it will not be released to another nation or international organization without the specific authority from the Defense Threat Reduction Agency. Individual or corporate rights originating in the information, whether patented or not, will be respected; that the recipient government will report promptly to the Defense Threat Reduction Agency any known or suspected compromise and that the information will be provided substantially the same degree of security afforded it by the Department of Defense of the United States. No U.S. Government commitment to sell, lend, lease, co-develop, or co-produce defense articles is implied or intended. Also, regardless of any other markings on the document, it will not be downgraded or declassified without written approval of the originating U.S. agency.

Gantt Chart

Description	Y1 Q1-2	Y1 Q3-4	Y2 Q1-2	Y3 Q3-4
Year 1, Milestone 1				
1.1.1 Layout a provision project network	■			
1.1.2 Set up continious integration pipelines	■			
1.1.3 Implement backup and data verification jobs	■			
1.1.4 Implement differential privacy testing	■			
1.2.1 Design database schema	■			
1.2.2 Write pipelines to ingest data	■			
1.2.3 Cross-link data sources via common ontology	■			
1.2.4 Write quality assurance/quality control (QA/QC) tests for data and perform data cleaning	■	■		
1.2.5 Create automatic extraction routines to populate relevant predictors from location information	■	■		
1.2.6 Update data from live sources and clean and maintain data continuously	■	■		
1.3.1 Establish quantitative and qualitative metrics of model performance	■			
1.3.2 Implement "practical naïve" model baseline	■			
1.3.3 Design model structure	■			
1.3.4 Design alternative structure	■	■		
1.3.5 Implement within-disease, all-disease, and partial-pooled disease model versions	■	■		
1.3.6 Measure variable contribution by re-fitting		■		
1.3.7 Analyze prediction-level variable contributions and model performance		■		
1.3.8 Iteratively update models to improve performance		■		
1.4.1 Write and maintain initial codebase documentation	■	■		
1.4.2 Perform code review, testing, and validation	■	■		
Option Year 1 (Option I)				
2.1.1 Extend database schema to include genetic data			■	
2.1.2 Write pipelines to ingest genetic data			■	
2.1.3 Cross-link data sources via common ontologies			■	
2.1.4 Write QA/QC tests for data and perform data cleaning			■	■
2.1.5 Update data from live sources and clean and maintain data continuously			■	■
2.2.1 Develop genetic predictor variable set via neural-network autoencoding			■	
2.2.2 Modify BART and GAM structures to incorporate genetic variables			■	
2.2.3 Implement within-disease, all-disease, and partial-pooled disease models			■	
2.2.4 Compare performance of genetic, pathogen-trait, and combined models			■	
2.4.1 Establish quantitative and qualitative metrics of model performance			■	
2.4.2 Design mechanistic model structure			■	
2.4.3 Determine mechanistic model prior forms			■	
2.4.4 Modify ML model to predict mechanistic parameters rather than outcomes			■	
2.4.5 Implement within-disease, all-disease, and partial-pooled disease model versions			■	■
2.4.6 Measure variable contribution by re-fitting			■	■
2.4.7 Analyze prediction-level variable contributions and model performance				■
2.4.8 Compare Hybrid and ML performance along outbreak time-series progression				■
2.4.9 Iteratively update models to improve performance				■
2.5.1 Write and maintain initial codebase documentation			■	■
2.5.2 Perform code review, testing, and validation			■	■
Option Task (Option II)				
3.1.1 Port model into portable framework usable for standalone or web-based interaction			■	
3.1.2 Optimize for rapid response time and application size			■	
3.1.3 Design input interface			■	
3.1.4 Design visualizations for predictions, uncertainty, and variable importance			■	
3.2.1 Create GUI documentation			■	
3.2.2 Perform code review, testing, and validation			■	

RESEARCH & RELATED BUDGET - Budget Period 1

OMB Number: 4040-0001
Expiration Date: 12/31/2022

ORGANIZATIONAL DUNS: 0770900660000 **Enter name of Organization:** EcoHealth Alliance

Budget Type: ☒ Project ☐ Subaward/Consortium **Budget Period: 1** **Start Date:** 07/01/2020 **End Date:** 06/30/2021

A. Senior/Key Person

Prefix	First	Middle	Last	Suffix	Base Salary ($)	Months Cal.	Months Acad.	Months Sum.	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
Dr.	Noam		Ross			3.00			25,000.00	9,200.00	34,200.00
Project Role:	PD/PI										
	Robert		Young			6.00			52,500.00	19,320.00	71,820.00
Project Role:	Senior Engineer										
	Emma		Mendelsohn			6.00			42,500.00	15,640.00	58,140.00
Project Role:	Research Scientist										

Additional Senior Key Persons: Add Attachment

Total Funds requested for all Senior Key Persons in the attached file

Total Senior/Key Person 164,160.00

B. Other Personnel

Number of Personnel	Project Role	Months Cal.	Months Acad.	Months Sum.	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
	Post Doctoral Associates						
	Graduate Students						
	Undergraduate Students						
	Secretarial/Clerical						

Total Number Other Personnel

Total Other Personnel

Total Salary, Wages and Fringe Benefits (A+B) 164,160.00

C. Equipment Description

List items and dollar amount for each item exceeding $5,000

Equipment item	**Funds Requested ($)**

Additional Equipment: Add Attachment

Total funds requested for all equipment listed in the attached file	
Total Equipment	

D. Travel

		Funds Requested ($)
1.	Domestic Travel Costs (Incl. Canada, Mexico and U.S. Possessions)	1,576.00
2.	Foreign Travel Costs	7,088.00
	Total Travel Cost	8,664.00

E. Participant/Trainee Support Costs

		Funds Requested ($)
1.	Tuition/Fees/Health Insurance	
2.	Stipends	
3.	Travel	
4.	Subsistence	
5.	Other	

Number of Participants/Trainees

Total Participant/Trainee Support Costs

F. Other Direct Costs

		Funds Requested ($)
1.	Materials and Supplies	7,000.00
2.	Publication Costs	1,500.00
3.	Consultant Services	
4.	ADP/Computer Services	
5.	Subawards/Consortium/Contractual Costs	
6.	Equipment or Facility Rental/User Fees	
7.	Alterations and Renovations	
8.		
9.		
10.		
	Total Other Direct Costs	8,500.00

G. Direct Costs

	Funds Requested ($)
Total Direct Costs (A thru F)	181,324.00

H. Indirect Costs

Indirect Cost Type	Indirect Cost Rate (%)	Indirect Cost Base ($)	Funds Requested ($)
EcoHealth Alliance's NICA rate	35.84	181,324.00	64,986.52
		Total Indirect Costs	64,986.52

Cognizant Federal Agency
(Agency Name, POC Name, and POC Phone Number) Department of Defense, Department of the Navy, Sharon Gales, +1.703.696.8559

I. Total Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Institutional Costs (G + H)	246,310.52

J. Fee

	Funds Requested ($)

K. Total Costs and Fee

	Funds Requested ($)
Total Costs and Fee (I + J)	246,310.52

L. Budget Justification

(Only attach one file.) 1234 DTRA ML_Budget Justification.pdf [Delete Attachment] [View Attachment]

RESEARCH & RELATED BUDGET - Budget Period 2

ORGANIZATIONAL DUNS: 0770900660000 **Enter name of Organization:** EcoHealth Alliance

Budget Type: ☒ Project ☐ Subaward/Consortium **Budget Period: 2** **Start Date:** 07/01/2021 **End Date:** 06/30/2022

A. Senior/Key Person

Prefix	First	Middle	Last	Suffix	Base Salary ($)	Months Cal.	Months Acad.	Months Sum.	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
Dr.	Noam		Ross			3.00			26,250.00	9,660.00	35,910.00
Project Role:	PD/PI										
	Robert		Young			6.00			55,125.00	20,286.00	75,411.00
Project Role:	Senior Engineer										
	Emma		Mendelsohn			6.00			44,625.00	16,422.00	61,047.00
Project Role:	Research Scientist										

Additional Senior Key Persons: ☐ Add Attachment

Total Funds requested for all Senior Key Persons in the attached file

Total Senior/Key Person 172,368.00

B. Other Personnel

Number of Personnel	Project Role	Months Cal.	Months Acad.	Months Sum.	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
	Post Doctoral Associates						
	Graduate Students						
	Undergraduate Students						
	Secretarial/Clerical						

Total Number Other Personnel

Total Other Personnel

Total Salary, Wages and Fringe Benefits (A+B) 172,368.00

C. Equipment Description

List items and dollar amount for each item exceeding $5,000

Equipment item	**Funds Requested ($)**

Additional Equipment: ☐ Add Attachment

Total funds requested for all equipment listed in the attached file

Total Equipment

D. Travel

		Funds Requested ($)
1.	Domestic Travel Costs (Incl. Canada, Mexico and U.S. Possessions)	5,996.00
2.	Foreign Travel Costs	
	Total Travel Cost	5,996.00

E. Participant/Trainee Support Costs

		Funds Requested ($)
1.	Tuition/Fees/Health Insurance	
2.	Stipends	
3.	Travel	
4.	Subsistence	
5.	Other	
	Total Participant/Trainee Support Costs	

Number of Participants/Trainees

F. Other Direct Costs

		Funds Requested ($)
1.	Materials and Supplies	3,000.00
2.	Publication Costs	1,500.00
3.	Consultant Services	
4.	ADP/Computer Services	
5.	Subawards/Consortium/Contractual Costs	
6.	Equipment or Facility Rental/User Fees	
7.	Alterations and Renovations	
8.		
9.		
10.		
	Total Other Direct Costs	4,500.00

G. Direct Costs

	Funds Requested ($)
Total Direct Costs (A thru F)	182,864.00

H. Indirect Costs

Indirect Cost Type	Indirect Cost Rate (%)	Indirect Cost Base ($)	Funds Requested ($)
EcoHealth Alliance's NICA rate	35.84	182,864.00	65,538.46
		Total Indirect Costs	65,538.46

Cognizant Federal Agency
(Agency Name, POC Name, and POC Phone Number) Department of Defense, Department of the Navy, Sharon Gales, +1.703.696.8559

I. Total Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Institutional Costs (G + H)	248,402.46

J. Fee

	Funds Requested ($)

K. Total Costs and Fee

	Funds Requested ($)
Total Costs and Fee (I + J)	248,402.46

L. Budget Justification

(Only attach one file.) 1234 DTRA ML_Budget Justification.pdf

RESEARCH & RELATED BUDGET - Cumulative Budget

		Totals ($)
Section A, Senior/Key Person		336,528.00
Section B, Other Personnel		
Total Number Other Personnel		
Total Salary, Wages and Fringe Benefits (A+B)		336,528.00
Section C, Equipment		
Section D, Travel		14,660.00
1. Domestic	7,572.00	
2. Foreign	7,088.00	
Section E, Participant/Trainee Support Costs		
1. Tuition/Fees/Health Insurance		
2. Stipends		
3. Travel		
4. Subsistence		
5. Other		
6. Number of Participants/Trainees		
Section F, Other Direct Costs		13,000.00
1. Materials and Supplies	10,000.00	
2. Publication Costs	3,000.00	
3. Consultant Services		
4. ADP/Computer Services		
5. Subawards/Consortium/Contractual Costs		
6. Equipment or Facility Rental/User Fees		
7. Alterations and Renovations		
8. Other 1		
9. Other 2		
10. Other 3		
Section G, Direct Costs (A thru F)		364,188.00
Section H, Indirect Costs		130,524.98
Section I, Total Direct and Indirect Costs (G + H)		494,712.98
Section J, Fee		
Section K, Total Costs and Fee (I + J)		494,712.98

BUDGET JUSTIFICATION FOR ECOHEALTH ALLIANCE

EcoHealth Alliance requests a total of $4,975,681 over all-years of the proposed project to support personnel, travel, equipment, consortium agreements, and applicable indirect costs.

A. Key Personnel
Noam Ross, Ph D., Principal Investigator (3.0 calendar months for all years). Dr. Ross will oversee the project and be responsible for project management, research, development, design, analysis, and manuscript writing and conference presentations, as well as communication with DTRA. We request $25,000 in Y1 due to the high cost of living in New York City and a 5% cost of living increase in OY1.

Emma Mendelsohn, M.Sc, Research Scientist. (6.0 calendar months for all years). Ms. Mendelsohn will lead data engineering and contribute expertise to algorithm development. She will contribute to manuscript writing and conference presentations. We request $42,500 in Y1 with a 5% cost of living increase in OY1

Robert Young M.Sc, Senior Research Software Engineer. (6.0 calendar months for all years). Mr. Young will lead infrastructure engineering and contribute expertise to algorithm development. He will contribute to manuscript writing and conference presentations.We request $52,500 in Y1 with a 5% cost of living increase in OY1.

Fringe Benefits
Fringe benefits are calculated as 36.80% of base salary p.a. with $44,160 requested in Y1 calculated from the base salary for all personnel. In OY1, we budget for a 5% per year cost of living allowance increase in all salaries.

B. Other Personnel
No funds are requested for other personnel.

C. Equipment
No funds are requested for equipment.

D. Travel
Per recommendations in the BAA, we request travel funds to Nationally Recognized Conferences and the Annual Technical Review.

Domestic Travel
Domestic travel is requested for one trip per year from New York City per year to Northern Virginia the Annual Technical Review. Transportation is estimated at $350 per trip along with the government GSA per diem rates for Northern Virginia ($161 for accommodation and $71 for meals and incidentals). Additional domestic travel support will facilitate two EcoHealth Alliance team members presenting at one conference. In OY1, this will be the EEID conference held in Bozeman, MT in 2022, with transportation costs of $500, $225 for accommodation and $55 for meals and incidentals. For each trip, $25 per day is estimated in taxi costs and for those that

require transport to the airport $150 RT is included. In total, we are requesting $1,576 in Y1 and $5,996 in OY1 for domestic travel

International Travel
One international trip for two team members to present at the EEID conference held in Montpelier, France, in 2021 requested for Y1. Flights are estimated at $1500 and the federal per diem rates of $196 for lodging and $155 for meals in Montpelier. $25 per day is estimated in taxi costs plus $150 RT trips to airport is included. In total we are requesting $7,088 in Y1.

E. Participant/Trainee Support Costs

No funds are requested for participant or trainee support costs.

F. Other Direct Costs

Materials and Supplies
PI Ross and Research Scientist Mendelsohn will both need a new computer, equipped with Microsoft software for which we request a total of $4,000, in only Y1.

Cloud Computing and Storage Services
We will make use of cloud computer services including spot server rental for compute-intensive jobs, data storage, continuous integration and testing of computer code. We request $2,000 per year in Y1-OY1.

Team Communication and Collaboration Software and Services
We request $1,000 per year for subscriptions for software and services for document sharing, chat, voice, and video communications.

Publication Costs
To facilitate the dissemination of project findings, $1,500 per year in only Y1-OY1 is requested for open access publication costs in international peer-reviewed journals.

H. Indirect Costs

We are requesting the EcoHealth Alliance federally approved indirect cost rate of 35.84% on all applicable direct costs. The USA Department of Defense's Department of the Navy has approved this rate on 01 April 2020. We request $ $64,986.52 in Y1 and $65,538.46 in OY1.

Predicting Biothreat Impacts from Early-Stage Data via Transfer Learning

Phase II Technical Proposal

ABSTRACT

Accurately forecasting the impacts of novel biological agents in the early stages of their emergence is critical to planning control measures for warfighters and civilians. However, at the beginning of outbreaks, data about pathogen properties and dynamics are often scarce. Machine learning (ML) techniques generally require large data sets, thus hampering their utility in these contexts. Our proposed work addresses this challenge by using cross-disease prediction via transfer learning utilizing data from previous emergence events to improve early-stage predictions for future events. We will use partial-pooling to determine the degree to which information can be shared across diseases according to hierarchical similarities in pathogen and host properties, and in environmental and population conditions. We will also determine which properties contribute most to predictive accuracy, providing guidance for prioritizing data-collection in early outbreak stages. We will test and compare two approaches – pure ML predictions and hybrid ML/mechanistic models – to determine which provides better predictions of outbreak size and impacts. We will determine at what point in an outbreak current data overtakes historical data as a better predictor of outbreak dynamics. Making use of data sets from multiple host species as well as efficient model-validation techniques, we will expand the size of available training data and thus models' predictive capacity.

SCOPE

__Objective__

Our primary research objectives are to determine the efficacy of ML techniques in predicting epidemic impacts in early-stage, data-sparse conditions, particularly novel biothreats both intentional (e.g. novel genetically-modified pathogens) and natural (e.g. zoonotic). Specifically, we will answer three questions that will enable rapid decision-making based on ML models of epidemic impacts:

Q1: How much does partial-pooling improve predictions of epidemic impacts, and what information transfers best across diseases?

Q2: What variables are most predictive of epidemic impacts at early stages of an outbreak?

Q3: At what point in epidemic growth do hybrid models that incorporate mechanistic epidemiological components become more accurate than pure ML models?

This work will contribute to fundamental knowledge of properties and variables that contribute most to predictive accuracy at early-stage stages in emerging outbreak prediction and forecasting. It will enable the development of robust and deployable predictive models at early stages of outbreaks, and support informed choices for data collection and model selection.

Background

Situational awareness and risk assessment are critical at early stages of disease outbreaks, when interventions can best mitigate adverse outcomes. Yet decision-makers often face a paucity of data at these stages. Traditional modeling methods to forecast disease impact severity rely heavily on prior knowledge or assumptions on mechanisms of disease spread progression, and they frequently do not anticipate the actual mechanisms.[1-3] They also take considerable time and effort to develop.

Recent theory suggests disease dynamics are fundamentally predictable[4], and machine learning (ML) methods have demonstrated utility for some aspects of emerging disease science, e.g. to predict the likelihood of disease emergence and zoonotic potential of various hosts and viruses[5,6], and deep learning has been used to infer viral hosts from the comparatively richer data of genetic sequences of viruses.[7,8]

Machine learning (ML) refers to a group of methods, ranging from simple nearest-neighbor approaches to function-approximation methods such as boosted trees and penalized splines, to complex deep-learning neural networks. These methods are generally unstructured, flexible, and offer greater predictive power over traditional statistical approaches. However, these methods can also be data-intensive; a key challenge with ML methods development is that data are too sparse, or signal/noise ratio too low, to effectively train algorithms. Surveillance data for even existing, well-studied diseases is rarely rich enough for the data scale of many modern machine learning or deep learning techniques. For instance, an ML approach to predict impacts from a new outbreak of Ebola would have training data from to less than twenty previous events for which there is comprehensive epidemiological data from 10 West and Central African nations

Transfer learning, or data fusion, provides a solution for using data from other domains to train parts of models that are general, thus limiting new data requirements for more specific components. Hierarchical modeling, or *partial pooling*, is a transfer learning approach for partitioning out which data can be shared between models and which are only applicable to a specific case. For instance, Ebola forecasts from countries outside of the virus' historic range may be improved by calibrating against influenza outbreaks, which have occurred both within and outside countries with Ebola outbreaks. The degree to which the disease outcomes are correlated (e.g, similarity of modes of transmission) are learned, rather than assumed.

An alternative recent development in disease forecast is the development of hybrid models that incorporate simple mechanistic structures and predictive ML methods to learn model parameters. These approaches have demonstrated high predictive accuracy for near-term forecasting of epidemic growth and impact, particularly during the COVID-19 pandemic[9]. However, these approaches require adequate time-series of data to project forward from current conditions. Their utility in early stages and long-term forecasting accuracy has yet to be determined. In opting to apply these models, it is critical to understand these data requirements and at what point in an outbreak hybrid approaches can overtake pure ML early-stage predictions in accuracy.

We will develop algorithms to predict the dynamics and impacts of outbreaks of new infectious diseases, based on data available at early stages of outbreaks. In doing so, we will answer the following key questions.

- How much does partial-pooling improve predictions of epidemic impacts, and what information transfers best across diseases?
- What variables are most predictive of epidemic impacts at early stages of an outbreak?
- At what point in epidemic growth do hybrid models that incorporate mechanistic epidemiological components become more accurate than pure ML models?

Algorithmic Methods:

We will test the ability to ML methods incorporating partial pooling to predict impacts from a new outbreak of disease. Our primary model structure will be built around Bayesian additive regression trees (BARTs)[10]. BARTs provide three features appropriate for this application: First, they can provide both high-quality predictions as well as robustness in relatively data-poor scenarios. Secondly, they have explicit uncertainty structures is better able to characterize error than other regression tree methods that do not. Thirdly, they are able to incorporate hierarchical partial pooling. In some scenarios where data are smooth rather than categorical, generalized additive models (GAMs) can offer similar performance and similar features[11], and we will test these as an alternate formulation.

We will parametrize the models using data on pathogen traits (disease symptoms, pathogen traits, modes of transmission), pathogen sources (point of origin, geographic range of potential natural hosts), environmental context (climatic conditions, ecosystem traits), and socioeconomic context (local population densities, demographics, transportation networks, healthcare systems), as well as time-series data of infections from the earliest phase of the outbreaks. Not all these data are typically available at the early stages of a new bioagent outbreak, and are in many cases incomplete even in the case of historical outbreaks. Thus, we will use multiple imputation[12] in all models to allow for model fitting, prediction and assessment of uncertainty under incomplete data.

We will explore multiple model structures, but all formulations will be fit and tested under three conditions: *within-disease* forecasting where models are fit only on data from a single disease and tested at ability to predict impacts from that disease, *all-disease* forecasting where models are fit on data from *all* diseases and tested against ability to predict each disease, and *partial-pooled* where models are fit all models from all diseases but parameter sharing across diseases are partially pooled. (See 'Model Evaluation and Validation' below)

While ML approaches are best for predictive power, they do not have the flexibility to be used for alternate scenarios or intervention evaluation that traditional compartmental models do. We will compare "pure" ML algorithms to a hybrid approach using ML to generate parameters for mechanistic epidemiological models. In this hybrid case, we will use the ML model to predict prior parameters for compartmental epidemiological model using the same data as used in the pure ML model, excluding early time-series data. The model be structured to have high flexibility under small number of parameters – i.e. SIR-type model with variable contact structure and latent/infectious periods. This model will then be fit to the time series data for the outbreak under the constraint of these prior parameters. Using this approach (see figure), we will determine whether the structural knowledge embedded in the epidemiological model improves outbreak predictions or hinders them due to assumptions. As with the pure ML approach, we will test the hybrid model approach under *within-disease*, *all-disease, and partial-pooled* approaches.

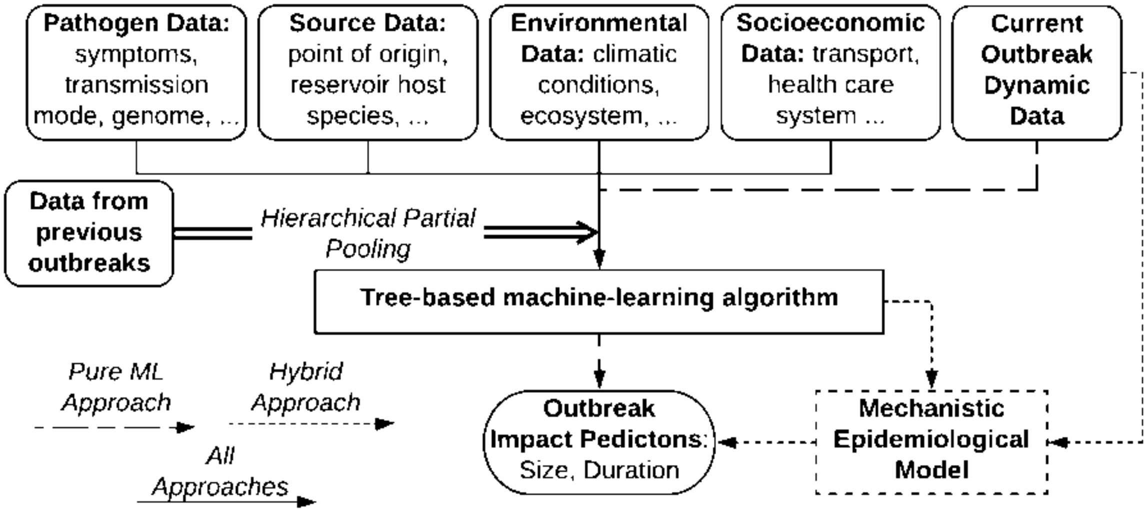

Figure: Schematic of machine-learning approaches. ML algorithm ingests biothreat condition data and makes predictions based on training from previous outbreak data. In pure ML approach, current outbreak dynamics are used as ML predictors of outbreak impacts. In hybrid approach, ML algorithm predicts parameters of an epidemiological model, which predicts impacts using parameters and current outbreak dynamics.

Model variables will be analyzed at both model-wide and individual case level to determine their contribution to performance. First, to evaluate model-wide predictive performance, we will re-fit models successively dropping each predictor to determine which provide the greatest improvement in performance. At the individual case level, we will calculate Shapley Additive Explanation (SHAP) scores[13] for all variables. This will allow for inspection of the role of variables across major categories (pathogen type, continent), and determine how accuracy varies across these contexts. Clusters of similar SHAP scores will also allow us to identify clusters of diseases or conditions that have similar behavior or performance accuracy. Such information will ultimately support decision-making in selecting models or variables to select for prediction based on the context of new outbreaks.

To measure the capacity of algorithms to predict *new*, emerging diseases, we will score using structured cross-validation in which no disease outbreak prediction is based on an algorithm trained on the same pathogen. For example, for Ebola outbreak predictions, all previous Ebola outbreaks will be held out from training data.

Model Evaluation and Validation

Models will be fit and tested against their ability predict (a) size of an outbreak (total number of cases), (b) peak size of outbreak (number of cases at highest point), (c) time to completion of an outbreak, (d) time to peak of an outbreak, and (e) geographic spread of outbreak (distance to farthest case from point of origin). Prediction scores will consist of mean-square-error of each of these prediction against true values, as well as a score of equal-weighted errors of all five measures. All models will also be tested for fidelity of uncertainty measures the fraction of true data values that fall within prediction confidence intervals and these metrics will be reported along with predictive performance.

All model performance scores will be compared against meaningful, "practical naïve" baselines. While it is common practice to use a "null" or "zero-knowledge" baseline, this often amounts to inflating the apparent power of the algorithm. We will opt for a more realistic, "practical naïve" baseline, which instead follows what an analyst would approximate in practice. For these models, we will use a practical baseline model of expecting outbreaks to follow the average size and timing of outbreaks of the same disease in the past 25 years. All model scores will be reported as percentage improvements over this baseline.

Algorithm performance will be measured against holdout data to validate true predictive performance. Repeat testing on holdout data can lead to overfitting, with predictions too specific to the hold-out set and not indicative of future performance.[9] Yet increasing holdout reduces the availability of training data. Thus, we will use a *differential privacy* approach drawn from information security to validate prediction results. The hold-out data will be obfuscated, and validation performance will be measured against bootstrapped replicates of validation data, essentially introducing noise to reduce overfitting against the hold-out. This will ensure accurate estimates of predictive performance in an operational environment.[10]

Data Sources

Data sources for fitting and testing models include output data of number, timing, and geography of disease outbreaks, and predictor data include pathogen traits (disease symptoms, pathogen traits, modes of transmission), pathogen sources (point of origin, geographic range of potential natural hosts), environmental context (climatic conditions, ecosystem traits), and socioeconomic context (local population densities, demographics, transportation networks, healthcare systems). Gathering predictor data is often as large a factor in the time required to create first-pass predictions at the early stage of an outbreak. Thus, we will create automated pipelines for gathering, merging, and updating these data sets, and to extract key predictors from basic location and host variables to minimize manual inputs required. For instance, by linking to high-resolution geospatial databases, we will automatically populate data for population density, ecosystem types, transport infrastructure that can be updated and refined with on-the-ground data if available.

Disease outbreak impact data: We will draw a variety of sources to build a database of several thousand of outbreak time-series to train our models. First, we will use time series from AIDO, the most comprehensive such repository, with approximately 700 series across 40 diseases. Recognizing that AIDO has limits and data gaps, we will supplement this with several other sources including One Health disease datasets compiled and maintained by EHA:

- *COVID-19 Data:* Data on cases, hospitalization, and deaths from COVID-19 are uniquely available at national, sub-national and city scales for a broad swath of countries with varying conditions and policy responses. While the COVID-19 pandemic is linked across countries, in our hierarchical modeling framework we will to separate these out into multiple regional outbreaks, shedding more light on the effects of environmental and socioeconomic factors under a common host and pathogen.
- *Multispecies datasets:* We will supplement human disease outbreaks with data on veterinary disease outbreaks. EHA maintains a database on veterinary disease outbreaks derived from OIE and FAO data and supplemented by digitized archival reports (extending back to 1992), with 2900 outbreak records across 122 diseases. This will more than quadruple the available disease time series for training. Partial-pooling will ensure that only information in relevant veterinary data sets will be applied to human outbreaks and vice versa. For instance, effects of population density or health/veterinary capacity are expected to have partial correlation across all diseases. In addition, this will allows the model to predict impacts from these diseases, which has direct defense applications given the food supply, trade, and political stability impacts of veterinary diseases
- *Emerging Infections Disease Repository:* EHA's Emerging Infectious Disease Repository (eidr.ecohealthalliance.org/)[14] contains data on an additional 350 zoonotic disease emergence outbreaks, giving additional insights in particular to new emergence events from zoonotic sources. Full time-series are incomplete but outbreak size and duration are recorded, allowing them to be integrated into our framework with multiple imputation.

Predictor variables: Disease dynamics depend on a complex interplay of pathogen, host, and environmental conditions. We will use data on pathogens (traits, genomes), sources (reservoir host traits, range, relatedness to humans), environmental context (climate, ecosystems traits), and socioeconomic context (local population densities, transportation networks, healthcare systems) as predictors for our models, as well as time-series data of infections from the earliest phase of the outbreaks. As we expect all data will be available for neither our full training set nor in common condition of new outbreaks, use multiple imputation[12] in all models to allow for prediction as well as uncertainty assessment under incomplete data.

- *Pathogen Trait Data* consists of information about pathogen taxa, transmission mode, structural, and biological traits. Relevant traits for pathogens, and have been largely aggregated for viruses by our Host-Pathogen Phylogeny Project[5] and parallel projects for bacterial pathogens[15] and non-zoonotic human viruses[16].
- *Pathogen Genetic Data* consist of genetic sequence of representative samples of individual pathogen species. Representative sequences of nearly all relevant pathogens are available via genetic repositories GenBank, ICTV, or GISAID. We expect pathogen data at the scale of pathogen species to largely predict similar information as pathogen traits, but genomic data may be faster to use in cases of rapid sequencing of novel pathogens. We will test whether incorporating genetic data into model features via neural-network autoencoders[17] provides improved performance over separate representation of pathogen traits (e.g., taxonomic classification, transmission mode), or other representations of genetic data such as phylogeny. Whether this performance is additive, or whether these two types of information are redundant. Even if redundant, genetic data may improve predictive capacity in the case of new pathogens where pathogen traits have not been fully delineated. Rich inputs from genetic data will be integrated using neural-network encoders.
- *Source Data* refers to intelligence about the origin of the disease, which includes location and mode of origin (environmental, zoonotic host species, laboratory or accidental release). In many cases source data is unknown, particularly in the early stages of a new outbreak event. For zoonotic-origin diseases, the pool of known host species and their geographic provide probabilistic information on the source. Our own Host-Pathogen Phylogeny Project aggregates host traits for all known mammalian diseases hosts.[5]
- *Environmental Data* refers to information describing the conditions in which the disease may spread. These will include local climate variables from the BIOCLIM database, land-use coverage (HYDE), and human and livestock population densities (World Bank, FAO).
- *Socioeconomic Data* these include economic activity, governance, medical and veterinary capacity (World Bank, FAO), and transportation network connectivity in the region of disease spread.

Programmatics

All work will be undertaken by the project prime, EcoHealth Alliance (EHA). EHA has a proven track record of project management with U.S. government agencies including USAID, DTRA, DHS, NIH, and NSF, ranging from global epidemiological research and surveillance programs to small-to-medium scale technology development.

Our management approach is to bring production-quality software development practices to data science for research and development. We use agile development methodology, with weekly development meetings, monthly project status reviews, and regular organization-wide review seminars to gather feedback from our broader interdisciplinary expertise. All tasks in the statement of work will benefit from the significant experience of the project staff and in-kind contribution from other EHA personnel with combined expertise in global emerging infectious disease epidemiology, public health, veterinary medicine, machine learning, and biostatistics. We also focus on *deployment-ready* research infrastructure to minimize the need to re-engineer models developed in the research process for applied use.

We engage multiple best practices to minimize project disruption risk. *Personnel risk* entails loss of expertise and project or institutional knowledge due to loss of core project staff. EHA maintains project data, documentation, and code in common cross-team repositories. Version-controlled project repositories ensure that project histories are tracked, and all team members can retrieve previous work by others. Through regular code review, we ensure all team members have working knowledge of project modules and the ability to re-task. *Infrastructure risk entails* loss of project infrastructure such a. EHA performs on-site high-performance computing cluster or data storage. We keep code, data, results and documentation on-site only for active experiments, and back up these to off-site cloud infrastructure. Our compute environment is reproducible, being configured by pre-programmed, self-documenting methods such as Dockerfiles, Ansible playbooks, and Bash scripts. It can be re-deployed to off-site cloud resources or new hardware as needed.

Relevance

Our research will fundamentally improve infectious disease forecasting by identifying the relative importance of early-stage factors in outbreak prediction. While pathogen-host-environment linkages are fundamental in disease modeling, predictive methods developed to assess emerging biothreats usually focus on each individually. We will also advance knowledge of hybrid ML/mechanistic models, which have not yet been used in applied disease forecasting. Together this research will impact C-WMD science by providing practical guidance for early-stage data-gathering and prototyping an interactive decision support tool for biothreat impact forecasting.

Credentials

EcoHealth Alliance (EHA) will implement this project, with Noam Ross, Principal Scientist for Computational Research, as project lead. EHA's mission is focused on emerging diseases and cutting-edge research into the critical connections between human, wildlife, and ecosystem health that drive disease emergence and spread.

PI: Dr. Ross will direct he project. He is a computational disease ecologist who provides expertise in dynamic epidemiological processes, machine learning and biostatistics, and high-performance computing. He has led work in ecological and epidemiological modeling and data management for EHA's work on USAID PREDICT and NIH NIAID viral surveillance research. He has experience developing livestock disease outbreak and spread simulations in collaboration with FAO as well as private industry. Dr. Ross is PI for EcoHealth's work with DHS on machine learning for veterinary disease outbreaks. He also a leader in open-source scientific computing.

He is a founding editorial board member of rOpenSci, an organization that defines standards for reproducibility and runs peer review for scientific software, and is a core contributor to the Rocker project, which provides open-source, standardized computing containers for data science. Dr. Ross holds a Ph.D. in computational ecology from the University of California-Davis.

Organization: EHA has a proven track record of large project management with U.S. government agencies. We lead the largest global country portfolio, and serve as lead for Modeling and Analytics and Behavioral Risk Analysis teams, for the USAID Emerging Pandemic Threats PREDICT program, a $118 million program focused on predicting and preventing pandemic diseases. The PREDICT project is building a global early warning system to detect and reduce the impacts of emerging diseases that move between wildlife and people (zoonotic diseases). EHA also leads multiple field epidemiological contracts funded by DTRA, NIH, and NSF.

EHA has proven expertise in surveillance-oriented technology development. We managed a five-year contract to develop applications for DTRA's Chemical Biological Integration Platform (CBIP, formerly the Biosurveillance Ecosystem BSVE), as well as the development of the Inbound Bioevent Information System (IBIS), and Rapid Evaluation to Prevent Epidemics in Livestock (REPEL) project under DHS's Analytics for Prevention of Biothreat Incidents (APBI) program and Science and Technology Directorate. Through this work, EHA scientists have gained substantial expertise in both basic research and working with government project managers and analysts to develop technologies that are in line with the goals of the funding. The expertise resulting from this effort serves as the foundation for the current proposal.

Team: *Robert Young, Senior Research Software Engineer*, will lead project infrastructure development and the creation ML pipelines. Mr. Young has a background in artificial intelligence and bioinformatics. He has developed and managed laboratory information systems in neuroscience, genomics and performed research in neural-network design for image-recognition in astronomy. Mr. Young currently leads cyperinfrastructure work for EHA's veterinary disease forecasting under DHS as well as the DTRA-Funded Western Asia Bat Research Network.

Emma Mendelsohn, M.Sc., Research Scientist is a data scientist with extensive expertise in dynamic systems modeling, biostatistics, web application development and data engineering. Emma is lead analyst for EHA's work on antimicrobial resistance emergence work as well as projects linking emerging infectious diseases with nutrition and non-communicable diseases. Emma will lead data engineering and contribute expertise to algorithm development and application design.

Peter Daszak, Ph.D., President of EcoHealth Alliance will provide oversight and act as project advisor on infectious disease spread. Dr. Daszak is a leader in the field of emerging diseases and disease ecology.

William Karesh, DVM, Senior Vice President of EcoHealth Alliance will serve as project advisor on veterinary topics as well as liaise with data-providing organizations, such as OIE and ProMED, as required. Dr. Karesh is President of the Working Group on Animal Health and COVID-19 Task Forces for OIE, Co-Chair of the Wildlife Health Specialist Group of the IUCN.

Facilities: EcoHealth Alliance is a 48-year old scientific research NGO that specializes in multidisciplinary research and surveillance of the spread of zoonotic emerging diseases. EcoHealth Alliance is based in New York City with 10,000 ft^2 of office space. The scientific and technology staff of *30* are supported by a core administrative staff of *8* people who are available for work on this project and are funded through core funds.

EcoHealth Alliance is equipped with fiber optic Internet access and video conferencing facilities to facilitate easy communication between collaborators. EcoHealth Alliance employees have around the clock access to servers, VPNs, encryption software, and IT support. We use standard office suite services including Google Apps (Hosted email and web-based collaboration software), Microsoft Office, and Slack, running on Apple macOS, Ubuntu Linux, and Windows Operating Systems. EHA teams work in multiple computer languages (Python, NodeJS, and R programming languages), development frameworks (Agile, continuous integration), and machine-learning toolboxes. Our development operations are based on reproducible, containerized frameworks (Ansible, Docker). We perform high-performance computation across our dedicated cluster of System76 multi-core serversand with NVIDIA deep-learning GPUs and spot cloud somputs instances through Amazon Web Services EC2 and Microsoft Virtual Machines, We use a variety of other cloud services for storage (AWS S3, Azure Blob), continuous integration (GitHub, Gitlab), and other tasks.

Work to be Performed

Tasks in Year.Task.Subtask format

YEAR 1:

Task 1.1 – Develop and deploy project infrastructure: Infrastructure engineering consists of provisioning a best-in-class computational environment that enables continuous model development and testing and allows for research and models to be reproduced and extended by external teams. It includes continuous maintenance and documentation of project codebase.

Subtasks
1.1.1 Layout a provision project network
1.1.2 Set up continuous integration pipelines
1.1.3 Implement backup and data verification jobs
1.1.4 Implement differential privacy testing
1.1.5 Write and maintain codebase documentation
1.1.6 Perform code review, testing and validation

Task 1.2 – Engineer Project Database: Data engineering consists of curating, integrating and cross-linking and validating relevant data sets from various sources into a project database. This allows data with different sources, space and time scales, formats, and completeness to be used in common models establishes a database that can be used as a common resource.

Subtasks
1.2.1 Design database schema
1.2.1 Write pipelines to ingest time-series data
1.2.2 Write pipelines to ingest predictor data
1.2.3 Cross-link data sources via common ontologies
1.2.4 Write quality assurance/quality control (QA/QC) tests for data and perform data cleaning
1.2.5 Create automatic extraction routines to populate relevant predictors from location information

1.2.6 Update data from live sources and clean and maintain data continuously

Task 1.3 – ML Model Development and Testing: The core ML development task consists of designing, implementing, testing, and analyzing performance of ML model structures and iteratively improving them.

Subtasks
1.3.1 Implement "practical naïve" model baseline
1.3.2 Design Bayesian additive regression tree (BART) model structure
1.3.3 Design alternative generalized additive model (GAM) structure
1.3.4 Implement within-disease, all-disease, and partial-pooled disease model versions
1.3.5 Measure variable contribution by re-fitting
1.3.6 Analyze prediction-level variable contributions and model performance
1.3.7 Iteratively update models to improve performance

OPTION YEAR:

Task 2.1 – Develop and deploy project infrastructure: In the option year we will continue to perform maintenance and documentation of project codebase to ensure reproducibility and reusability of additional components

Subtasks
2.1.1 Write and maintain codebase documentation
2.1.2 Perform code review, testing and validation

Task 2.2 – Engineer Project Database: In the option year we will extend the database to include additional predictors and continuously maintain and update to accumulate more data from upstream sources.

Subtasks
2.2.1 Extend database schema to include genetic data and auto-encoded variables
2.2.2 Write pipelines to ingest genetic data
2.2.3 Cross-link data sources via common ontologies
2.2.4 Write QA/QC tests for data and perform data cleaning

2.2.5 Update data from live sources and clean and maintain data continuously

Task 2.3 – BART Model Development and Testing: In the option year we will extend the BART model to ingest genetic data and test the contribution of this data in enhancing or recapitulating pathogen trait data.

Subtasks
2.3.1 Develop genetic predictor variable set via neural-network autoencoding
2.3.2 Modify BART and GAM structures to incorporate genetic variables
2.3.3 Implement within-disease, all-disease, and partial-pooled disease model versions
2.3.4 Compare performance of genetic, pathogen-trait, and combined models

Task 2.4 – Hybrid ML-Mechanistic Model Development and Testing: In the option year will develop the hybrid machine-learning mechanistic model, compare its performance to a pure ML model and determine the switch-over time when the mechanistic model becomes more predictive in the course of the outbreak.

Subtasks
2.4.1 Design mechanistic model structure
2.4.2 Determine mechanistic model prior forms
2.4.3 Modify ML model to predict mechanistic parameters rather than outcomes
2.4.4 Implement within-disease, all-disease, and partial-pooled disease model versions
2.4.5 Measure variable contribution by re-fitting
2.4.6 Analyze prediction-level variable contributions and model performance
2.4.7 Compare Hybrid and ML performance along outbreak time-series progression
2.4.8 Iteratively update models to improve performance

Performance Schedule

Description	Y1 Q1-2	Y1 Q3-4	OY Q1-2	OY Q3-4
Task 1: Develop and deploy project infrastructure				
1.1.1 Layout a provision project network	■			
1.1.2 Set up continious integration pipelines	■			
1.1.3 Implement backup and data verification jobs	■			
1.1.4 Implement differential privacy testing	■			
1.1.5 Write and maintain codebase documentation	■	■		
1.1.6 Code review, testing and validation	■	■		
2.1.5 Write and maintain codebase documentation			■	■
2.1.6 Perform code review, testing and validation			■	■
Task 2: Engineer Project Database				
1.2.1 Design database schema	■			
1.2.1 Write pipelines to ingest time-series data	■			
1.2.2 Write pipelines to ingest predictor data	■			
1.2.4 Cross-link data sources via common ontologies	■			
1.2.4 Write QA/QC tests for data and perform data cleaning	■	■		
1.2.5 Create automatic extraction routines to populate relevant predictors	■	■		
1.2.6 Update data from live sources and clean and maintain data continuously	■	■		
2.2.1 Extend database schema to include genetic data			■	
2.2.2 Write pipelines to ingest genetic data			■	
2.2.3 Cross-link data sources via common ontologies			■	
2.2.4 Write QA/QC tests for data and perform data cleaning			■	■
2.2.5 Update data from live sources and clean and maintain data continuously			■	■
Task 3: ML Model Development and Testing				
1.3.1 Implement "practical naïve" model baseline	■			
1.3.2 Design BART model structure	■			
1.3.3 Design alternative GAM model structure	■	■		
1.3.4 Implement within-disease, all-disease, and partial-pooled disease models versions	■	■		
1.3.5 Measure variable contribution by re-fitting		■		
1.3.6 Analyze prediction-level variable contributions and model performance		■		
1.3.7 Iteratively update models to improve performance		■		
2.3.1 Develop genetic predictor variable set via neural-network autoencoding			■	
2.3.2 Modify BART and GAM structures to incorporate genetic variables			■	
2.3.3 Implement within-disease, all-disease, and partial-pooled disease models				
2.3.4 Compare performance of genetic, pathogen-trait, and combined models			■	
Task 4: Hybrid Model Development and Testing				
2.4.1 Design mechanistic model structure			■	
2.4.2 Determine mechanistic model prior forms			■	
2.4.3 Modify ML model to predict mechanistic parameters			■	
2.4.4 Implement within-disease, all-disease, and partial-pooled models			■	■
2.4.5 Measure variable contribution by re-fitting			■	■
2.4.6 Analyze prediction-level variable contributions and model performance				■
2.4.7 Compare Hybrid and ML performance along outbreak time-series progression				■
2.4.8 Iteratively update models to improve performance				■

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1 MacDiarmid, S. C. *et al. Handbook On Import Risk Analysis for animals and animal products: quantitative risk assessment.* Vol. 2 (Office International des Épizooties, 2004).

2 Moura, J. A., McManus, C. M., Bernal, F. E. M. & de Melo, C. B. An analysis of the 1978 African swine fever outbreak in Brazil and its eradication. *Rev. Sci. Tech.* **29**, 549-563, doi:10.20506/rst.29.3.1992 (2010).

3 Delgado, J. *et al.* U.K. Foot and Mouth Disease: A Systemic Risk Assessment of Existing Controls. *Risk Anal.* **37**, 1768-1782, doi:10.1111/risa.12704 (2017).

4 Scarpino, S. V. & Petri, G. On the predictability of infectious disease outbreaks. *Nat. Commun.* **10**, 898, doi:10.1038/s41467-019-08616-0 (2019).

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7 Mock, F., Viehweger, A., Barth, E. & Marz, M. VIDHOP, viral host prediction with Deep Learning. *Bioinformatics* (2019).

8 Babayan, S. A., Orton, R. J. & Streicker, D. G. Predicting reservoir hosts and arthropod vectors from evolutionary signatures in RNA virus genomes. *Science* **362**, 577-580, doi:10.1126/science.aap9072 (2018).

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10 Hill, J., Linero, A. & Murray, J. Bayesian Additive Regression Trees: A Review and Look Forward. *Annu. Rev. Stat. Appl.* 7, doi:10.1146/annurev-statistics-031219-041110 (2020).

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17 Agarwal, V., Reddy, N. J. K. & Anand, A. Unsupervised Representation Learning of DNA Sequences. *arXiv e-prints*, arXiv:1906.03087 (2019). <https://ui.adsabs.harvard.edu/abs/2019arXiv190603087A>.

Attachment 1 - Statement of Work (SOW)

Project Title: Predicting Biothreat Impacts from Early-Stage Data via Transfer Learning
Document Date: May 28, 2020

Objective

The project's objectives are to determine the efficacy of machine learning (ML) techniques in predicting epidemic impacts in early-stage, data-sparse conditions, particularly novel biothreats, both intentional (e.g. novel genetically-modified pathogens) and natural (e.g. zoonotic). Specifically, we will answer three questions that will enable rapid decision-making based on ML models of epidemic impacts:

Q1: How much does partial-pooling improve predictions of epidemic impacts, and what information transfers best across diseases?
Q2: What variables are most predictive of epidemic impacts at early stages of an outbreak?
Q3: At what point in epidemic growth do hybrid models that incorporate mechanistic epidemiological components become more accurate than pure ML models?

This work will contribute to fundamental knowledge of properties and variables that contribute most to predictive accuracy at early-stage stages in emerging outbreak prediction and forecasting. It will enable the development of robust and deployable predictive models at early stages of outbreaks, and support informed choices for data collection and model selection.

Scope

The awardee proposes a two-year study to determine the efficacy of ML techniques in predicting epidemic impacts in early-stage, data-sparse conditions, particularly novel biothreats. The awardee team shall focus on the following major goals and milestones:

- *Year 1, Milestone 1 (6 months)*: Create and curate predictor database, project infrastructure, continuous integration/validation, establish data-imputation and automatic predictor workflow (Tasks 1.1-1.2).
- *Year 1, Milestone 2 (12 months)*: Bayesian additive regression tree (BART) model fitting and tuning, determination of variable contribution to prediction accuracy (Task 1.3)
- *Option Year, Milestone 3 (18 months)*: Maintain and document project infrastructure, extend the database to include additional predictors, extend the BART model to ingest genetic data (Tasks 2.1-2.3)
- *Option Year, Milestone 4* (24 months): Construction of hybrid ML/mechanistic model structure, comparative testing of pure and hybrid version, determination of timing when current data overtakes transfer data (Task 2.4)

Background

Situational awareness and risk assessment are critical at early stages of disease outbreaks, when interventions can best mitigate adverse outcomes. Yet decision-makers often face a paucity of data at these stages. Traditional modeling methods to forecast disease impact severity rely heavily on prior knowledge or assumptions about mechanisms of disease spread progression, and they frequently do not anticipate the actual mechanisms.[1-3] They also take considerable time and effort to develop.

Recent theory suggests disease dynamics are fundamentally predictable[4], and ML methods have been successfully applied in emerging disease science. ML refers to a group of methods, ranging from simple nearest-neighbor approaches to function-approximation methods such as boosted trees and penalized splines, to complex deep-learning neural networks. ML has been used to predict the likelihood of disease emergence and the zoonotic potential of various hosts and viruses[5,6], and deep-learning approaches have been used to infer viral hosts from the comparatively richer data of genetic sequences of viruses.[7,8]

ML methods are generally unstructured, flexible, and offer greater predictive power over traditional statistical approaches. However, these methods are data-intensive, and a key challenge with ML development is data paucity and/or a low signal-to-noise ratio. Surveillance data for even existing, well-studied diseases is rarely rich enough for the data scale of many modern ML techniques. For instance, a ML approach to predict impacts from a new outbreak of Ebola would draw training data from fewer than twenty previous events, each with varying levels of data coverage.

Transfer learning, or data fusion, provides a solution to data paucity issues by using data from other domains to train parts of models that are general, thus limiting new data requirements for more specific components. Hierarchical modeling, or *partial pooling*, is a transfer learning approach for partitioning out which data can be shared between models and which are only applicable to a specific case. For instance, Ebola forecasts for countries outside the historic range of the disease may be improved by calibrating against Cholera outbreaks, which have occurred both within and outside countries with Ebola outbreaks. The degree to which the disease outcomes are correlated is learned, rather than assumed.

An alternative recent development in disease forecasting is the development of hybrid models that incorporate simple mechanistic structures and predictive ML methods to learn model parameters. These approaches have demonstrated high predictive accuracy for near-term forecasting of epidemic growth and impact, particularly during the COVID-19 pandemic[9]. However, these approaches require adequate time-series of data to project forward from current conditions. Their utility in early stages and long-term forecasting accuracy has yet to be determined. In opting to apply these models, it is critical to understand these data requirements and at what point in an outbreak hybrid approaches can overtake pure ML early-stage predictions in accuracy. This project seeks to develop, apply, and compare pure and hybrid-ML techniques to enable the development of robust, rapidly usable predictions at early stages of outbreaks.

Key references (additional references can be found in the Technical Proposal):

1 MacDiarmid, S. C. *et al. Handbook On Import Risk Analysis for animals and animal products: quantitative risk assessment.* Vol. 2 (Office International des Épizooties, 2004).
2 Moura, J. A., McManus, C. M., Bernal, F. E. M. & de Melo, C. B. An analysis of the 1978 African swine fever outbreak in Brazil and its eradication. *Rev. Sci. Tech.* **29**, 549-563, doi:10.20506/rst.29.3.1992 (2010).
3 Delgado, J. *et al.* U.K. Foot and Mouth Disease: A Systemic Risk Assessment of Existing Controls. *Risk Anal.* **37**, 1768-1782, doi:10.1111/risa.12704 (2017).

4 Scarpino, S. V. & Petri, G. On the predictability of infectious disease outbreaks. *Nat. Commun.* **10**, 898, doi:10.1038/s41467-019-08616-0 (2019).
5 Olival, K. J. *et al.* Host and viral traits predict zoonotic spillover from mammals. *Nature*, doi:10.1038/nature22975 (2017).
6 Allen, T. *et al.* Global hotspots and correlates of emerging zoonotic diseases. *Nat. Commun.* **8**, 1124, doi:10.1038/s41467-017-00923-8 (2017).
7 Mock, F., Viehweger, A., Barth, E. & Marz, M. VIDHOP, viral host prediction with Deep Learning. *Bioinformatics* (2019).
8 Babayan, S. A., Orton, R. J. & Streicker, D. G. Predicting reservoir hosts and arthropod vectors from evolutionary signatures in RNA virus genomes. *Science* **362**, 577-580, doi:10.1126/science.aap9072 (2018).
9 Gu, Y. *COVID-19 Projections Using Machine Learning*, <https://covid19-projections.com/about/#historical-performance> (2020).

Data Sources

Fitting and testing models will draw from disease outbreak data (counts, timing, and geography) and predictor data including pathogen traits (disease symptoms, pathogen traits, modes of transmission), pathogen sources (point of origin, geographic range of potential natural hosts), environmental context (climatic conditions, ecosystem traits), and socioeconomic context (local population densities, demographics, transportation networks, healthcare systems). Please see the Technical Proposal for available data sources.

Tasks/Scientific Goals (Format: Year.Task.Subtask)

YEAR 1

Task 1.1 – Develop and deploy project infrastructure

The awardee shall develop a computational environment that enables continuous model development and testing and allows for research and models to be reproduced and extended by external teams. The computational environment will include continuous maintenance and documentation of project codebase.

Subtasks

1.1.1 Layout a provision project network
1.1.2 Set up continuous integration pipelines
1.1.3 Implement backup and data verification jobs
1.1.4 Implement differential privacy testing
1.1.5 Write and maintain codebase documentation
1.1.6 Perform code review, testing and validation

Task 1.2 – Engineer project database

The awardee shall curate, integrate, cross-link, and validate relevant datasets from various sources into a project database, accounting for differing space and time scales, data formats, and data completeness.

Subtasks

1.2.1 Design database schema
1.2.1 Write pipelines to ingest time-series data
1.2.2 Write pipelines to ingest predictor data
1.2.3 Cross-link data sources via common ontologies

1.2.4 Write quality assurance/quality control (QA/QC) tests for data and perform data cleaning
1.2.5 Create automatic extraction routines to populate relevant predictors from location information
1.2.6 Update data from live sources and clean and maintain data continuously

Task 1.3 – Machine Learning (ML) model development and testing

The awardee shall design, implement, test, and analyze performance of ML model structures and iteratively improvw them.

Subtasks

1.3.1 Implement "practical naïve" model baseline
1.3.2 Design Bayesian additive regression tree (BART) model structure
1.3.3 Design alternative generalized additive model (GAM) structure
1.3.4 Implement within-disease, all-disease, and partial-pooled disease model versions
1.3.5 Measure variable contribution by re-fitting
1.3.6 Analyze prediction-level variable contributions and model performance
1.3.7 Iteratively update models to improve performance

OPTION YEAR:

Task 2.1 – Maintain and document project infrastructure

In the option year, the awardee shall continue to perform maintenance and documentation of project codebase to ensure reproducibility and reusability of additional components

Subtasks

2.1.1 Write and maintain codebase documentation
2.1.2 Perform code review, testing and validation

Task 2.2 – Extend project database

In the option year, the awardee shall extend the database to include additional predictors and continuously maintain and update to accumulate more data from upstream sources.

Subtasks

2.2.1 Extend database schema to include genetic data and auto-encoded variables
2.2.2 Write pipelines to ingest genetic data
2.2.3 Cross-link data sources via common ontologies
2.2.4 Write QA/QC tests for data and perform data cleaning
2.2.5 Update data from live sources and clean and maintain data continuously

Task 2.3 – Extend BART model

In the option year, the awardee shall extend the BART model to ingest genetic data and test the contribution of this data in enhancing or recapitulating pathogen trait data.

Subtasks

2.3.1 Develop genetic predictor variable set via neural-network autoencoding
2.3.2 Modify BART and GAM structures to incorporate genetic variables
2.3.3 Implement within-disease, all-disease, and partial-pooled disease model versions
2.3.4 Compare performance of genetic, pathogen-trait, and combined models

Task 2.4 – Hybrid ML-mechanistic model development and testing

In the option year, the awardee shall develop the hybrid machine-learning mechanistic model, compare its performance to a pure ML model, and determine the switch-over time when the mechanistic model becomes more predictive in the course of the outbreak.

Subtasks

2.4.1 Design mechanistic model structure
2.4.2 Determine mechanistic model prior forms
2.4.3 Modify ML model to predict mechanistic parameters rather than outcomes
2.4.4 Implement within-disease, all-disease, and partial-pooled disease model versions
2.4.5 Measure variable contribution by re-fitting
2.4.6 Analyze prediction-level variable contributions and model performance
2.4.7 Compare Hybrid and ML performance along outbreak time-series progression
2.4.8 Iteratively update models to improve performance

Deliverables

Reports and Documents

- Monthly reports on task status
- Technical papers describing algorithm design and performance
- Conference presentations

Code Modules and Database Archives

All code modules and documentation will be continually available on EcoHealth Alliance's GitHub page with access provided to DTRA. Databases will be made available for download and provided on-disk to DTRA per request.

Cover Sheet

Proposal Number	FRBAA14-6-2-0502
Phase I Proposal Number	
Topic	Thrust Area 6
Proposal Title	Predicting Biothreat Impacts from Early-Stage Data via Transfer Learning

Applicant Information

Applicant	EcoHealth Alliance	**Mail Address**	460 West 34th Street Suite 1701
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POC Name	Dr. Noam Ross	**POC Email**	ross@ecohealthalliance.org

Cost

Applicant Certification

Organization Type	Non-Profit Organization		
Are Human Subjects involved?	No		
Are Vertebrate Animals involved?	No		
Has a proposal for essentially equivalent work been submitted to other US government agencies or DoD components?	No		
Agency 1		**Contract/Grant No.**	
Agency 2		**Contract/Grant No.**	
Agency 3		**Contract/Grant No.**	
Are you a current DoD Contractor or Grantee?	No		
Agency		**Point Of Contact**	
Phone #			

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For any purpose other than to evaluate the white paper/proposal this data shall not be disclosed outside the Government and shall not be duplicated used or disclosed in whole or in part provided that if an award is made to the offeror as a result of or in connection with the submission of this data the Government shall have the right to duplicate use or disclose the data to the extent provided in the agreement This restriction does not limit the right of the Government to use information contained in the data if it is obtained from another source without restriction The data subject to this restriction is contained on the pages listed below

Proprietary Information (list page numbers)

List a maximum of 8 Key Words or phrases, separated by commas, that describe the Project.

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information)

Knowingly and willfully making any false fictitious or fraudulent statements or representations may be a felony under the Federal Criminal False Statement Act (18 USC Sec 1001) punishable by a fine of up to $10 000 up to five years in prison or both

Predicting Biothreat Impacts from Early-Stage Data via Transfer Learning

Phase II Technical Proposal

ABSTRACT

Accurately forecasting the impacts of novel biological agents in the early stages of their emergence is critical to planning control measures for warfighters and civilians. However, at the beginning of outbreaks, data about pathogen properties and dynamics are often scarce. Machine learning (ML) techniques generally require large data sets, thus hampering their utility in these contexts. Our proposed work addresses this challenge by using cross-disease prediction via transfer learning utilizing data from previous emergence events to improve early-stage predictions for future events. We will use partial-pooling to determine the degree to which information can be shared across diseases according to hierarchical similarities in pathogen and host properties, and in environmental and population conditions. We will also determine which properties contribute most to predictive accuracy, providing guidance for prioritizing data-collection in early outbreak stages. We will test and compare two approaches – pure ML predictions and hybrid ML/mechanistic models – to determine which provides better predictions of outbreak size and impacts. We will determine at what point in an outbreak current data overtakes historical data as a better predictor of outbreak dynamics. Making use of data sets from multiple host species as well as efficient model-validation techniques, we will expand the size of available training data and thus models' predictive capacity.

SCOPE

Objective

Our primary research objectives are to determine the efficacy of ML techniques in predicting epidemic impacts in early-stage, data-sparse conditions, particularly novel biothreats both intentional (e.g. novel genetically-modified pathogens) and natural (e.g. zoonotic). Specifically, we will answer three questions that will enable rapid decision-making based on ML models of epidemic impacts:

Q1: How much does partial-pooling improve predictions of epidemic impacts, and what information transfers best across diseases?

Q2: What variables are most predictive of epidemic impacts at early stages of an outbreak?

Q3: At what point in epidemic growth do hybrid models that incorporate mechanistic epidemiological components become more accurate than pure ML models?

This work will contribute to fundamental knowledge of properties and variables that contribute most to predictive accuracy at early-stage stages in emerging outbreak prediction and forecasting. It will enable the development of robust and deployable predictive models at early stages of outbreaks, and support informed choices for data collection and model selection.

Background

Situational awareness and risk assessment are critical at early stages of disease outbreaks, when interventions can best mitigate adverse outcomes. Yet decision-makers often face a paucity of data at these stages. Traditional modeling methods to forecast disease impact severity rely heavily on prior knowledge or assumptions on mechanisms of disease spread progression, and they frequently do not anticipate the actual mechanisms.[1-3] They also take considerable time and effort to develop.

Recent theory suggests disease dynamics are fundamentally predictable[4], and machine learning (ML) methods have demonstrated utility for some aspects of emerging disease science, e.g. to predict the likelihood of disease emergence and zoonotic potential of various hosts and viruses[5,6], and deep learning has been used to infer viral hosts from the comparatively richer data of genetic sequences of viruses.[7,8]

Machine learning (ML) refers to a group of methods, ranging from simple nearest-neighbor approaches to function-approximation methods such as boosted trees and penalized splines, to complex deep-learning neural networks. These methods are generally unstructured, flexible, and offer greater predictive power over traditional statistical approaches. However, these methods can also be data-intensive; a key challenge with ML methods development is that data are too sparse, or signal/noise ratio too low, to effectively train algorithms. Surveillance data for even existing, well-studied diseases is rarely rich enough for the data scale of many modern machine learning or deep learning techniques. For instance, an ML approach to predict impacts from a new outbreak of Ebola would have training data from to less than twenty previous events for which there is comprehensive epidemiological data from 10 West and Central African nations

Transfer learning, or data fusion, provides a solution for using data from other domains to train parts of models that are general, thus limiting new data requirements for more specific components. Hierarchical modeling, or *partial pooling*, is a transfer learning approach for partitioning out which data can be shared between models and which are only applicable to a specific case. For instance, Ebola forecasts from countries outside of the virus' historic range may be improved by calibrating against influenza outbreaks, which have occurred both within and outside countries with Ebola outbreaks. The degree to which the disease outcomes are correlated (e.g, similarity of modes of transmission) are learned, rather than assumed.

An alternative recent development in disease forecast is the development of hybrid models that incorporate simple mechanistic structures and predictive ML methods to learn model parameters. These approaches have demonstrated high predictive accuracy for near-term forecasting of epidemic growth and impact, particularly during the COVID-19 pandemic[9]. However, these approaches require adequate time-series of data to project forward from current conditions. Their utility in early stages and long-term forecasting accuracy has yet to be determined. In opting to apply these models, it is critical to understand these data requirements and at what point in an outbreak hybrid approaches can overtake pure ML early-stage predictions in accuracy.

We will develop algorithms to predict the dynamics and impacts of outbreaks of new infectious diseases, based on data available at early stages of outbreaks. In doing so, we will answer the following key questions.

- How much does partial-pooling improve predictions of epidemic impacts, and what information transfers best across diseases?
- What variables are most predictive of epidemic impacts at early stages of an outbreak?
- At what point in epidemic growth do hybrid models that incorporate mechanistic epidemiological components become more accurate than pure ML models?

Algorithmic Methods:

We will test the ability to ML methods incorporating partial pooling to predict impacts from a new outbreak of disease. Our primary model structure will be built around Bayesian additive regression trees (BARTs)[10]. BARTs provide three features appropriate for this application: First, they can provide both high-quality predictions as well as robustness in relatively data-poor scenarios. Secondly, they have explicit uncertainty structures is better able to characterize error than other regression tree methods that do not. Thirdly, they are able to incorporate hierarchical partial pooling. In some scenarios where data are smooth rather than categorical, generalized additive models (GAMs) can offer similar performance and similar features[11], and we will test these as an alternate formulation.

We will parametrize the models using data on pathogen traits (disease symptoms, pathogen traits, modes of transmission), pathogen sources (point of origin, geographic range of potential natural hosts), environmental context (climatic conditions, ecosystem traits), and socioeconomic context (local population densities, demographics, transportation networks, healthcare systems), as well as time-series data of infections from the earliest phase of the outbreaks. Not all these data are typically available at the early stages of a new bioagent outbreak, and are in many cases incomplete even in the case of historical outbreaks. Thus, we will use multiple imputation[12] in all models to allow for model fitting, prediction and assessment of uncertainty under incomplete data.

We will explore multiple model structures, but all formulations will be fit and tested under three conditions: *within-disease* forecasting where models are fit only on data from a single disease and tested at ability to predict impacts from that disease, *all-disease* forecasting where models are fit on data from *all* diseases and tested against ability to predict each disease, and *partial-pooled* where models are fit all models from all diseases but parameter sharing across diseases are partially pooled. (See 'Model Evaluation and Validation' below)

While ML approaches are best for predictive power, they do not have the flexibility to be used for alternate scenarios or intervention evaluation that traditional compartmental models do. We will compare "pure" ML algorithms to a hybrid approach using ML to generate parameters for mechanistic epidemiological models. In this hybrid case, we will use the ML model to predict prior parameters for compartmental epidemiological model using the same data as used in the pure ML model, excluding early time-series data. The model be structured to have high flexibility under small number of parameters – i.e. SIR-type model with variable contact structure and latent/infectious periods. This model will then be fit to the time series data for the outbreak under the constraint of these prior parameters. Using this approach (see figure), we will determine whether the structural knowledge embedded in the epidemiological model improves outbreak predictions or hinders them due to assumptions. As with the pure ML approach, we will test the hybrid model approach under *within-disease*, *all-disease, and partial-pooled* approaches.

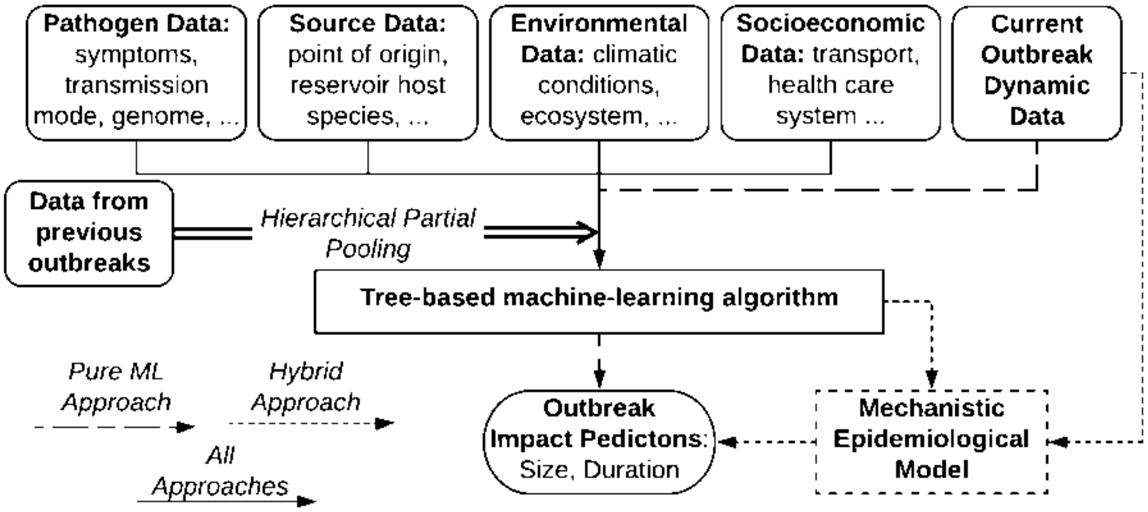

Figure: Schematic of machine-learning approaches. ML algorithm ingests biothreat condition data and makes predictions based on training from previous outbreak data. In pure ML approach, current outbreak dynamics are used as ML predictors of outbreak impacts. In hybrid approach, ML algorithm predicts parameters of an epidemiological model, which predicts impacts using parameters and current outbreak dynamics.

Model variables will be analyzed at both model-wide and individual case level to determine their contribution to performance. First, to evaluate model-wide predictive performance, we will re-fit models successively dropping each predictor to determine which provide the greatest improvement in performance. At the individual case level, we will calculate Shapley Additive Explanation (SHAP) scores[13] for all variables. This will allow for inspection of the role of variables across major categories (pathogen type, continent), and determine how accuracy varies across these contexts. Clusters of similar SHAP scores will also allow us to identify clusters of diseases or conditions that have similar behavior or performance accuracy. Such information will ultimately support decision-making in selecting models or variables to select for prediction based on the context of new outbreaks.

To measure the capacity of algorithms to predict *new*, emerging diseases, we will score using structured cross-validation in which no disease outbreak prediction is based on an algorithm trained on the same pathogen. For example, for Ebola outbreak predictions, all previous Ebola outbreaks will be held out from training data.

Model Evaluation and Validation

Models will be fit and tested against their ability predict (a) size of an outbreak (total number of cases), (b) peak size of outbreak (number of cases at highest point), (c) time to completion of an outbreak, (d) time to peak of an outbreak, and (e) geographic spread of outbreak (distance to farthest case from point of origin). Prediction scores will consist of mean-square-error of each of these prediction against true values, as well as a score of equal-weighted errors of all five measures. All models will also be tested for fidelity of uncertainty measures the fraction of true data values that fall within prediction confidence intervals and these metrics will be reported along with predictive performance.

All model performance scores will be compared against meaningful, "practical naïve" baselines. While it is common practice to use a "null" or "zero-knowledge" baseline, this often amounts to inflating the apparent power of the algorithm. We will opt for a more realistic, "practical naïve" baseline, which instead follows what an analyst would approximate in practice. For these models, we will use a practical baseline model of expecting outbreaks to follow the average size and timing of outbreaks of the same disease in the past 25 years. All model scores will be reported as percentage improvements over this baseline.

Algorithm performance will be measured against holdout data to validate true predictive performance. Repeat testing on holdout data can lead to overfitting, with predictions too specific to the hold-out set and not indicative of future performance.[9] Yet increasing holdout reduces the availability of training data. Thus, we will use a *differential privacy* approach drawn from information security to validate prediction results. The hold-out data will be obfuscated, and validation performance will be measured against bootstrapped replicates of validation data, essentially introducing noise to reduce overfitting against the hold-out. This will ensure accurate estimates of predictive performance in an operational environment.[10]

Data Sources

Data sources for fitting and testing models include output data of number, timing, and geography of disease outbreaks, and predictor data include pathogen traits (disease symptoms, pathogen traits, modes of transmission), pathogen sources (point of origin, geographic range of potential natural hosts), environmental context (climatic conditions, ecosystem traits), and socioeconomic context (local population densities, demographics, transportation networks, healthcare systems). Gathering predictor data is often as large a factor in the time required to create first-pass predictions at the early stage of an outbreak. Thus, we will create automated pipelines for gathering, merging, and updating these data sets, and to extract key predictors from basic location and host variables to minimize manual inputs required. For instance, by linking to high-resolution geospatial databases, we will automatically populate data for population density, ecosystem types, transport infrastructure that can be updated and refined with on-the-ground data if available.

Disease outbreak impact data: We will draw a variety of sources to build a database of several thousand of outbreak time-series to train our models. First, we will use time series from AIDO, the most comprehensive such repository, with approximately 700 series across 40 diseases. Recognizing that AIDO has limits and data gaps, we will supplement this with several other sources including One Health disease datasets compiled and maintained by EHA:

- *COVID-19 Data:* Data on cases, hospitalization, and deaths from COVID-19 are uniquely available at national, sub-national and city scales for a broad swath of countries with varying conditions and policy responses. While the COVID-19 pandemic is linked across countries, in our hierarchical modeling framework we will to separate these out into multiple regional outbreaks, shedding more light on the effects of environmental and socioeconomic factors under a common host and pathogen.
- *Multispecies datasets:* We will supplement human disease outbreaks with data on veterinary disease outbreaks. EHA maintains a database on veterinary disease outbreaks derived from OIE and FAO data and supplemented by digitized archival reports (extending back to 1992), with 2900 outbreak records across 122 diseases. This will more than quadruple the available disease time series for training. Partial-pooling will ensure that only information in relevant veterinary data sets will be applied to human outbreaks and vice versa. For instance, effects of population density or health/veterinary capacity are expected to have partial correlation across all diseases. In addition, this will allows the model to predict impacts from these diseases, which has direct defense applications given the food supply, trade, and political stability impacts of veterinary diseases
- *Emerging Infections Disease Repository:* EHA's Emerging Infectious Disease Repository (eidr.ecohealthalliance.org/)[14] contains data on an additional 350 zoonotic disease emergence outbreaks, giving additional insights in particular to new emergence events from zoonotic sources. Full time-series are incomplete but outbreak size and duration are recorded, allowing them to be integrated into our framework with multiple imputation.

Predictor variables: Disease dynamics depend on a complex interplay of pathogen, host, and environmental conditions. We will use data on pathogens (traits, genomes), sources (reservoir host traits, range, relatedness to humans), environmental context (climate, ecosystems traits), and socioeconomic context (local population densities, transportation networks, healthcare systems) as predictors for our models, as well as time-series data of infections from the earliest phase of the outbreaks. As we expect all data will be available for neither our full training set nor in common condition of new outbreaks, use multiple imputation[12] in all models to allow for prediction as well as uncertainty assessment under incomplete data.

- *Pathogen Trait Data* consists of information about pathogen taxa, transmission mode, structural, and biological traits. Relevant traits for pathogens, and have been largely aggregated for viruses by our Host-Pathogen Phylogeny Project[5] and parallel projects for bacterial pathogens[15] and non-zoonotic human viruses[16].
- *Pathogen Genetic Data* consist of genetic sequence of representative samples of individual pathogen species. Representative sequences of nearly all relevant pathogens are available via genetic repositories GenBank, ICTV, or GISAID. We expect pathogen data at the scale of pathogen species to largely predict similar information as pathogen traits, but genomic data may be faster to use in cases of rapid sequencing of novel pathogens. We will test whether incorporating genetic data into model features via neural-network autoencoders[17] provides improved performance over separate representation of pathogen traits (e.g., taxonomic classification, transmission mode), or other representations of genetic data such as phylogeny. Whether this performance is additive, or whether these two types of information are redundant. Even if redundant, genetic data may improve predictive capacity in the case of new pathogens where pathogen traits have not been fully delineated. Rich inputs from genetic data will be integrated using neural-network encoders.
- *Source Data* refers to intelligence about the origin of the disease, which includes location and mode of origin (environmental, zoonotic host species, laboratory or accidental release). In many cases source data is unknown, particularly in the early stages of a new outbreak event. For zoonotic-origin diseases, the pool of known host species and their geographic provide probabilistic information on the source. Our own Host-Pathogen Phylogeny Project aggregates host traits for all known mammalian diseases hosts.[5]
- *Environmental Data* refers to information describing the conditions in which the disease may spread. These will include local climate variables from the BIOCLIM database, land-use coverage (HYDE), and human and livestock population densities (World Bank, FAO).
- *Socioeconomic Data* these include economic activity, governance, medical and veterinary capacity (World Bank, FAO), and transportation network connectivity in the region of disease spread.

Programmatics

All work will be undertaken by the project prime, EcoHealth Alliance (EHA). EHA has a proven track record of project management with U.S. government agencies including USAID, DTRA, DHS, NIH, and NSF, ranging from global epidemiological research and surveillance programs to small-to-medium scale technology development.

Our management approach is to bring production-quality software development practices to data science for research and development. We use agile development methodology, with weekly development meetings, monthly project status reviews, and regular organization-wide review seminars to gather feedback from our broader interdisciplinary expertise. All tasks in the statement of work will benefit from the significant experience of the project staff and in-kind contribution from other EHA personnel with combined expertise in global emerging infectious disease epidemiology, public health, veterinary medicine, machine learning, and biostatistics. We also focus on *deployment-ready* research infrastructure to minimize the need to re-engineer models developed in the research process for applied use.

We engage multiple best practices to minimize project disruption risk. *Personnel risk* entails loss of expertise and project or institutional knowledge due to loss of core project staff. EHA maintains project data, documentation, and code in common cross-team repositories. Version-controlled project repositories ensure that project histories are tracked, and all team members can retrieve previous work by others. Through regular code review, we ensure all team members have working knowledge of project modules and the ability to re-task. *Infrastructure risk entails* loss of project infrastructure such a. EHA performs on-site high-performance computing cluster or data storage. We keep code, data, results and documentation on-site only for active experiments, and back up these to off-site cloud infrastructure. Our compute environment is reproducible, being configured by pre-programmed, self-documenting methods such as Dockerfiles, Ansible playbooks, and Bash scripts. It can be re-deployed to off-site cloud resources or new hardware as needed.

Relevance

Our research will fundamentally improve infectious disease forecasting by identifying the relative importance of early-stage factors in outbreak prediction. While pathogen-host-environment linkages are fundamental in disease modeling, predictive methods developed to assess emerging biothreats usually focus on each individually. We will also advance knowledge of hybrid ML/mechanistic models, which have not yet been used in applied disease forecasting. Together this research will impact C-WMD science by providing practical guidance for early-stage data-gathering and prototyping an interactive decision support tool for biothreat impact forecasting.

Credentials

EcoHealth Alliance (EHA) will implement this project, with Noam Ross, Principal Scientist for Computational Research, as project lead. EHA's mission is focused on emerging diseases and cutting-edge research into the critical connections between human, wildlife, and ecosystem health that drive disease emergence and spread.

PI: Dr. Ross will direct he project. He is a computational disease ecologist who provides expertise in dynamic epidemiological processes, machine learning and biostatistics, and high-performance computing. He has led work in ecological and epidemiological modeling and data management for EHA's work on USAID PREDICT and NIH NIAID viral surveillance research. He has experience developing livestock disease outbreak and spread simulations in collaboration with FAO as well as private industry. Dr. Ross is PI for EcoHealth's work with DHS on machine learning for veterinary disease outbreaks. He also a leader in open-source scientific computing.

He is a founding editorial board member of rOpenSci, an organization that defines standards for reproducibility and runs peer review for scientific software, and is a core contributor to the Rocker project, which provides open-source, standardized computing containers for data science. Dr. Ross holds a Ph.D. in computational ecology from the University of California-Davis.

Organization: EHA has a proven track record of large project management with U.S. government agencies. We lead the largest global country portfolio, and serve as lead for Modeling and Analytics and Behavioral Risk Analysis teams, for the USAID Emerging Pandemic Threats PREDICT program, a $118 million program focused on predicting and preventing pandemic diseases. The PREDICT project is building a global early warning system to detect and reduce the impacts of emerging diseases that move between wildlife and people (zoonotic diseases). EHA also leads multiple field epidemiological contracts funded by DTRA, NIH, and NSF.

EHA has proven expertise in surveillance-oriented technology development. We managed a five-year contract to develop applications for DTRA's Chemical Biological Integration Platform (CBIP, formerly the Biosurveillance Ecosystem BSVE), as well as the development of the Inbound Bioevent Information System (IBIS), and Rapid Evaluation to Prevent Epidemics in Livestock (REPEL) project under DHS's Analytics for Prevention of Biothreat Incidents (APBI) program and Science and Technology Directorate. Through this work, EHA scientists have gained substantial expertise in both basic research and working with government project managers and analysts to develop technologies that are in line with the goals of the funding. The expertise resulting from this effort serves as the foundation for the current proposal.

Team: *Robert Young, Senior Research Software Engineer*, will lead project infrastructure development and the creation ML pipelines. Mr. Young has a background in artificial intelligence and bioinformatics. He has developed and managed laboratory information systems in neuroscience, genomics and performed research in neural-network design for image-recognition in astronomy. Mr. Young currently leads cyperinfrastructure work for EHA's veterinary disease forecasting under DHS as well as the DTRA-Funded Western Asia Bat Research Network.

Emma Mendelsohn, M.Sc., Research Scientist is a data scientist with extensive expertise in dynamic systems modeling, biostatistics, web application development and data engineering. Emma is lead analyst for EHA's work on antimicrobial resistance emergence work as well as projects linking emerging infectious diseases with nutrition and non-communicable diseases. Emma will lead data engineering and contribute expertise to algorithm development and application design.

Peter Daszak, Ph.D., President of EcoHealth Alliance will provide oversight and act as project advisor on infectious disease spread. Dr. Daszak is a leader in the field of emerging diseases and disease ecology.

William Karesh, DVM, Senior Vice President of EcoHealth Alliance will serve as project advisor on veterinary topics as well as liaise with data-providing organizations, such as OIE and ProMED, as required. Dr. Karesh is President of the Working Group on Animal Health and COVID-19 Task Forces for OIE, Co-Chair of the Wildlife Health Specialist Group of the IUCN.

Facilities: EcoHealth Alliance is a 48-year old scientific research NGO that specializes in multidisciplinary research and surveillance of the spread of zoonotic emerging diseases. EcoHealth Alliance is based in New York City with 10,000 ft^2 of office space. The scientific and technology staff of *30* are supported by a core administrative staff of *8* people who are available for work on this project and are funded through core funds.

EcoHealth Alliance is equipped with fiber optic Internet access and video conferencing facilities to facilitate easy communication between collaborators. EcoHealth Alliance employees have around the clock access to servers, VPNs, encryption software, and IT support. We use standard office suite services including Google Apps (Hosted email and web-based collaboration software), Microsoft Office, and Slack, running on Apple macOS, Ubuntu Linux, and Windows Operating Systems. EHA teams work in multiple computer languages (Python, NodeJS, and R programming languages), development frameworks (Agile, continuous integration), and machine-learning toolboxes. Our development operations are based on reproducible, containerized frameworks (Ansible, Docker). We perform high-performance computation across our dedicated cluster of System76 multi-core serversand with NVIDIA deep-learning GPUs and spot cloud somputs instances through Amazon Web Services EC2 and Microsoft Virtual Machines, We use a variety of other cloud services for storage (AWS S3, Azure Blob), continuous integration (GitHub, Gitlab), and other tasks.

Work to be Performed

Tasks in Year.Task.Subtask format

YEAR 1:

Task 1.1 – Develop and deploy project infrastructure: Infrastructure engineering consists of provisioning a best-in-class computational environment that enables continuous model development and testing and allows for research and models to be reproduced and extended by external teams. It includes continuous maintenance and documentation of project codebase.

Subtasks
1.1.1 Layout a provision project network
1.1.2 Set up continuous integration pipelines
1.1.3 Implement backup and data verification jobs
1.1.4 Implement differential privacy testing
1.1.5 Write and maintain codebase documentation
1.1.6 Perform code review, testing and validation

Task 1.2 – Engineer Project Database: Data engineering consists of curating, integrating and cross-linking and validating relevant data sets from various sources into a project database. This allows data with different sources, space and time scales, formats, and completeness to be used in common models establishes a database that can be used as a common resource.

Subtasks
1.2.1 Design database schema
1.2.1 Write pipelines to ingest time-series data
1.2.2 Write pipelines to ingest predictor data
1.2.3 Cross-link data sources via common ontologies
1.2.4 Write quality assurance/quality control (QA/QC) tests for data and perform data cleaning
1.2.5 Create automatic extraction routines to populate relevant predictors from location information

1.2.6 Update data from live sources and clean and maintain data continuously

Task 1.3 – ML Model Development and Testing: The core ML development task consists of designing, implementing, testing, and analyzing performance of ML model structures and iteratively improving them.

Subtasks
1.3.1 Implement "practical naïve" model baseline
1.3.2 Design Bayesian additive regression tree (BART) model structure
1.3.3 Design alternative generalized additive model (GAM) structure
1.3.4 Implement within-disease, all-disease, and partial-pooled disease model versions
1.3.5 Measure variable contribution by re-fitting
1.3.6 Analyze prediction-level variable contributions and model performance
1.3.7 Iteratively update models to improve performance

OPTION YEAR:

Task 2.1 – Develop and deploy project infrastructure: In the option year we will continue to perform maintenance and documentation of project codebase to ensure reproducibility and reusability of additional components

Subtasks
2.1.1 Write and maintain codebase documentation
2.1.2 Perform code review, testing and validation

Task 2.2 – Engineer Project Database: In the option year we will extend the database to include additional predictors and continuously maintain and update to accumulate more data from upstream sources.
Subtasks
2.2.1 Extend database schema to include genetic data and auto-encoded variables
2.2.2 Write pipelines to ingest genetic data
2.2.3 Cross-link data sources via common ontologies
2.2.4 Write QA/QC tests for data and perform data cleaning

2.2.5 Update data from live sources and clean and maintain data continuously

Task 2.3 – BART Model Development and Testing: In the option year we will extend the BART model to ingest genetic data and test the contribution of this data in enhancing or recapitulating pathogen trait data.

Subtasks
2.3.1 Develop genetic predictor variable set via neural-network autoencoding
2.3.2 Modify BART and GAM structures to incorporate genetic variables
2.3.3 Implement within-disease, all-disease, and partial-pooled disease model versions
2.3.4 Compare performance of genetic, pathogen-trait, and combined models

Task 2.4 – Hybrid ML-Mechanistic Model Development and Testing: In the option year will develop the hybrid machine-learning mechanistic model, compare its performance to a pure ML model and determine the switch-over time when the mechanistic model becomes more predictive in the course of the outbreak.

Subtasks
2.4.1 Design mechanistic model structure
2.4.2 Determine mechanistic model prior forms
2.4.3 Modify ML model to predict mechanistic parameters rather than outcomes
2.4.4 Implement within-disease, all-disease, and partial-pooled disease model versions
2.4.5 Measure variable contribution by re-fitting
2.4.6 Analyze prediction-level variable contributions and model performance
2.4.7 Compare Hybrid and ML performance along outbreak time-series progression
2.4.8 Iteratively update models to improve performance

Performance Schedule

Description	**Y1 Q1-2**	**Y1 Q3-4**	**OY Q1-2**	**OY Q3-4**
Task 1: Develop and deploy project infrastructure				
1.1.1 Layout a provision project network	■			
1.1.2 Set up continious integration pipelines	■			
1.1.3 Implement backup and data verification jobs	■			
1.1.4 Implement differential privacy testing	■			
1.1.5 Write and maintain codebase documentation	■	■		
1.1.6 Code review, testing and validation	■	■		
2.1.5 Write and maintain codebase documentation			■	■
2.1.6 Perform code review, testing and validation			■	■
Task 2: Engineer Project Database				
1.2.1 Design database schema	■			
1.2.1 Write pipelines to ingest time-series data	■			
1.2.2 Write pipelines to ingest predictor data	■			
1.2.4 Cross-link data sources via common ontologies	■			
1.2.4 Write QA/QC tests for data and perform data cleaning	■	■		
1.2.5 Create automatic extraction routines to populate relevant predictors	■	■		
1.2.6 Update data from live sources and clean and maintain data continuously	■	■		
2.2.1 Extend database schema to include genetic data			■	
2.2.2 Write pipelines to ingest genetic data			■	
2.2.3 Cross-link data sources via common ontologies			■	
2.2.4 Write QA/QC tests for data and perform data cleaning			■	■
2.2.5 Update data from live sources and clean and maintain data continuously			■	■
Task 3: ML Model Development and Testing				
1.3.1 Implement "practical naïve" model baseline	■			
1.3.2 Design BART model structure	■			
1.3.3 Design alternative GAM model structure	■	■		
1.3.4 Implement within-disease, all-disease, and partial-pooled disease models versions	■	■		
1.3.5 Measure variable contribution by re-fitting		■		
1.3.6 Analyze prediction-level variable contributions and model performance		■		
1.3.7 Iteratively update models to improve performance		■		
2.3.1 Develop genetic predictor variable set via neural-network autoencoding			■	
2.3.2 Modify BART and GAM structures to incorporate genetic variables			■	
2.3.3 Implement within-disease, all-disease, and partial-pooled disease models				
2.3.4 Compare performance of genetic, pathogen-trait, and combined models			■	
Task 4: Hybrid Model Development and Testing				
2.4.1 Design mechanistic model structure			■	
2.4.2 Determine mechanistic model prior forms			■	
2.4.3 Modify ML model to predict mechanistic parameters			■	
2.4.4 Implement within-disease, all-disease, and partial-pooled models			■	■
2.4.5 Measure variable contribution by re-fitting			■	■
2.4.6 Analyze prediction-level variable contributions and model performance				■
2.4.7 Compare Hybrid and ML performance along outbreak time-series progression				■
2.4.8 Iteratively update models to improve performance				■

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RESEARCH & RELATED BUDGET - Budget Period 1

OMB Number: 4040-0001
Expiration Date: 12/31/2022

ORGANIZATIONAL DUNS: 0770900660000 **Enter name of Organization:** EcoHealth Alliance

Budget Type: ☒ Project ☐ Subaward/Consortium **Budget Period: 1** **Start Date:** 07/01/2020 **End Date:** 06/30/2021

A. Senior/Key Person

Prefix	First	Middle	Last	Suffix	Base Salary ($)	Months Cal.	Months Acad.	Months Sum.	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
Dr.	Noam		Ross			3.00			25,000.00	9,200.00	34,200.00
Project Role:	PD/PI										
	Robert		Young			6.00			52,500.00	19,320.00	71,820.00
Project Role:	Senior Engineer										
	Emma		Mendelsohn			6.00			42,500.00	15,640.00	58,140.00
Project Role:	Research Scientist										

Additional Senior Key Persons: Add Attachment

Total Funds requested for all Senior Key Persons in the attached file

Total Senior/Key Person 164,160.00

B. Other Personnel

Number of Personnel	Project Role	Months Cal.	Months Acad.	Months Sum.	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
	Post Doctoral Associates						
	Graduate Students						
	Undergraduate Students						
	Secretarial/Clerical						

Total Number Other Personnel

Total Other Personnel

Total Salary, Wages and Fringe Benefits (A+B) 164,160.00

C. Equipment Description

List items and dollar amount for each item exceeding $5,000

Equipment item	Funds Requested ($)

Additional Equipment: Add Attachment

Total funds requested for all equipment listed in the attached file	
Total Equipment	

D. Travel

		Funds Requested ($)
1.	Domestic Travel Costs (Incl. Canada, Mexico and U.S. Possessions)	1,576.00
2.	Foreign Travel Costs	7,088.00
	Total Travel Cost	8,664.00

E. Participant/Trainee Support Costs

		Funds Requested ($)
1.	Tuition/Fees/Health Insurance	
2.	Stipends	
3.	Travel	
4.	Subsistence	
5.	Other	

Number of Participants/Trainees

Total Participant/Trainee Support Costs

F. Other Direct Costs

		Funds Requested ($)
1.	Materials and Supplies	7,000.00
2.	Publication Costs	1,500.00
3.	Consultant Services	
4.	ADP/Computer Services	
5.	Subawards/Consortium/Contractual Costs	
6.	Equipment or Facility Rental/User Fees	
7.	Alterations and Renovations	
8.		
9.		
10.		
	Total Other Direct Costs	8,500.00

G. Direct Costs

	Funds Requested ($)
Total Direct Costs (A thru F)	181,324.00

H. Indirect Costs

Indirect Cost Type	Indirect Cost Rate (%)	Indirect Cost Base ($)	Funds Requested ($)
EcoHealth Alliance's NICA rate	35.84	181,324.00	64,986.52
		Total Indirect Costs	64,986.52

Cognizant Federal Agency (Agency Name, POC Name, and POC Phone Number): Department of Defense, Department of the Navy, Sharon Gales, +1.703.696.8559

I. Total Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Institutional Costs (G + H)	246,310.52

J. Fee

	Funds Requested ($)

K. Total Costs and Fee

	Funds Requested ($)
Total Costs and Fee (I + J)	246,310.52

L. Budget Justification

(Only attach one file.) 1234 DTRA ML_Budget Justification.pdf Delete Attachment View Attachment

RESEARCH & RELATED BUDGET - Budget Period 2

OMB Number: 4040-0001
Expiration Date: 12/31/2022

ORGANIZATIONAL DUNS: 0770900660000 **Enter name of Organization:** EcoHealth Alliance

Budget Type: ☒ Project ☐ Subaward/Consortium **Budget Period: 2** **Start Date:** 07/01/2021 **End Date:** 06/30/2022

A. Senior/Key Person

Prefix	First	Middle	Last	Suffix	Base Salary ($)	Months Cal.	Months Acad.	Months Sum.	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
Dr.	Noam		Ross			3.00			26,250.00	9,660.00	35,910.00
Project Role: PD/PI											
	Robert		Young			6.00			55,125.00	20,286.00	75,411.00
Project Role: Senior Engineer											
	Emma		Mendelsohn			6.00			44,625.00	16,422.00	61,047.00
Project Role: Research Scientist											

Additional Senior Key Persons: Add Attachment

Total Funds requested for all Senior Key Persons in the attached file

Total Senior/Key Person 172,368.00

B. Other Personnel

Number of Personnel	Project Role	Months Cal.	Months Acad.	Months Sum.	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
	Post Doctoral Associates						
	Graduate Students						
	Undergraduate Students						
	Secretarial/Clerical						

Total Number Other Personnel

Total Other Personnel

Total Salary, Wages and Fringe Benefits (A+B) 172,368.00

C. Equipment Description

List items and dollar amount for each item exceeding $5,000

Equipment item	Funds Requested ($)

Additional Equipment: Add Attachment

Total funds requested for all equipment listed in the attached file

Total Equipment

D. Travel

		Funds Requested ($)
1.	Domestic Travel Costs (Incl. Canada, Mexico and U.S. Possessions)	5,996.00
2.	Foreign Travel Costs	
	Total Travel Cost	5,996.00

E. Participant/Trainee Support Costs

		Funds Requested ($)
1.	Tuition/Fees/Health Insurance	
2.	Stipends	
3.	Travel	
4.	Subsistence	
5.	Other	
	Total Participant/Trainee Support Costs	

Number of Participants/Trainees

F. Other Direct Costs

		Funds Requested ($)
1.	Materials and Supplies	3,000.00
2.	Publication Costs	1,500.00
3.	Consultant Services	
4.	ADP/Computer Services	
5.	Subawards/Consortium/Contractual Costs	
6.	Equipment or Facility Rental/User Fees	
7.	Alterations and Renovations	
8.		
9.		
10.		
	Total Other Direct Costs	4,500.00

G. Direct Costs

	Funds Requested ($)
Total Direct Costs (A thru F)	182,864.00

H. Indirect Costs

Indirect Cost Type	Indirect Cost Rate (%)	Indirect Cost Base ($)	Funds Requested ($)
EcoHealth Alliance's NICA rate	35.84	182,864.00	65,538.46
		Total Indirect Costs	65,538.46

Cognizant Federal Agency
(Agency Name, POC Name, and POC Phone Number)
Department of Defense, Department of the Navy, Sharon Gales, +1.703.696.8559

I. Total Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Institutional Costs (G + H)	248,402.46

J. Fee

	Funds Requested ($)

K. Total Costs and Fee

	Funds Requested ($)
Total Costs and Fee (I + J)	248,402.46

L. Budget Justification

(Only attach one file.) 1234 DTRA ML_Budget Justification.pdf

RESEARCH & RELATED BUDGET - Cumulative Budget

		Totals ($)
Section A, Senior/Key Person		336,528.00
Section B, Other Personnel		
Total Number Other Personnel		
Total Salary, Wages and Fringe Benefits (A+B)		336,528.00
Section C, Equipment		
Section D, Travel		14,660.00
1. Domestic	7,572.00	
2. Foreign	7,088.00	
Section E, Participant/Trainee Support Costs		
1. Tuition/Fees/Health Insurance		
2. Stipends		
3. Travel		
4. Subsistence		
5. Other		
6. Number of Participants/Trainees		
Section F, Other Direct Costs		13,000.00
1. Materials and Supplies	10,000.00	
2. Publication Costs	3,000.00	
3. Consultant Services		
4. ADP/Computer Services		
5. Subawards/Consortium/Contractual Costs		
6. Equipment or Facility Rental/User Fees		
7. Alterations and Renovations		
8. Other 1		
9. Other 2		
10. Other 3		
Section G, Direct Costs (A thru F)		364,188.00
Section H, Indirect Costs		130,524.98
Section I, Total Direct and Indirect Costs (G + H)		494,712.98
Section J, Fee		
Section K, Total Costs and Fee (I + J)		494,712.98

BUDGET JUSTIFICATION FOR ECOHEALTH ALLIANCE

EcoHealth Alliance requests a total of $4,975,681 over all-years of the proposed project to support personnel, travel, equipment, consortium agreements, and applicable indirect costs.

A. Key Personnel

Noam Ross, Ph D., Principal Investigator (3.0 calendar months for all years). Dr. Ross will oversee the project and be responsible for project management, research, development, design, analysis, and manuscript writing and conference presentations, as well as communication with DTRA. We request $25,000 in Y1 due to the high cost of living in New York City and a 5% cost of living increase in OY1.

Emma Mendelsohn, M.Sc, Research Scientist. (6.0 calendar months for all years). Ms. Mendelsohn will lead data engineering and contribute expertise to algorithm development. She will contribute to manuscript writing and conference presentations. We request $42,500 in Y1 with a 5% cost of living increase in OY1

Robert Young M.Sc, Senior Research Software Engineer. (6.0 calendar months for all years). Mr. Young will lead infrastructure engineering and contribute expertise to algorithm development. He will contribute to manuscript writing and conference presentations.We request $52,500 in Y1 with a 5% cost of living increase in OY1.

Fringe Benefits

Fringe benefits are calculated as 36.80% of base salary p.a. with $44,160 requested in Y1 calculated from the base salary for all personnel. In OY1, we budget for a 5% per year cost of living allowance increase in all salaries.

B. Other Personnel

No funds are requested for other personnel.

C. Equipment

No funds are requested for equipment.

D. Travel

Per recommendations in the BAA, we request travel funds to Nationally Recognized Conferences and the Annual Technical Review.

Domestic Travel

Domestic travel is requested for one trip per year from New York City per year to Northern Virginia the Annual Technical Review. Transportation is estimated at $350 per trip along with the government GSA per diem rates for Northern Virginia ($161 for accommodation and $71 for meals and incidentals). Additional domestic travel support will facilitate two EcoHealth Alliance team members presenting at one conference. In OY1, this will be the EEID conference held in Bozeman, MT in 2022, with transportation costs of $500, $225 for accommodation and $55 for meals and incidentals. For each trip, $25 per day is estimated in taxi costs and for those that require transport to the airport S150 RT is included. In total, we are requesting $1,576 in Y1 and $5,996 in OY1 for domestic travel

International Travel
One international trip for two team members to present at the EEID conference held in Montpelier, France, in 2021 requested for Y1. Flights are estimated at $1500 and the federal per diem rates of S196 for lodging and $155 for meals in Montpelier. S25 per day is estimated in taxi costs plus $150 RT trips to airport is included. In total we are requesting S7,088 in Y1.

E. Participant/Trainee Support Costs
No funds are requested for participant or trainee support costs.

F. Other Direct Costs
Materials and Supplies
PI Ross and Research Scientist Mendelsohn will both need a new computer, equipped with Microsoft software for which we request a total of S4,000, in only Y1.

Cloud Computing and Storage Services
We will make use of cloud computer services including spot server rental for compute-intensive jobs, data storage, continuous integration and testing of computer code. We request S2,000 per year in Y1-OY1.

Team Communication and Collaboration Software and Services
We request $1,000 per year for subscriptions for software and services for document sharing, chat, voice, and video communications.

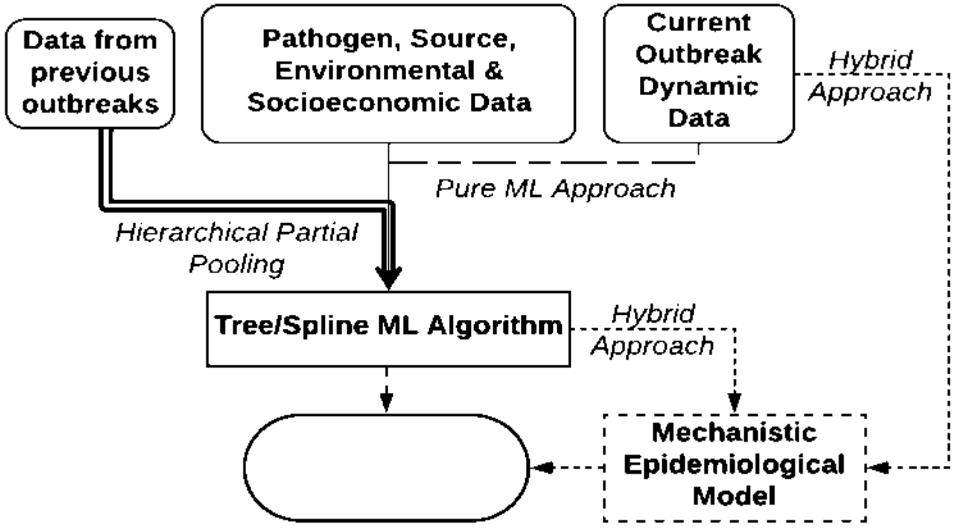
Publication Costs
To facilitate the dissemination of project findings, S1,500 per year in only Y1-OY1 is requested for open access publication costs in international peer-reviewed journals.

H. Indirect Costs
We are requesting the EcoHealth Alliance federally approved indirect cost rate of 35.84% on all applicable direct costs. The USA Department of Defense's Department of the Navy has approved this rate on 01 April 2020. We request S $64,986.52 in Y1 and S65,538.46 in OY1.

Predicting Biothreat Impacts from Early-Stage Data via Transfer Learning
Dr. Noam Ross, EcoHealth Alliance, HDTRA1-14-24c-FRCWMD-BAA

Objective: Test new ML approaches - transfer learning by partial pooling, and hybrid mechanistic-ML models, for predicting impacts of novel biothreats at early, data-sparse stage of outbreak.

Method:
- Quantify gain in prediction by training models to learn information across diseases (partial pooling)
- Assess variables most predictive of epidemic impacts at early stages outbreak.
- Quantify gain in power from using model to predict parameters of mechanistic compartmental model.
- Determine point in epidemic growth where hybrid models become more accurate than pure ML models.



Data from previous outbreaks

Pathogen, Source, Environmental & Socioeconomic Data

Current Outbreak Dynamic Data

Hybrid Approach

Pure ML Approach

Hierarchical Partial Pooling

Tree/Spline ML Algorithm

Hybrid Approach

Mechanistic Epidemiological Model

Benefits of Technology: Disease forecasts in early stages of outbreaks, especially novel outbreaks, require strong assumptions in highly structured models. Hierarchical partial pooling learns what factors from previous outbreaks may be transferred to apply to new predictions, improving early-stage assessments of severity and risk.

Challenges:
- Missing data in early-stage outbreak conditions ➜ Learn most important variables to prioritize data collection
- ML models non-interpretable and poor at extrapolation ➜ Use hybrid approach with ML parameterizing structured mechanistic model capable of simulating scenarios

Readiness: **TRL1**

Milestones:
- **Y1Q2:** Engineer project database & test infrastructure
- **Y1Q4:** Build, fit, and compare ML model structures to
- **OY1Q2:** Extend models to incorporate genetic data
- **OY1Q4:** Compare pure ML models to ML-mechanistic hybrids

Funding Profile:
$246,211 Year 1, $248,402 Option Year

Contact information:
Noam Ross, Senior Research Scientist,
ross@ecohealthalliance.org, 1.212.380.4471

Attachment 1 - Statement of Work (SOW)

Project Title: Predicting Biothreat Impacts from Early-Stage Data via Transfer Learning
Document Date: May 28, 2020

Objective

The project's objectives are to determine the efficacy of machine learning (ML) techniques in predicting epidemic impacts in early-stage, data-sparse conditions, particularly novel biothreats, both intentional (e.g. novel genetically-modified pathogens) and natural (e.g. zoonotic). Specifically, we will answer three questions that will enable rapid decision-making based on ML models of epidemic impacts:

Q1: How much does partial-pooling improve predictions of epidemic impacts, and what information transfers best across diseases?
Q2: What variables are most predictive of epidemic impacts at early stages of an outbreak?
Q3: At what point in epidemic growth do hybrid models that incorporate mechanistic epidemiological components become more accurate than pure ML models?

This work will contribute to fundamental knowledge of properties and variables that contribute most to predictive accuracy at early-stage stages in emerging outbreak prediction and forecasting. It will enable the development of robust and deployable predictive models at early stages of outbreaks, and support informed choices for data collection and model selection.

Scope

The awardee proposes a two-year study to determine the efficacy of ML techniques in predicting epidemic impacts in early-stage, data-sparse conditions, particularly novel biothreats. The awardee team shall focus on the following major goals and milestones:

- *Year 1, Milestone 1 (6 months)*: Create and curate predictor database, project infrastructure, continuous integration/validation, establish data-imputation and automatic predictor workflow (Tasks 1.1-1.2).
- *Year 1, Milestone 2 (12 months)*: Bayesian additive regression tree (BART) model fitting and tuning, determination of variable contribution to prediction accuracy (Task 1.3)
- *Option Year, Milestone 3 (18 months)*: Maintain and document project infrastructure, extend the database to include additional predictors, extend the BART model to ingest genetic data (Tasks 2.1-2.3)
- *Option Year, Milestone 4* (24 months): Construction of hybrid ML/mechanistic model structure, comparative testing of pure and hybrid version, determination of timing when current data overtakes transfer data (Task 2.4)

Background

Situational awareness and risk assessment are critical at early stages of disease outbreaks, when interventions can best mitigate adverse outcomes. Yet decision-makers often face a paucity of data at these stages. Traditional modeling methods to forecast disease impact severity rely heavily on prior knowledge or assumptions about mechanisms of disease spread progression, and they frequently do not anticipate the actual mechanisms.[1-3] They also take considerable time and effort to develop.

Recent theory suggests disease dynamics are fundamentally predictable[4], and ML methods have been successfully applied in emerging disease science. ML refers to a group of methods, ranging from simple nearest-neighbor approaches to function-approximation methods such as boosted trees and penalized splines, to complex deep-learning neural networks. ML has been used to predict the likelihood of disease emergence and the zoonotic potential of various hosts and viruses[5,6], and deep-learning approaches have been used to infer viral hosts from the comparatively richer data of genetic sequences of viruses.[7,8]

ML methods are generally unstructured, flexible, and offer greater predictive power over traditional statistical approaches. However, these methods are data-intensive, and a key challenge with ML development is data paucity and/or a low signal-to-noise ratio. Surveillance data for even existing, well-studied diseases is rarely rich enough for the data scale of many modern ML techniques. For instance, a ML approach to predict impacts from a new outbreak of Ebola would draw training data from fewer than twenty previous events, each with varying levels of data coverage.

Transfer learning, or data fusion, provides a solution to data paucity issues by using data from other domains to train parts of models that are general, thus limiting new data requirements for more specific components. Hierarchical modeling, or *partial pooling*, is a transfer learning approach for partitioning out which data can be shared between models and which are only applicable to a specific case. For instance, Ebola forecasts for countries outside the historic range of the disease may be improved by calibrating against Cholera outbreaks, which have occurred both within and outside countries with Ebola outbreaks. The degree to which the disease outcomes are correlated is learned, rather than assumed.

An alternative recent development in disease forecasting is the development of hybrid models that incorporate simple mechanistic structures and predictive ML methods to learn model parameters. These approaches have demonstrated high predictive accuracy for near-term forecasting of epidemic growth and impact, particularly during the COVID-19 pandemic[9]. However, these approaches require adequate time-series of data to project forward from current conditions. Their utility in early stages and long-term forecasting accuracy has yet to be determined. In opting to apply these models, it is critical to understand these data requirements and at what point in an outbreak hybrid approaches can overtake pure ML early-stage predictions in accuracy. This project seeks to develop, apply, and compare pure and hybrid-ML techniques to enable the development of robust, rapidly usable predictions at early stages of outbreaks.

Key references (additional references can be found in the Technical Proposal):

1 MacDiarmid, S. C. *et al. Handbook On Import Risk Analysis for animals and animal products: quantitative risk assessment.* Vol. 2 (Office International des Épizooties, 2004).
2 Moura, J. A., McManus, C. M., Bernal, F. E. M. & de Melo, C. B. An analysis of the 1978 African swine fever outbreak in Brazil and its eradication. *Rev. Sci. Tech.* **29**, 549-563, doi:10.20506/rst.29.3.1992 (2010).
3 Delgado, J. *et al.* U.K. Foot and Mouth Disease: A Systemic Risk Assessment of Existing Controls. *Risk Anal.* **37**, 1768-1782, doi:10.1111/risa.12704 (2017).

4 Scarpino, S. V. & Petri, G. On the predictability of infectious disease outbreaks. *Nat. Commun.* **10**, 898, doi:10.1038/s41467-019-08616-0 (2019).
5 Olival, K. J. *et al.* Host and viral traits predict zoonotic spillover from mammals. *Nature*, doi:10.1038/nature22975 (2017).
6 Allen, T. *et al.* Global hotspots and correlates of emerging zoonotic diseases. *Nat. Commun.* **8**, 1124, doi:10.1038/s41467-017-00923-8 (2017).
7 Mock, F., Viehweger, A., Barth, E. & Marz, M. VIDHOP, viral host prediction with Deep Learning. *Bioinformatics* (2019).
8 Babayan, S. A., Orton, R. J. & Streicker, D. G. Predicting reservoir hosts and arthropod vectors from evolutionary signatures in RNA virus genomes. *Science* **362**, 577-580, doi:10.1126/science.aap9072 (2018).
9 Gu, Y. *COVID-19 Projections Using Machine Learning*, <https://covid19-projections.com/about/#historical-performance> (2020).

Data Sources
Fitting and testing models will draw from disease outbreak data (counts, timing, and geography) and predictor data including pathogen traits (disease symptoms, pathogen traits, modes of transmission), pathogen sources (point of origin, geographic range of potential natural hosts), environmental context (climatic conditions, ecosystem traits), and socioeconomic context (local population densities, demographics, transportation networks, healthcare systems). Please see the Technical Proposal for available data sources.

Tasks/Scientific Goals (Format: Year.Task.Subtask)

YEAR 1

Task 1.1 – Develop and deploy project infrastructure

The awardee shall develop a computational environment that enables continuous model development and testing and allows for research and models to be reproduced and extended by external teams. The computational environment will include continuous maintenance and documentation of project codebase.

Subtasks
1.1.1 Layout a provision project network
1.1.2 Set up continuous integration pipelines
1.1.3 Implement backup and data verification jobs
1.1.4 Implement differential privacy testing
1.1.5 Write and maintain codebase documentation
1.1.6 Perform code review, testing and validation

Task 1.2 – Engineer project database

The awardee shall curate, integrate, cross-link, and validate relevant datasets from various sources into a project database, accounting for differing space and time scales, data formats, and data completeness.

Subtasks
1.2.1 Design database schema
1.2.1 Write pipelines to ingest time-series data
1.2.2 Write pipelines to ingest predictor data
1.2.3 Cross-link data sources via common ontologies

1.2.4 Write quality assurance/quality control (QA/QC) tests for data and perform data cleaning
1.2.5 Create automatic extraction routines to populate relevant predictors from location information
1.2.6 Update data from live sources and clean and maintain data continuously

Task 1.3 – Machine Learning (ML) model development and testing
The awardee shall design, implement, test, and analyze performance of ML model structures and iteratively improvw them.

Subtasks
1.3.1 Implement "practical naïve" model baseline
1.3.2 Design Bayesian additive regression tree (BART) model structure
1.3.3 Design alternative generalized additive model (GAM) structure
1.3.4 Implement within-disease, all-disease, and partial-pooled disease model versions
1.3.5 Measure variable contribution by re-fitting
1.3.6 Analyze prediction-level variable contributions and model performance
1.3.7 Iteratively update models to improve performance

OPTION YEAR:
Task 2.1 – Maintain and document project infrastructure
In the option year, the awardee shall continue to perform maintenance and documentation of project codebase to ensure reproducibility and reusability of additional components

Subtasks
2.1.1 Write and maintain codebase documentation
2.1.2 Perform code review, testing and validation

Task 2.2 – Extend project database
In the option year, the awardee shall extend the database to include additional predictors and continuously maintain and update to accumulate more data from upstream sources.

Subtasks
2.2.1 Extend database schema to include genetic data and auto-encoded variables
2.2.2 Write pipelines to ingest genetic data
2.2.3 Cross-link data sources via common ontologies
2.2.4 Write QA/QC tests for data and perform data cleaning
2.2.5 Update data from live sources and clean and maintain data continuously

Task 2.3 – Extend BART model
In the option year, the awardee shall extend the BART model to ingest genetic data and test the contribution of this data in enhancing or recapitulating pathogen trait data.

Subtasks
2.3.1 Develop genetic predictor variable set via neural-network autoencoding
2.3.2 Modify BART and GAM structures to incorporate genetic variables
2.3.3 Implement within-disease, all-disease, and partial-pooled disease model versions
2.3.4 Compare performance of genetic, pathogen-trait, and combined models

Task 2.4 – Hybrid ML-mechanistic model development and testing

In the option year, the awardee shall develop the hybrid machine-learning mechanistic model, compare its performance to a pure ML model, and determine the switch-over time when the mechanistic model becomes more predictive in the course of the outbreak.

Subtasks

2.4.1 Design mechanistic model structure
2.4.2 Determine mechanistic model prior forms
2.4.3 Modify ML model to predict mechanistic parameters rather than outcomes
2.4.4 Implement within-disease, all-disease, and partial-pooled disease model versions
2.4.5 Measure variable contribution by re-fitting
2.4.6 Analyze prediction-level variable contributions and model performance
2.4.7 Compare Hybrid and ML performance along outbreak time-series progression
2.4.8 Iteratively update models to improve performance

Deliverables

Reports and Documents

- Monthly reports on task status
- Technical papers describing algorithm design and performance
- Conference presentations

Code Modules and Database Archives

All code modules and documentation will be continually available on EcoHealth Alliance's GitHub page with access provided to DTRA. Databases will be made available for download and provided on-disk to DTRA per request.

OMB Number: 4040-0001
Expiration Date: 12/31/2022

APPLICATION FOR FEDERAL ASSISTANCE
SF 424 (R&R)

3. DATE RECEIVED BY STATE

State Application Identifier

1. TYPE OF SUBMISSION

☐ Pre-application ☒ Application ☐ Changed/Corrected Application

4. a. Federal Identifier

b. Agency Routing Identifier

2. DATE SUBMITTED

Applicant Identifier

c. Previous Grants.gov Tracking ID

5. APPLICANT INFORMATION

Organizational DUNS: 077090066000

Legal Name: EcoHealth Alliance
Department:
Division:
Street1: 460 West 34th Street
Street2: Suite 1701
City: New York
County / Parish: NY
State: NY: New York
Province:
Country: USA: UNITED STATES
ZIP / Postal Code: 10001-2317

Person to be contacted on matters involving this application
Prefix: Dr.
First Name: Noam
Middle Name:
Last Name: Ross
Suffix:
Position/Title: Principal Scientist, Computational Research
Street1: 460 West 34th Street
Street2: Suite 1701
City: New York
County / Parish:
State: NY: New York
Province:
Country: USA: UNITED STATES
ZIP / Postal Code: 10001-2317
Phone Number: 2123804460
Fax Number: 2123804465
Email: ross@ecohealthalliance.org

6. EMPLOYER IDENTIFICATION *(EIN) or (TIN):* 311726494

7. TYPE OF APPLICANT: M: Nonprofit with 501C3 IRS Status (Other than Institution of Higher Education)
Other (Specify):
Small Business Organization Type ☐ Women Owned ☐ Socially and Economically Disadvantaged

8. TYPE OF APPLICATION:
☒ New ☐ Resubmission
☐ Renewal ☐ Continuation ☐ Revision

If Revision, mark appropriate box(es).
☐ A. Increase Award ☐ B. Decrease Award ☐ C. Increase Duration ☐ D. Decrease Duration
☐ E. Other (specify):

Is this application being submitted to other agencies? Yes ☐ No ☒ What other Agencies?

9. NAME OF FEDERAL AGENCY:
Defense Threat Reduction Agency

10. CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER: 12.351
TITLE: Scientific Research - Combating Weapons of Mass Destruction

11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT:
Predicting Biothreat Impacts from Early-Stage Data via Transfer Learning

12. PROPOSED PROJECT:
Start Date: 07/01/2020
Ending Date: 06/30/2022

13. CONGRESSIONAL DISTRICT OF APPLICANT
NY-010

SF 424 (R&R) APPLICATION FOR FEDERAL ASSISTANCE

Page 2

14. PROJECT DIRECTOR/PRINCIPAL INVESTIGATOR CONTACT INFORMATION

Prefix: Dr.
First Name: Noam
Middle Name:
Last Name: Ross
Suffix:
Position/Title: Principal Scientist, Computational Research
Organization Name: EcoHealth Alliance
Department:
Division:
Street1: 460 West 34th Street
Street2: Suite 1701
City: New York
County / Parish: NY
State: NY: New York
Province:
Country: USA: UNITED STATES
ZIP / Postal Code: 10001-2317
Phone Number: 2123804460
Fax Number: 2123804465
Email: ross@ecohealthalliance.org

15. ESTIMATED PROJECT FUNDING

a. Total Federal Funds Requested: 494,712.98
b. Total Non-Federal Funds: 0.00
c. Total Federal & Non-Federal Funds: 494,712.98
d. Estimated Program Income: 0.00

16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS?

a. YES ☐ THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON:
DATE:

b. NO ☐ PROGRAM IS NOT COVERED BY E.O. 12372; OR
☒ PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW

17. By signing this application, I certify (1) to the statements contained in the list of certifications* and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances * and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious. or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

☒ **I agree**

**The list of certifications and assurances, or an Internet site where you may obtain this list, is contained in the announcement or agency specific instructions.*

18. SFLLL (Disclosure of Lobbying Activities) or other Explanatory Documentation

Add Attachment

19. Authorized Representative

Prefix: Dr.
First Name: Aleksei
Middle Name:
Last Name: Chmura
Suffix:
Position/Title: Authorized Organizational Representative
Organization: EcoHealth Alliance
Department:
Division:
Street1: 460 West 34th Street
Street2: Suite 1701
City: New York
County / Parish: NY
State: NY: New York
Province:
Country: USA: UNITED STATES
ZIP / Postal Code: 10001-2317
Phone Number: 2123804460
Fax Number: 2123804465
Email: chmura@ecohealthalliance.org

Signature of Authorized Representative: Aleksei Chmura

Date Signed: 05/28/2020

20. Pre-application Add Attachment

21. Cover Letter Attachment Add Attachment

This publicly releasable abstract is provided to DTRA for use in fulfillment of Section 8123 of the Defense Appropriations Act and future versions of the same.

Predicting Biothreat Impacts from Early-Stage Data via Transfer Learning

Project Summary

Accurately forecasting the impacts of new disease outbreaks is key to decision-making and planning. However, at the early stage of outbreaks, little data is available to to make predictions. Modern "Big Data" machine learning (ML) techniques generally require large data sets, reducing their usability in these situations. Our proposed work addresses this challenge by using models that can learn how much data from previous events is useful for making predictions about current conditions. We will use this approach to understand what aspects of diseases, their hosts, or environments can be used for prediction and how much they can contribute to making accurate forecasts.

RESEARCH & RELATED Other Project Information

OMB Number: 4040-0001
Expiration Date: 12/31/2022

1. Are Human Subjects Involved? ☐ Yes ☒ No

1.a. If YES to Human Subjects

Is the Project Exempt from Federal regulations? ☐ Yes ☐ No

If yes, check appropriate exemption number. ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8

If no, is the IRB review Pending? ☐ Yes ☐ No

IRB Approval Date:

Human Subject Assurance Number:

2. Are Vertebrate Animals Used? ☐ Yes ☒ No

2.a. If YES to Vertebrate Animals

Is the IACUC review Pending? ☐ Yes ☐ No

IACUC Approval Date:

Animal Welfare Assurance Number:

3. Is proprietary/privileged information included in the application? ☒ Yes ☐ No

4.a. Does this Project Have an Actual or Potential Impact - positive or negative - on the environment? ☐ Yes ☒ No

4.b. If yes, please explain:

4.c. If this project has an actual or potential impact on the environment, has an exemption been authorized or an environmental assessment (EA) or environmental impact statement (EIS) been performed? ☐ Yes ☐ No

4.d. If yes, please explain:

5. Is the research performance site designated, or eligible to be designated, as a historic place? ☐ Yes ☒ No

5.a. If yes, please explain:

6. Does this project involve activities outside of the United States or partnerships with international collaborators? ☐ Yes ☒ No

6.a. If yes, identify countries:

6.b. Optional Explanation:

7. Project Summary/Abstract 1245-DTRA-ML_Project-Summary_2020-05- Delete Attachment View Attachment

8. Project Narrative 1246-DTRA-ML-Technical Proposal-2020- Delete Attachment View Attachment

9. Bibliography & References Cited Add Attachment

10. Facilities & Other Resources Add Attachment

11. Equipment Add Attachment

12. Other Attachments Add Attachments ☐

OMB Number: 4040-0001
Expiration Date: 12/31/2022

RESEARCH & RELATED Senior/Key Person Profile (Expanded)

PROFILE - Project Director/Principal Investigator

Prefix: Dr. * First Name: Noam Middle Name:
* Last Name: Ross Suffix:
Position/Title: Principal Scientist, Computational Research Department:
Organization Name: EcoHealth Alliance Division:
* Street1: 460 West 34th Street
Street2: Suite 1701
* City: New York County/ Parish: NY
* State: NY: New York Province:
* Country: USA: UNITED STATES * Zip / Postal Code: 10001-2317
* Phone Number: 2123804460 Fax Number: 2123804465
* E-Mail: ross@ecohealthalliance.org

Credential, e.g., agency login:

*** Project Role:** PD/PI **Other Project Role Category:**

Degree Type: PhD
Degree Year: 2015

***Attach Biographical Sketch** 1235-Ross_BioSketch.pdf Delete Attachment View Attachment
Attach Current & Pending Support 1236-Ross_C&P.pdf Delete Attachment View Attachment

PROFILE - Senior/Key Person 1

Prefix: * First Name: Robert Middle Name:
* Last Name: Young Suffix:
Position/Title: Research Software Engineer Department:
Organization Name: EcoHealth Alliance Division:
* Street1: 460 West 34th Street
Street2: Suite 1701
* City: New York County/ Parish:
* State: NY: New York Province:
* Country: USA: UNITED STATES * Zip / Postal Code: 10001-2317
* Phone Number: 2123804460 Fax Number: 2123804465
* E-Mail: young@ecohealthalliance.org

Credential, e.g., agency login:

*** Project Role:** Other Professional **Other Project Role Category:** Senior Engineer

Degree Type: MSc
Degree Year: 2007

Attach Biographical Sketch 1237-Young_BioSketch.pdf Delete Attachment View Attachment
Attach Current & Pending Support 1238-Young_C&P.pdf Delete Attachment View Attachment

RESEARCH & RELATED Senior/Key Person Profile (Expanded)

PROFILE - Senior/Key Person 2

Prefix:
* First Name: Emma
Middle Name:
* Last Name: Mendelsohn
Suffix:
Position/Title: Research Scientist
Department:
Organization Name: EcoHealth Alliance
Division:
* Street1: 460 West 34th Street
Street2: Suite 1701
* City: New York
County/ Parish:
* State: NY: New York
Province:
* Country: USA: UNITED STATES
* Zip / Postal Code: 10001-2317
* Phone Number: 2123804460
Fax Number: 2123804465
* E-Mail: mendelsohn@ecohealthalliance.org

Credential, e.g., agency login:

*** Project Role:** Other Professional
Other Project Role Category: Research Scientist

Degree Type: MSc
Degree Year: 2015

Attach Biographical Sketch 1239-Mendelsohn_Biosketch.pdf Delete Attachment View Attachment
Attach Current & Pending Support 1240-Mendelsohn_C&P.pdf Delete Attachment View Attachment

PROFILE - Senior/Key Person 3

Prefix: Dr.
* First Name: Peter
Middle Name:
* Last Name: Daszak
Suffix:
Position/Title: President
Department:
Organization Name: EcoHealth Alliance
Division:
* Street1: 460 West 34th Street
Street2: Ste 1701
* City: New York
County/ Parish:
* State: NY: New York
Province:
* Country: USA: UNITED STATES
* Zip / Postal Code: 10001 2317
* Phone Number: 12123804460
Fax Number: 12123804465
* E-Mail: daszak@ecohealthalliance.org

Credential, e.g., agency login: daszak

*** Project Role:** Other Professional
Other Project Role Category: Senior Advisor

Degree Type: PhD
Degree Year: 1993

Attach Biographical Sketch 1241 Daszak_BioSketch.pdf Delete Attachment View Attachment
Attach Current & Pending Support 1242 Daszak_C&P.pdf Delete Attachment View Attachment

RESEARCH & RELATED Senior/Key Person Profile (Expanded)

PROFILE - Senior/Key Person 4

Prefix: Dr. * First Name: Billy Middle Name:
* Last Name: Karesh Suffix:
Position/Title: Executive VP for Health and Policy Department:
Organization Name: EcoHealth Alliance Division:
* Street1: 460 West 34th Street
Street2: Ste 1701
* City: New York County/ Parish:
* State: NY: New York Province:
* Country: USA: UNITED STATES * Zip / Postal Code: 10001-2317
* Phone Number: 12134804460 Fax Number: 12023084465
* E-Mail: karesh@ecohealthalliance.org

Credential, e.g., agency login: wkaresh

*** Project Role:** Other Professional **Other Project Role Category:** Senior Advisor

Degree Type: DVM
Degree Year: 1982

Attach Biographical Sketch 1243-Karesh_BioSketch.pdf Delete Attachment View Attachment
Attach Current & Pending Support 1244-Karesh_C&P.pdf Delete Attachment View Attachment

Noam Ross
EcoHealth Alliance, 460 W 34th St, New York, NY 10001
E-mail: ross@ecohealthalliance.org

Professional Preparation

Brown University	Environmental Science	B.S.	2006
University of California-Davis	Ecology	Ph.D.	2015

Appointments

Principal Scientist, Computational Research, EcoHealth Alliance	2020 - present
Senior Research Scientist Ecologist, EcoHealth Alliance	2016 - 2019
Disease Ecologist, EcoHealth Alliance	2015 - 2016
Graduate Researcher, University of California-Davis	2010 - 2015
Senior Analyst, Environmental Strategy and Markets, GreenOrder	2007 - 2009
Analyst, Environmental Strategy and Markets, GreenOrder	2006 - 2007
Contract Researcher: Energy Efficient Products Initiative, Wal-Mart	2006

Publications

Albery, G.F., Eskew, E.A., Ross, N. et al. Predicting the global mammalian viral sharing network using phylogeography. **Nature Communications 11,** 2260 (2020).

Carlson CJ, Albery GF, Merow C, Trisos CH, Zipfel CM, Eskew EA, Ross Net al. Climate change will drive novel cross-species viral transmission. **bioRxiv,** Cold Spring Harbor Laboratory; (2020)

Eskew EA, White AM, Ross N, Smith KM, Smith KF, Rodríguez JP, et al. United States wildlife and wildlife product imports from 2000 2014. **Scientific Data** 16;7(1).

Li, H., Mendelsohn, E., Zong, C., Zhang, W., Hagan, E., Wang, N., … Ross N., … Daszak, P. (2019). Human-animal interactions and bat coronavirus spillover potential among rural residents in Southern China. **Biosafety and Health**, 1(2), 84 90.

Ross, N., Eskew, E., & Ray, N. (2019). citesdb: An R package to support analysis of CITES Trade Database shipment-level data. **Journal of Open Source Software**, 4(37), 1483.

Pedersen, E. J., Miller, D. L., Simpson, G. L., & Ross, N. (2019). Hierarchical generalized additive models in ecology: an introduction with mgcv. **PeerJ**, 7, e6876.

Carlson CJ, Kracalik I, Ross N, Alexander K, Hugh-Jones ME, Fegan M, Elkin B, Epp T, Shury T, Bagirova M, Getz WM, Blackburn JK. (2019). The global distribution of Bacillus anthracis and associated anthrax risk to humans, livestock, and wildlife. **Nature Microbiology**. 4(8):1337-1343 a

Rostal MK, Ross N, Machalaba C, Cordel C, Paweska JT, Karesh WB. (2018) Benefits of a One Health approach: An example using Rift Valley fever. **One Health** 5:34-36.

Olival KJ, Hosseini P, Zambrana-Torrelio C, Ross N, Bogich T, Daszak P. (2017) Host and viral traits predict zoonotic spillover from mammals. **Nature** 546:646 650.

Salerno J, Ross N, Ghai R, Mahero M, Travis DA, Gillespie TR, Hartter J. (2017) Self-reported fever associated with human-wildlife interactions across park landscapes in western Uganda. **EcoHealth** 14(4):675-690.

Schreiber S, Ross N. (2016) Individual-based integral projection models: The role of size-structure on extinction risk and establishment success. **Methods in Ecology and Evolution** 7(7):867-74.

Boettiger C, Ross N, Hastings A. (2013) Early warning signals: The charted and uncharted territories. **Theoretical Ecology** 6(3):255-64.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Noam Ross
Other agencies (including NSF) to which this proposal has

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Expanding Software Peer Review

Source of Support: Sloan Foundation
Total Award Amount: $677,784 Total Award Period Covered: 09/01/2019 - 09/30/2021
Location of Project: EcoHealth Alliance, subcontract from UC Berekeley (prime)
Person-Months Per Year Committed to the Cal: 3 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Rapid Evaluation of Pathogens to prevent Epidemics in Livestock

Source of Support: DHS Science and Technology Directorate
Total Award Amount: $566,274.26 Total Award Period Covered: 09/05/2019-09/04/2021
Location of Project: EcoHealth Alliance
Person-Months Per Year Committed to the Cal: 3 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Software Containers for Science

Source of Support: Chan-Zuckerbug Foundation
Total Award Amount: $75,000 Total Award Period Covered: 01/01/2020 – 12/31/2020
Location of Project: Berkeley, CA and New York, NY
Person-Months Per Year Committed to the Cal: 1 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Understanding Risk of Zoonotic Virus Emergence in EID Hotspots of Southeast Asia

Source of Support: NIH
Total Award Amount: $7,573,721.35 Total Award Period Covered: 3/1/20 – 2/28/25
Location of Project: Global
Person-Months Per Year Committed to the Cal: 1 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Reducing the threat of Rift Valley Fever through Ecology, Epidemiology and Socio-Economics

Source of Support: DTRA
Total Award Amount: $4,988,526 Total Award Period Covered: 06/01/2019 - 05/31/2024
Location of Project: USA, South Africa
Person-Months Per Year Committed to the Cal: 1 Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Robert J. Young
520 Eighth Avenue, Ste. 1201, New York, NY 10018
E-mail: young@ecohealthalliance.org

Professional Preparation

University of Minnesota	Computer Science	BS	1999
University of New Mexico	Computer Science	MS	2007

Appointments

Senior Research Software Engineer, EcoHealth Alliance, New York, NY	2020 - present
Bioinformatics Programmer, Institute for Genomic Medicine, CUMC	2016 - 2020
Computer Analyst, Laboratory for Computational Vision, HHMI	2007 - 2016
Research Assistant, CTI-II/NESSI Project, University of New Mexico	2005 - 2007
Research Assistant, University of New Mexico	2004 - 2005
Bioinformatics Specialist, Visual Neuroscience Laboratory, HHMI	2000 - 2002

Publications and Presentations

Healy, M.J., Olinger, R. D., Young, R.J., Taylor, S.E., Caudell, T., Larson, K.W., (2009) Applying Category Theory to Improve the Performance of a Neural Architecture, **Neurocomputing,** 72(13-15):3158-3173.

Young, R.J., Ritthaler, M., Zimmer, P., McGraw, J., Healy, M.J., Caudell, T.P., (2007) Comparison of Adaptive Resonance Theory Neural Networks for Astronomical Region of Interest Detection and Noise Characterization, **International Joint Conference on Neural Networks**, 2123-2128.

Young, R.J., Ritthaler, M., Healy, M., Caudell, T.P., Zimmer, P. and McGraw, J. (2006) Adaptive Resonance Theory Neural Networks for Astronomical Region of Interest Detection and Noise Characterization, **Astronomical Data Analysis Software and Systems (ADASS) XVI, ASP Conference Series, Vol. XXX,** Phoenix, AZ (Poster).

Ritthaler, M., Luger, G. F., Young, R., McGraw, J. and Zimmer, P. (2006) Bayesian Belief Networks for Astronomical Object Recognition and Classification in CTI-II, **Astronomical Data Analysis Software and Systems XVI, ASP Conference Series, Vol XXX**, Phoenix, AZ (Poster).

Young, R.J. & Williams, L.R., Psychophysical Demonstration of (An)isotropy in Illusory Surface Computation, **Second Annual CS UNM Student Conference (CSUSC 2006),** Albuquerque, NM (Poster).

Healy, M.J., Olinger, R., Young, R.J., Caudell, T.P., and Larson, K., (2005) Modification of the ART-1 Architecture Based on Category Theoretic Design Principles, **Special Session in the INNS/IEEE International Joint Conference on Neural Networks**, 457-462.

Young, R.J. & Williams, L.R., (2005) Psychophysical Measurement of Illusory Contour Shape, **First Annual CS UNM Student Conference (CSUSC 2005),** Albuquerque, NM (Poster).

Peter Daszak
EcoHealth Alliance, 520 Eighth Avenue, Suite 1201, New York, NY 10018, USA
E-mail: daszak@ecohealthalliance.org

Professional Preparation

Bangor University, UK	Zoology	BS	1986
Univ. of East London, UK	Infectious Diseases	PhD	1993

Appointments

President & Chief Scientist, EcoHealth Alliance New York	2009- present
Executive Director, Consortium for Conservation Medicine	2001- 2009
Faculty Research Scientist, University of Georgia	1999- 2001
Guest Researcher, Centers for Disease Control and Prevention (CDC)	1999
Faculty Research Scientist, Kingston University, UK	1993- 1998
Research Assistant, University of East London, UK	1989- 1992

Publications

Nikolay B, Salje H, Hossain MJ, Khan AKMD, Sazzad HMS, Rahman M, Daszak P, Ströher U, Pulliam JRC, Kilpatrick AM, Nichol ST, Klena JD, Sultana S, Afroj S, Luby SP, Cauchemez S & Gurley ES. (2019). Transmission of Nipah Virus - 14 Years of Investigations in Bangladesh. **New Engl J Med** 380:1804-1814

Carroll D, Daszak P*, Wolfe ND, Gao GF, Morel C, Morzaria S, Pablos-Méndez A, Tomori O, Mazet JAK (2018). The global virome project. **Science** 359: 872-874

Zhou P, Fan H, Lan T, Yang X-L, Shi W-F, Zhang W, Zhu Y, Zhang Y-W, Xie Q-M, Mani S, Zheng X-S, Li B, Li J-M, Guo H, Pei G-Q, An X-P, Chen J-W, Zhou L, Mai K-J, Wu Z-X, Li D, Anderson DE, Zhang L-B, Li S-Y, Mi Z-Q, He T-T, Cong F, Fuo P-J, Huang R, Luo Y, Liu X-L, Chen J, Huang Y, Sun Q, Zhang X-L-L, Wang Y-Y, Xing S-Z, Chen Y-S, Sun Y, Li J, Daszak P*, Wang L-F*, Shi Z-L*, Tong Y-G*, Ma J-Y* (2018). Fatal Swine Acute Diarrhea Syndrome caused by an HKU2-related Coronavirus of Bat Origin. **Nature** 556: 255-258

Olival KJ*, Hosseini PR, Zambrana-Torrelio C, Ross N, Bogich TL, Daszak P* (2017). Host and viral traits predict zoonotic spillover from mammals. **Nature** 546, 646 650

Allen T, Murray KA, Zambrana-Torrelio C, Morse SS, Rondinini C, Di Marco M, Breit N, Olival KJ, Daszak P* (2017). Global hotspots and correlates of emerging zoonotic diseases. **Nature Comm** 8: 1124

Ge X-Y, Li J-L, Yang X-L, Chmura AA, Zhu G, Epstein JH, Mazet JK, Hu B, Zhang W, Peng C, Zhang Y-J, Luo C-M, Tan B, Wang N, Zhu Y, Crameri G, Zhang S-Y, Wang L-F, Daszak P*, Shi Z-L* (2013). Isolation and characterization of a bat SARS-like Coronavirus that uses the ACE2 receptor. **Nature** 503: 535-538

Daszak P*, Zambrana-Torellio C, Bogich TL, Fernandez M, Epstein JH, Murray KA, Hamilton H (2013). Interdisciplinary approaches to understanding disease emergence: The past, present and future drivers of Nipah virus emergence. **PNAS** 110: 3681-3688

Li W, Shi Z, Yu M, Ren W, Smith C, Epstein JH, Wang H, Crameri G, Hu Z, Zhang H, Zhang J, McEachern J, Field H, Daszak P, Eaton BT, Zhang S, Wang L-F. (2005). Bats are natural reservoirs of SARS-like coronaviruses. **Science** 310: 676-679

Daszak P*, Cunningham AA, Hyatt AD (2000). Emerging infectious diseases of wildlife - threats to biodiversity and human health. **Science** 287: 443-449

Emma Mendelsohn
EcoHealth Alliance, 520 Eighth Avenue, Ste. 1201, New York City, NY 10001, USA
E-mail: mendelsohn@ecohealthalliance.org

Professional Preparation

Wesleyan University, CT	Earth and Environmental Science	BA	2010
Duke University, NC	Ecotoxicology and Environmental Health	MEM	2015

Appointments

Research Scientist, EcoHealth Alliance	2018 - present
Open-source software peer reviewer, rOpenSci	2019 - present
Project Scientist, Integral Consulting	2015 - 2018
Statistics Teaching Assistant, Duke University	2014
Environmental Health Science Intern, Cardo ChemRisk	2014

Publications

Li, H., E. Mendelsohn, C. Zong, E. Hagan, W. Zhang, N. Wang, S. Li, H. Yan, H. Huang, G. Zhu, N. Ross, A. Chmura, P. Terry, M. Fielder, M. Miller, Z. Shi, P. Daszak. (2019). Human-animal interaction and bat coronavirus spillover potential among rural residents in Southern China. **Biosafety and Health**. 1(2):84-90.

Iwai, H., Hoberman A.M., Goodrum, P.E., Mendelsohn, E., and Anderson, J.K. (2019). Addendum to Iwai and Hoberman (2014) Reassessment of Developmental Toxicity of PFHxA in Mice. **International Journal of Toxicology**. 38(3):183-191.

Mendelsohn, E., A. Hagopian, K. Hoffman, C.M. Butt, A. Lorenzo, J. Congleton, T.F. Webster, and H.M. Stapleton. (2016). Nail polish as a source of exposure to triphenyl phosphate. **Environment International**. 86:45 51.

Hoffman, K., C.M. Butt, T.F. Webster, E.V. Preston, S.C. Hammel, C. Makey, A. Lorenzo, E.M. Cooper, C. Carignan, J.D. Meeker, R. Hauser, A. Soubry, S.K. Murphy, T.M. Price, C. Hoyo, E. Mendelsohn, J. Congleton, J.L. Daniels, and H.M. Stapleton. (2017). Temporal trends in exposure to organophosphate flame retardants in the United States. **Environmental Science and Technology Letters**. 4(3):112-118

Kopelovich, L., A.L. Perez, N. Jacobs, E. Mendelsohn, and J.J. Keenan. (2015). Screening level human health risk assessment of toluene and dibutyl phthalate in nail lacquers. **Food and Chemical Toxicology**. 81:46 53.

William B. Karesh
EcoHealth Alliance, 460 W. 34th St, New York City, NY 10001, USA
E-mail: karesh@ecohealthalliance.org

Professional Preparation

Clemson University	Biology	BS	1977
Univ. of Georgia	Veterinary Medicine	DVM	1982
Zool. Society of San Diego	Residency Wildlife Health		1982 - 1984

Appointments

Life Member, Council on Foreign Relations	2016 - present
Emerging Pandemic Threats Partner Liaison, USAID EPT PREDICT-2	2014 - present
Advisor, WHO Expert Panel on MERS-CoV	2013 - present
Expert, WHO International Health Regulation Roster of Experts	2013 - present
Executive Vice President for Health & Policy, EcoHealth Alliance	2010 - present
President, Working Group on Wildlife Diseases, OIE, France	2008 - present
Co-Chair, Wildlife Health Specialist Group, IUCN, Switzerland	2001 - present
Chief Technical Officer, USAID EPT PREDICT	2009 - 2014
Chief of Party, USAID Global Avian Influenza Network for Surveillance	2006 - 2009
Vice President & Director, Global Health Programs, Wildlife Cons. Society	2001 - 2010

Publications

Kandeil A, Gomaa M, Shehata M, El Taweel AN, Mahmoud SH, Bagato O, Moatasim Y, Kutkat O, Kayed AS, *Dawson P*, Oui X, Bahl J, Webby RJ, Karesh WB, *Kayali G*. (2019) Isolation and characterization of a distinct influenza A virus from Egyptian bats. **Journal of Virology** 93(2).

Anthony SJ, Johnson CK, Grieg D, Kramer S, Che X, Wells HL, Hicks AL, Joly D, Wolfe ND, Daszak P, Karesh WB, Lipkin WI, Morse SS, Predict Consortium, Mazet J, Goldstein T. (2019) Global patterns in coronavirus diversity. **Virus Evolution** 3(1).

Machalaba CC, Elwood SE, Forcella S, Karesh WB. Global avian influenza surveillance in wild birds: A strategy to capture viral diversity. (2015) **Emerging Infectious Diseases** 21(4):e1-7.

Alagaili AN, Briese T, Mishra N, Kapoor V, Sameroff SC, de Wit E, Munster VJ, Hensley LE, Zalmout IS, Kapoor A, Epstein JH, Karesh WB, Daszak P, Mohammed OB, Lipkin WI. (2014) Middle East Respiratory Syndrome Coronavirus infection in dromedary camels in Saudi Arabia. **mBio** 5(2):e00884-14.

Karesh WB, Dobson A, Lloyd-Smith JO, Lubroth J, Dixon MA, Bennett M, Aldrich S, Harrington T, Formenty P, Loh EH, *Machalaba CC*, Thomas MJ, Heymann DL. (2012) Ecology of zoonoses: Natural and unnatural histories. **The Lancet** 380(9857):1936-45.

Gaidet N, Caron A, Cappelle J, Cumming GS, Balanca G, Hammoumi S, Cattoli G, Abolnik C, De Almeida RS, Gil P, Fereidouni SR, Grosbois V, Tran A, Mundava J, Fofana B, El Mamy ABO, Ndlovu M, Mondain-Monval JY, Triplet P, Hagemeijer W, Karesh WB, Newman SH, Dodman T. (2012) Understanding the ecological drivers of avian influenza virus infection in wildfowl: A continental-scale study across Africa. **Proceedings of the Royal Society B: Biological Sciences** 279(1731):1131-41.

Morse SS, Mazet JAK, Woolhouse M, Parrish CR, Carroll D, Karesh WB, Zambrana-Torrelio C, Lipkin WI, Daszak P. (2012) Prediction and prevention of the next pandemic zoonosis. **The Lancet** 380:1956-65.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Emma Mendelsohn

Other agencies (including NSF) to which this proposal has: none

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Investigating Impact of Nutritional Deficiencies on Pandemics

Source of Support: Eleanor Crooks Foundation
Total Award Amount: $70,000 Total Award Period Covered: 05/01/2020 – 10/31/2020
Location of Project: Global
Person-Months Per Year Committed to the Cal: 2 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

REPEL: Rapid Evaluation of Pathogens to prevent Epidemics in Livestock

Source of Support: DHS
Total Award Amount: $566,274.26 Total Award Period Covered: 09/05/2019-09/04/2021
Location of Project: Global
Person-Months Per Year Committed to the Cal: 6 Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Robert Young

Other agencies (including NSF) to which this proposal has: none

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

REPEL: Rapid Evaluation of Pathogens to prevent Epidemics in Livestock

Source of Support: DTRA
Total Award Amount:
Total Award Period Covered: 04/09/2019-03/09/2021
Location of Project: Global
Person-Months Per Year Committed to the Cal: 6 Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support: DHS
Total Award Amount:
Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount:
Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount:
Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99)

USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: William Karesh

Other agencies (including NSF) to which this proposal has

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Reducing the Threat of Middle East Respiratory Syndrome Coronavirus (MERS) and Avian Influenza (AI) in Jordan & Strengthening Regional Disease Surveillance Capacity (current proposal)

Source of Support: DTRA

Total Award Amount: $4,975,681.29 Total Award Period Covered: 01/01/2020 - 12/31/2024

Location of Project: USA, Jordan

Person-Months Per Year Committed to the Cal: 2 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Understanding the Risk of Bat-Bourne Zoonotic Disease Emergence in Western Asia

Source of Support: DTRA

Total Award Amount: $4,391,443.65 Total Award Period Covered: 10/02/2017 - 10/01/2022

Location of Project: Global

Person-Months Per Year Committed to the Cal: 1.56 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Ground Truth Network

Source of Support: DHS

Total Award Amount: $2,231,114.13 Total Award Period Covered: 09/30/2016 - 09/29/2021

Location of Project: USA

Person-Months Per Year Committed to the Cal: 1.56 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

READY: Augmenting Capacity for Humanitarian Emergencies of Infectious Diseases with Epidemic or Pandemic Potential

Source of Support: USAID

Total Award Amount: $143,605 Total Award Period Covered: 09/25/2018 - 09/30/2021

Location of Project: Global

Person-Months Per Year Committed to the Cal: 1.56 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Emerging Pandemic Threats PREDICT-2

Source of Support: USAID

Total Award Amount: $100,000,000.00 Total Award Period Covered: 10/01/2014 - 09/30/2019

Location of Project: Global

Person-Months Per Year Committed to the Cal: 4.56 Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: William Karesh

Other agencies (including NSF) to which this proposal has

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Crimean-Congo hemorrhagic fever: Reducing an emerging health threat in Tanzania

Source of Support: DTRA
Total Award Amount: $4,848,483 Total Award Period Covered: 10/01/2019 - 07/31/2024
Location of Project: USA, Tanzania
Person-Months Per Year Committed to the Cal: 1.0 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Reducing the threat of Rift Valley Fever through Ecology, Epidemiology and Socio-Economics

Source of Support: DTRA
Total Award Amount: $4,988,526 Total Award Period Covered: 06/01/2019 - 05/31/2024
Location of Project: USA, South Africa
Person-Months Per Year Committed to the Cal: 2.0 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Understanding filovirus diversity in bat reservoirs and implications for human outbreaks in West Africa

Source of Support: NIH
Total Award Amount: $7,307,869 Total Award Period Covered: 03/01/2020 - 02/28/2025
Location of Project: Global
Person-Months Per Year Committed to the Cal: 2.0 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Reducing the Threat from high-risk pathogens causing febrile illness in Liberia

Source of Support: DTRA
Total Award Amount: $4,912,818.06 Total Award Period Covered: 01/01/2020 - 12/31/2024
Location of Project: USA, Liberia
Person-Months Per Year Committed to the Cal: 1.5 Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Peter Daszak

Other agencies (including NSF) to which this proposal has

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Reducing the Threat of Middle East Respiratory Syndrome Coronavirus (MERS) and Avian Influenza (AI) in Jordan & Strengthening Regional Disease Surveillance Capacity (current proposal)

Source of Support: DTRA

Total Award Amount: $4,975,681.29 Total Award Period Covered: 01/01/2020 - 12/31/2024

Location of Project: USA, Jordan

Person-Months Per Year Committed to the Cal: 2.0 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

CNH2: Land-use change and microbial spillover as a coupled human-Resilience

Source of Support: NSF

Total Award Amount: $1,599,738 Total Award Period Covered:

Location of Project: EcoHealth Alliance and Malaysia

Person-Months Per Year Committed to the Cal: 0.50 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Understanding Risk of Zoonotic Virus Emergence in EID Hotspots of South East Asia

Source of Support: NIH

Total Award Amount: $7,573,721.35 Total Award Period Covered: 3/1/2020 – 2/28/2025

Location of Project: EcoHealth Alliance and International Field and Lab Locations

Person-Months Per Year Committed to the Cal: 3.0 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

One Health Workforce – Next Generation

Source of Support: USAID

Total Award Amount: $5,000,000 Total Award Period Covered: 10/1/2019 – 9/30/2020

Location of Project: EcoHealth Alliance and International Field and Lab Locations

Person-Months Per Year Committed to the Cal: 1.44 Acad: Sumr:

Support: ☐ Current ☐ Pending ☒ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Strategies to Prevent (STOP) Spillover

Source of Support: USAID

Total Award Amount: $100,000,000 Total Award Period Covered: 8/31/2020 – 8/30/2025

Location of Project: EcoHealth Alliance and International Field and Lab Locations

Person-Months Per Year Committed to the Cal: 3.0 Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

DEFENSE THREAT REDUCTION AGENCY · UNITED STATES OF AMERICA

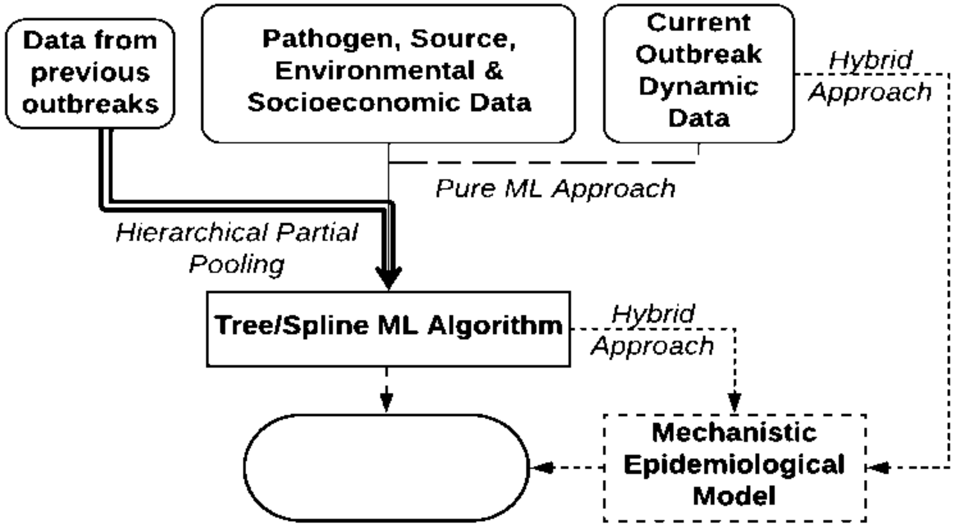
Predicting Biothreat Impacts from Early-Stage Data via Transfer Learning

Dr. Noam Ross, EcoHealth Alliance, HDTRA1-14-24c-FRCWMD-BAA

Objective: Test new ML approaches - transfer learning by partial pooling, and hybrid mechanistic-ML models, for predicting impacts of novel biothreats at early, data-sparse stage of outbreak.

Method:

- Quantify gain in prediction by training models to learn information across diseases (partial pooling)
- Assess variables most predictive of epidemic impacts at early stages outbreak.
- Quantify gain in power from using model to predict parameters of mechanistic compartmental model.
- Determine point in epidemic growth where hybrid models become more accurate than pure ML models.



Benefits of Technology: Disease forecasts in early stages of outbreaks, especially novel outbreaks, require strong assumptions in highly structured models. Hierarchical partial pooling learns what factors from previous outbreaks may be transferred to apply to new predictions, improving early-stage assessments of severity and risk.

Challenges:

- Missing data in early-stage outbreak conditions ➔ Learn most important variables to prioritize data collection
- ML models non-interpretable and poor at extrapolation ➔ Use hybrid approach with ML parameterizing structured mechanistic model capable of simulating scenarios

Readiness: **TRL1**

Milestones:

- **Y1Q2:** Engineer project database & test infrastructure
- **Y1Q4:** Build, fit, and compare ML model structures to
- **OY1Q2:** Extend models to incorporate genetic data
- **OY1Q4:** Compare pure ML models to ML-mechanistic hybrids

Funding Profile:

$246,211 Year 1, $248,402 Option Year

Contact information:

Noam Ross, Senior Research Scientist,
ross@ecohealthalliance.org, 1.212.380.4471

OMB Number: 4040-0001
Expiration Date: 12/31/2022

APPLICATION FOR FEDERAL ASSISTANCE
SF 424 (R&R)

3. DATE RECEIVED BY STATE

State Application Identifier

1. TYPE OF SUBMISSION

☐ Pre-application ☒ Application ☐ Changed/Corrected Application

4. a. Federal Identifier

b. Agency Routing Identifier

2. DATE SUBMITTED

Applicant Identifier

c. Previous Grants.gov Tracking ID

5. APPLICANT INFORMATION

Organizational DUNS: 0770900660000

Legal Name: EcoHealth Alliance
Department:
Division:
Street1: 460 West 34th Street
Street2: Suite 1701
City: New York
County / Parish: NY
State: NY: New York
Province:
Country: USA: UNITED STATES
ZIP / Postal Code: 10001-2317

Person to be contacted on matters involving this application

Prefix: Dr.
First Name: Noam
Middle Name:
Last Name: Ross
Suffix:
Position/Title: Principal Scientist, Computational Research
Street1: 460 West 34th Street
Street2: Suite 1701
City: New York
County / Parish:
State: NY: New York
Province:
Country: USA: UNITED STATES
ZIP / Postal Code: 10001-2317
Phone Number: 2123804460
Fax Number: 2123804465
Email: ross@ecohealthalliance.org

6. EMPLOYER IDENTIFICATION *(EIN) or (TIN)*: 311726494

7. TYPE OF APPLICANT: M: Nonprofit with 501C3 IRS Status (Other than Institution of Higher Education)

Other (Specify):

Small Business Organization Type ☐ Women Owned ☐ Socially and Economically Disadvantaged

8. TYPE OF APPLICATION:

☒ New ☐ Resubmission
☐ Renewal ☐ Continuation ☐ Revision

If Revision, mark appropriate box(es).

☐ A. Increase Award ☐ B. Decrease Award ☐ C. Increase Duration ☐ D. Decrease Duration
☐ E. Other (specify):

Is this application being submitted to other agencies? Yes ☐ No ☒ What other Agencies?

9. NAME OF FEDERAL AGENCY: Defense Threat Reduction Agency

10. CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER: 12.351
TITLE: Scientific Research - Combating Weapons of Mass Destruction

11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT:
Predicting Biothreat Impacts from Early-Stage Data via Transfer Learning

12. PROPOSED PROJECT:
Start Date: 07/01/2020
Ending Date: 06/30/2022

13. CONGRESSIONAL DISTRICT OF APPLICANT
NY-010

SF 424 (R&R) APPLICATION FOR FEDERAL ASSISTANCE

Page 2

14. PROJECT DIRECTOR/PRINCIPAL INVESTIGATOR CONTACT INFORMATION

Prefix: Dr.
First Name: Noam
Middle Name:
Last Name: Ross
Suffix:
Position/Title: Principal Scientist, Computational Research
Organization Name: EcoHealth Alliance
Department:
Division:
Street1: 460 West 34th Street
Street2: Suite 1701
City: New York
County / Parish: NY
State: NY: New York
Province:
Country: USA: UNITED STATES
ZIP / Postal Code: 10001-2317
Phone Number: 2123804460
Fax Number: 2123804465
Email: ross@ecohealthalliance.org

15. ESTIMATED PROJECT FUNDING

a. Total Federal Funds Requested	494,712.98
b. Total Non-Federal Funds	0.00
c. Total Federal & Non-Federal Funds	494,712.98
d. Estimated Program Income	0.00

16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS?

a. YES ☐ THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON:

DATE:

b. NO ☐ PROGRAM IS NOT COVERED BY E.O. 12372; OR

☒ PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW

17. By signing this application, I certify (1) to the statements contained in the list of certifications* and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances * and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious. or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

☒ **I agree**

**The list of certifications and assurances, or an Internet site where you may obtain this list, is contained in the announcement or agency specific instructions.*

18. SFLLL (Disclosure of Lobbying Activities) or other Explanatory Documentation

Add Attachment

19. Authorized Representative

Prefix: Dr.
First Name: Aleksei
Middle Name:
Last Name: Chmura
Suffix:
Position/Title: Authorized Organizational Representative
Organization: EcoHealth Alliance
Department:
Division:
Street1: 460 West 34th Street
Street2: Suite 1701
City: New York
County / Parish: NY
State: NY: New York
Province:
Country: USA: UNITED STATES
ZIP / Postal Code: 10001-2317
Phone Number: 2123804460
Fax Number: 2123804465
Email: chmura@ecohealthalliance.org

Signature of Authorized Representative	Date Signed
Aleksei Chmura	05/28/2020

20. Pre-application Add Attachment

21. Cover Letter Attachment Add Attachment

This publicly releasable abstract is provided to DTRA for use in fulfillment of Section 8123 of the Defense Appropriations Act and future versions of the same.

Predicting Biothreat Impacts from Early-Stage Data via Transfer Learning

Project Summary

Accurately forecasting the impacts of new disease outbreaks is key to decision-making and planning. However, at the early stage of outbreaks, little data is available to to make predictions. Modern "Big Data" machine learning (ML) techniques generally require large data sets, reducing their usability in these situations. Our proposed work addresses this challenge by using models that can learn how much data from previous events is useful for making predictions about current conditions. We will use this approach to understand what aspects of diseases, their hosts, or environments can be used for prediction and how much they can contribute to making accurate forecasts.

RESEARCH & RELATED Other Project Information

OMB Number: 4040-0001
Expiration Date: 12/31/2022

1. Are Human Subjects Involved? ☐ Yes ☒ No

1.a. If YES to Human Subjects

Is the Project Exempt from Federal regulations? ☐ Yes ☐ No

If yes, check appropriate exemption number. ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8

If no, is the IRB review Pending? ☐ Yes ☐ No

IRB Approval Date:

Human Subject Assurance Number:

2. Are Vertebrate Animals Used? ☐ Yes ☒ No

2.a. If YES to Vertebrate Animals

Is the IACUC review Pending? ☐ Yes ☐ No

IACUC Approval Date:

Animal Welfare Assurance Number:

3. Is proprietary/privileged information included in the application? ☒ Yes ☐ No

4.a. Does this Project Have an Actual or Potential Impact - positive or negative - on the environment? ☐ Yes ☒ No

4.b. If yes, please explain:

4.c. If this project has an actual or potential impact on the environment, has an exemption been authorized or an environmental assessment (EA) or environmental impact statement (EIS) been performed? ☐ Yes ☐ No

4.d. If yes, please explain:

5. Is the research performance site designated, or eligible to be designated, as a historic place? ☐ Yes ☒ No

5.a. If yes, please explain:

6. Does this project involve activities outside of the United States or partnerships with international collaborators? ☐ Yes ☒ No

6.a. If yes, identify countries:

6.b. Optional Explanation:

7. Project Summary/Abstract 1245-DTRA-ML_Project-Summary_2020-05- Delete Attachment View Attachment

8. Project Narrative 1246-DTRA-ML-Technical Proposal-2020- Delete Attachment View Attachment

9. Bibliography & References Cited Add Attachment

10. Facilities & Other Resources Add Attachment

11. Equipment Add Attachment

12. Other Attachments Add Attachments ☐

OMB Number: 4040-0001
Expiration Date: 12/31/2022

RESEARCH & RELATED Senior/Key Person Profile (Expanded)

PROFILE - Project Director/Principal Investigator

Prefix: Dr. * First Name: Noam Middle Name:
* Last Name: Ross Suffix:
Position/Title: Principal Scientist, Computational Research Department:
Organization Name: EcoHealth Alliance Division:
* Street1: 460 West 34th Street
Street2: Suite 1701
* City: New York County/ Parish: NY
* State: NY: New York Province:
* Country: USA: UNITED STATES * Zip / Postal Code: 10001-2317
* Phone Number: 2123804460 Fax Number: 2123804465
* E-Mail: ross@ecohealthalliance.org

Credential, e.g., agency login:

*** Project Role:** PD/PI **Other Project Role Category:**

Degree Type: PhD
Degree Year: 2015

***Attach Biographical Sketch** 1235-Ross_BioSketch.pdf Delete Attachment View Attachment
Attach Current & Pending Support 1236-Ross_C&P.pdf Delete Attachment View Attachment

PROFILE - Senior/Key Person 1

Prefix: * First Name: Robert Middle Name:
* Last Name: Young Suffix:
Position/Title: Research Software Engineer Department:
Organization Name: EcoHealth Alliance Division:
* Street1: 460 West 34th Street
Street2: Suite 1701
* City: New York County/ Parish:
* State: NY: New York Province:
* Country: USA: UNITED STATES * Zip / Postal Code: 10001-2317
* Phone Number: 2123804460 Fax Number: 2123804465
* E-Mail: young@ecohealthalliance.org

Credential, e.g., agency login:

*** Project Role:** Other Professional **Other Project Role Category:** Senior Engineer

Degree Type: MSc
Degree Year: 2007

Attach Biographical Sketch 1237-Young_BioSketch.pdf Delete Attachment View Attachment
Attach Current & Pending Support 1238-Young_C&P.pdf Delete Attachment View Attachment

RESEARCH & RELATED Senior/Key Person Profile (Expanded)

PROFILE - Senior/Key Person 2

Prefix: * First Name: Emma Middle Name:
* Last Name: Mendelsohn Suffix:
Position/Title: Research Scientist Department:
Organization Name: EcoHealth Alliance Division:
* Street1: 460 West 34th Street
Street2: Suite 1701
* City: New York County/ Parish:
* State: NY: New York Province:
* Country: USA: UNITED STATES * Zip / Postal Code: 10001-2317
* Phone Number: 2123804460 Fax Number: 2123804465
* E-Mail: mendelsohn@ecohealthalliance.org

Credential, e.g., agency login:

* **Project Role:** Other Professional **Other Project Role Category:** Research Scientist

Degree Type: MSc
Degree Year: 2015

Attach Biographical Sketch 1239-Mendelsohn_Biosketch.pdf Delete Attachment View Attachment
Attach Current & Pending Support 1240-Mendelsohn_C&P.pdf Delete Attachment View Attachment

PROFILE - Senior/Key Person 3

Prefix: Dr. * First Name: Peter Middle Name:
* Last Name: Daszak Suffix:
Position/Title: President Department:
Organization Name: EcoHealth Alliance Division:
* Street1: 460 West 34th Street
Street2: Ste 1701
* City: New York County/ Parish:
* State: NY: New York Province:
* Country: USA: UNITED STATES * Zip / Postal Code: 10001 2317
* Phone Number: 12123804460 Fax Number: 12123804465
* E-Mail: daszak@ecohealthalliance.org

Credential, e.g., agency login: daszak

* **Project Role:** Other Professional **Other Project Role Category:** Senior Advisor

Degree Type: PhD
Degree Year: 1993

Attach Biographical Sketch 1241 Daszak_BioSketch.pdf Delete Attachment View Attachment
Attach Current & Pending Support 1242 Daszak_C&P.pdf Delete Attachment View Attachment

RESEARCH & RELATED Senior/Key Person Profile (Expanded)

PROFILE - Senior/Key Person 4

Prefix: Dr.
* First Name: Billy
Middle Name:
* Last Name: Karesh
Suffix:
Position/Title: Executive VP for Health and Policy
Department:
Organization Name: EcoHealth Alliance
Division:
* Street1: 460 West 34th Street
Street2: Ste 1701
* City: New York
County/ Parish:
* State: NY: New York
Province:
* Country: USA: UNITED STATES
* Zip / Postal Code: 10001-2317
* Phone Number: 12134804460
Fax Number: 12023084465
* E-Mail: karesh@ecohealthalliance.org

Credential, e.g., agency login: wkaresh

*** Project Role:** Other Professional
Other Project Role Category: Senior Advisor

Degree Type: DVM
Degree Year: 1982

Attach Biographical Sketch	1243-Karesh_BioSketch.pdf		Delete Attachment	View Attachment
Attach Current & Pending Support	1244-Karesh_C&P.pdf		Delete Attachment	View Attachment

Noam Ross
EcoHealth Alliance, 460 W 34th St, New York, NY 10001
E-mail: ross@ecohealthalliance.org

Professional Preparation

Brown University	Environmental Science	B.S.	2006
University of California-Davis	Ecology	Ph.D.	2015

Appointments

Principal Scientist, Computational Research, EcoHealth Alliance	2020 - present
Senior Research Scientist Ecologist, EcoHealth Alliance	2016 - 2019
Disease Ecologist, EcoHealth Alliance	2015 - 2016
Graduate Researcher, University of California-Davis	2010 - 2015
Senior Analyst, Environmental Strategy and Markets, GreenOrder	2007 - 2009
Analyst, Environmental Strategy and Markets, GreenOrder	2006 - 2007
Contract Researcher: Energy Efficient Products Initiative, Wal-Mart	2006

Publications

Albery, G.F., Eskew, E.A., Ross, N. et al. Predicting the global mammalian viral sharing network using phylogeography. **Nature Communications 11,** 2260 (2020).

Carlson CJ, Albery GF, Merow C, Trisos CH, Zipfel CM, Eskew EA, Ross Net al. Climate change will drive novel cross-species viral transmission. **bioRxiv,** Cold Spring Harbor Laboratory; (2020)

Eskew EA, White AM, Ross N, Smith KM, Smith KF, Rodríguez JP, et al. United States wildlife and wildlife product imports from 2000 2014. **Scientific Data** 16;7(1).

Li, H., Mendelsohn, E., Zong, C., Zhang, W., Hagan, E., Wang, N., … Ross N., … Daszak, P. (2019). Human-animal interactions and bat coronavirus spillover potential among rural residents in Southern China. **Biosafety and Health**, 1(2), 84 90.

Ross, N., Eskew, E., & Ray, N. (2019). citesdb: An R package to support analysis of CITES Trade Database shipment-level data. **Journal of Open Source Software**, 4(37), 1483.

Pedersen, E. J., Miller, D. L., Simpson, G. L., & Ross, N. (2019). Hierarchical generalized additive models in ecology: an introduction with mgcv. **PeerJ**, 7, e6876.

Carlson CJ, Kracalik I, Ross N, Alexander K, Hugh-Jones ME, Fegan M, Elkin B, Epp T, Shury T, Bagirova M, Getz WM, Blackburn JK. (2019). The global distribution of Bacillus anthracis and associated anthrax risk to humans, livestock, and wildlife. **Nature Microbiology**. 4(8):1337-1343 a

Rostal MK, Ross N, Machalaba C, Cordel C, Paweska JT, Karesh WB. (2018) Benefits of a One Health approach: An example using Rift Valley fever. **One Health** 5:34-36.

Olival KJ, Hosseini P, Zambrana-Torrelio C, Ross N, Bogich T, Daszak P. (2017) Host and viral traits predict zoonotic spillover from mammals. **Nature** 546:646 650.

Salerno J, Ross N, Ghai R, Mahero M, Travis DA, Gillespie TR, Hartter J. (2017) Self-reported fever associated with human-wildlife interactions across park landscapes in western Uganda. **EcoHealth** 14(4):675-690.

Schreiber S, Ross N. (2016) Individual-based integral projection models: The role of size-structure on extinction risk and establishment success. **Methods in Ecology and Evolution** 7(7):867-74.

Boettiger C, Ross N, Hastings A. (2013) Early warning signals: The charted and uncharted territories. **Theoretical Ecology** 6(3):255-64.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Noam Ross

Other agencies (including NSF) to which this proposal has

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Expanding Software Peer Review

Source of Support: Sloan Foundation
Total Award Amount: $677,784 Total Award Period Covered: 09/01/2019 - 09/30/2021
Location of Project: EcoHealth Alliance, subcontract from UC Berekeley (prime)
Person-Months Per Year Committed to the Cal: 3 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Rapid Evaluation of Pathogens to prevent Epidemics in Livestock

Source of Support: DHS Science and Technology Directorate
Total Award Amount: $566,274.26 Total Award Period Covered: 09/05/2019-09/04/2021
Location of Project: EcoHealth Alliance
Person-Months Per Year Committed to the Cal: 3 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Software Containers for Science

Source of Support: Chan-Zuckerbug Foundation
Total Award Amount: $75,000 Total Award Period Covered: 01/01/2020 – 12/31/2020
Location of Project: Berkeley, CA and New York, NY
Person-Months Per Year Committed to the Cal: 1 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Understanding Risk of Zoonotic Virus Emergence in EID Hotspots of Southeast Asia

Source of Support: NIH
Total Award Amount: $7,573,721.35 Total Award Period Covered: 3/1/20 – 2/28/25
Location of Project: Global
Person-Months Per Year Committed to the Cal: 1 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Reducing the threat of Rift Valley Fever through Ecology, Epidemiology and Socio-Economics

Source of Support: DTRA
Total Award Amount: $4,988,526 Total Award Period Covered: 06/01/2019 - 05/31/2024
Location of Project: USA, South Africa
Person-Months Per Year Committed to the Cal: 1 Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Robert J. Young
520 Eighth Avenue, Ste. 1201, New York, NY 10018
E-mail: young@ecohealthalliance.org

Professional Preparation

University of Minnesota	Computer Science	BS	1999
University of New Mexico	Computer Science	MS	2007

Appointments

Senior Research Software Engineer, EcoHealth Alliance, New York, NY	2020 - present
Bioinformatics Programmer, Institute for Genomic Medicine, CUMC	2016 - 2020
Computer Analyst, Laboratory for Computational Vision, HHMI	2007 - 2016
Research Assistant, CTI-II/NESSI Project, University of New Mexico	2005 - 2007
Research Assistant, University of New Mexico	2004 - 2005
Bioinformatics Specialist, Visual Neuroscience Laboratory, HHMI	2000 - 2002

Publications and Presentations

Healy, M.J., Olinger, R. D., Young, R.J., Taylor, S.E., Caudell, T., Larson, K.W., (2009) Applying Category Theory to Improve the Performance of a Neural Architecture, **Neurocomputing,** 72(13-15):3158-3173.

Young, R.J., Ritthaler, M., Zimmer, P., McGraw, J., Healy, M.J., Caudell, T.P., (2007) Comparison of Adaptive Resonance Theory Neural Networks for Astronomical Region of Interest Detection and Noise Characterization, **International Joint Conference on Neural Networks**, 2123-2128.

Young, R.J., Ritthaler, M., Healy, M., Caudell, T.P., Zimmer, P. and McGraw, J. (2006) Adaptive Resonance Theory Neural Networks for Astronomical Region of Interest Detection and Noise Characterization, **Astronomical Data Analysis Software and Systems (ADASS) XVI, ASP Conference Series, Vol. XXX,** Phoenix, AZ (Poster).

Ritthaler, M., Luger, G. F., Young, R., McGraw, J. and Zimmer, P. (2006) Bayesian Belief Networks for Astronomical Object Recognition and Classification in CTI-II, **Astronomical Data Analysis Software and Systems XVI, ASP Conference Series, Vol XXX**, Phoenix, AZ (Poster).

Young, R.J. & Williams, L.R., Psychophysical Demonstration of (An)isotropy in Illusory Surface Computation, **Second Annual CS UNM Student Conference (CSUSC 2006)**, Albuquerque, NM (Poster).

Healy, M.J., Olinger, R., Young, R.J., Caudell, T.P., and Larson, K., (2005) Modification of the ART-1 Architecture Based on Category Theoretic Design Principles, **Special Session in the INNS/IEEE International Joint Conference on Neural Networks**, 457-462.

Young, R.J. & Williams, L.R., (2005) Psychophysical Measurement of Illusory Contour Shape, **First Annual CS UNM Student Conference (CSUSC 2005)**, Albuquerque, NM (Poster).

Peter Daszak
EcoHealth Alliance, 520 Eighth Avenue, Suite 1201, New York, NY 10018, USA
E-mail: daszak@ecohealthalliance.org

Professional Preparation

Bangor University, UK	Zoology	BS	1986
Univ. of East London, UK	Infectious Diseases	PhD	1993

Appointments

President & Chief Scientist, EcoHealth Alliance New York	2009- present
Executive Director, Consortium for Conservation Medicine	2001- 2009
Faculty Research Scientist, University of Georgia	1999- 2001
Guest Researcher, Centers for Disease Control and Prevention (CDC)	1999
Faculty Research Scientist, Kingston University, UK	1993- 1998
Research Assistant, University of East London, UK	1989- 1992

Publications

Nikolay B, Salje H, Hossain MJ, Khan AKMD, Sazzad HMS, Rahman M, Daszak P, Ströher U, Pulliam JRC, Kilpatrick AM, Nichol ST, Klena JD, Sultana S, Afroj S, Luby SP, Cauchemez S & Gurley ES. (2019). Transmission of Nipah Virus - 14 Years of Investigations in Bangladesh. **New Engl J Med** 380:1804-1814

Carroll D, Daszak P*, Wolfe ND, Gao GF, Morel C, Morzaria S, Pablos-Méndez A, Tomori O, Mazet JAK (2018). The global virome project. **Science** 359: 872-874

Zhou P, Fan H, Lan T, Yang X-L, Shi W-F, Zhang W, Zhu Y, Zhang Y-W, Xie Q-M, Mani S, Zheng X-S, Li B, Li J-M, Guo H, Pei G-Q, An X-P, Chen J-W, Zhou L, Mai K-J, Wu Z-X, Li D, Anderson DE, Zhang L-B, Li S-Y, Mi Z-Q, He T-T, Cong F, Fuo P-J, Huang R, Luo Y, Liu X-L, Chen J, Huang Y, Sun Q, Zhang X-L-L, Wang Y-Y, Xing S-Z, Chen Y-S, Sun Y, Li J, Daszak P*, Wang L-F*, Shi Z-L*, Tong Y-G*, Ma J-Y* (2018). Fatal Swine Acute Diarrhea Syndrome caused by an HKU2-related Coronavirus of Bat Origin. **Nature** 556: 255-258

Olival KJ*, Hosseini PR, Zambrana-Torrelio C, Ross N, Bogich TL, Daszak P* (2017). Host and viral traits predict zoonotic spillover from mammals. **Nature** 546, 646 650

Allen T, Murray KA, Zambrana-Torrelio C, Morse SS, Rondinini C, Di Marco M, Breit N, Olival KJ, Daszak P* (2017). Global hotspots and correlates of emerging zoonotic diseases. **Nature Comm** 8: 1124

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Li W, Shi Z, Yu M, Ren W, Smith C, Epstein JH, Wang H, Crameri G, Hu Z, Zhang H, Zhang J, McEachern J, Field H, Daszak P, Eaton BT, Zhang S, Wang L-F. (2005). Bats are natural reservoirs of SARS-like coronaviruses. **Science** 310: 676-679

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Emma Mendelsohn
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Professional Preparation

Wesleyan University, CT	Earth and Environmental Science	BA	2010
Duke University, NC	Ecotoxicology and Environmental Health	MEM	2015

Appointments

Research Scientist, EcoHealth Alliance	2018 - present
Open-source software peer reviewer, rOpenSci	2019 - present
Project Scientist, Integral Consulting	2015 - 2018
Statistics Teaching Assistant, Duke University	2014
Environmental Health Science Intern, Cardo ChemRisk	2014

Publications

Li, H., E. Mendelsohn, C. Zong, E. Hagan, W. Zhang, N. Wang, S. Li, H. Yan, H. Huang, G. Zhu, N. Ross, A. Chmura, P. Terry, M. Fielder, M. Miller, Z. Shi, P. Daszak. (2019). Human-animal interaction and bat coronavirus spillover potential among rural residents in Southern China. **Biosafety and Health**. 1(2):84-90.

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Hoffman, K., C.M. Butt, T.F. Webster, E.V. Preston, S.C. Hammel, C. Makey, A. Lorenzo, E.M. Cooper, C. Carignan, J.D. Meeker, R. Hauser, A. Soubry, S.K. Murphy, T.M. Price, C. Hoyo, E. Mendelsohn, J. Congleton, J.L. Daniels, and H.M. Stapleton. (2017). Temporal trends in exposure to organophosphate flame retardants in the United States. **Environmental Science and Technology Letters**. 4(3):112-118

Kopelovich, L., A.L. Perez, N. Jacobs, E. Mendelsohn, and J.J. Keenan. (2015). Screening level human health risk assessment of toluene and dibutyl phthalate in nail lacquers. **Food and Chemical Toxicology**. 81:46 53.

William B. Karesh
EcoHealth Alliance, 460 W. 34th St, New York City, NY 10001, USA
E-mail: karesh@ecohealthalliance.org

Professional Preparation

Clemson University	Biology	BS	1977
Univ. of Georgia	Veterinary Medicine	DVM	1982
Zool. Society of San Diego	Residency Wildlife Health		1982 - 1984

Appointments

Life Member, Council on Foreign Relations	2016 - present
Emerging Pandemic Threats Partner Liaison, USAID EPT PREDICT-2	2014 - present
Advisor, WHO Expert Panel on MERS-CoV	2013 - present
Expert, WHO International Health Regulation Roster of Experts	2013 - present
Executive Vice President for Health & Policy, EcoHealth Alliance	2010 - present
President, Working Group on Wildlife Diseases, OIE, France	2008 - present
Co-Chair, Wildlife Health Specialist Group, IUCN, Switzerland	2001 - present
Chief Technical Officer, USAID EPT PREDICT	2009 - 2014
Chief of Party, USAID Global Avian Influenza Network for Surveillance	2006 - 2009
Vice President & Director, Global Health Programs, Wildlife Cons. Society	2001 - 2010

Publications

Kandeil A, Gomaa M, Shehata M, El Taweel AN, Mahmoud SH, Bagato O, Moatasim Y, Kutkat O, Kayed AS, *Dawson P*, Oui X, Bahl J, Webby RJ, Karesh WB, *Kayali G*. (2019) Isolation and characterization of a distinct influenza A virus from Egyptian bats. **Journal of Virology** 93(2).

Anthony SJ, Johnson CK, Grieg D, Kramer S, Che X, Wells HL, Hicks AL, Joly D, Wolfe ND, Daszak P, Karesh WB, Lipkin WI, Morse SS, Predict Consortium, Mazet J, Goldstein T. (2019) Global patterns in coronavirus diversity. **Virus Evolution** 3(1).

Machalaba CC, Elwood SE, Forcella S, Karesh WB. Global avian influenza surveillance in wild birds: A strategy to capture viral diversity. (2015) **Emerging Infectious Diseases** 21(4):e1-7.

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Morse SS, Mazet JAK, Woolhouse M, Parrish CR, Carroll D, Karesh WB, Zambrana-Torrelio C, Lipkin WI, Daszak P. (2012) Prediction and prevention of the next pandemic zoonosis. **The Lancet** 380:1956-65.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Emma Mendelsohn

Other agencies (including NSF) to which this proposal has: none

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Investigating Impact of Nutritional Deficiencies on Pandemics

Source of Support: Eleanor Crooks Foundation
Total Award Amount: $70,000 Total Award Period Covered: 05/01/2020 – 10/31/2020
Location of Project: Global
Person-Months Per Year Committed to the Cal: 2 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

REPEL: Rapid Evaluation of Pathogens to prevent Epidemics in Livestock

Source of Support: DHS
Total Award Amount: $566,274.26 Total Award Period Covered: 09/05/2019-09/04/2021
Location of Project: Global
Person-Months Per Year Committed to the Cal: 6 Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Robert Young

Other agencies (including NSF) to which this proposal has: none

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

REPEL: Rapid Evaluation of Pathogens to prevent Epidemics in Livestock

Source of Support: DTRA
Total Award Amount: Total Award Period Covered: 04/09/2019-03/09/2021
Location of Project: Global
Person-Months Per Year Committed to the Cal: 6 Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support: DHS
Total Award Amount: Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: William Karesh	Other agencies (including NSF) to which this proposal has

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Reducing the Threat of Middle East Respiratory Syndrome Coronavirus (MERS) and Avian Influenza (AI) in Jordan & Strengthening Regional Disease Surveillance Capacity (current proposal)

Source of Support: DTRA
Total Award Amount: $4,975,681.29 Total Award Period Covered: 01/01/2020 - 12/31/2024
Location of Project: USA, Jordan
Person-Months Per Year Committed to the Cal: 2 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Understanding the Risk of Bat-Bourne Zoonotic Disease Emergence in Western Asia

Source of Support: DTRA
Total Award Amount: $4,391,443.65 Total Award Period Covered: 10/02/2017 - 10/01/2022
Location of Project: Global
Person-Months Per Year Committed to the Cal: 1.56 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Ground Truth Network

Source of Support: DHS
Total Award Amount: $2,231,114.13 Total Award Period Covered: 09/30/2016 - 09/29/2021
Location of Project: USA
Person-Months Per Year Committed to the Cal: 1.56 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
READY: Augmenting Capacity for Humanitarian Emergencies of Infectious Diseases with Epidemic or Pandemic Potential

Source of Support: USAID
Total Award Amount: $143,605 Total Award Period Covered: 09/25/2018 - 09/30/2021
Location of Project: Global
Person-Months Per Year Committed to the Cal: 1.56 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Emerging Pandemic Threats PREDICT-2

Source of Support: USAID
Total Award Amount: $100,000,000.00 Total Award Period Covered: 10/01/2014 - 09/30/2019
Location of Project: Global
Person-Months Per Year Committed to the Cal: 4.56 Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: William Karesh

Other agencies (including NSF) to which this proposal has

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Crimean-Congo hemorrhagic fever: Reducing an emerging health threat in Tanzania

Source of Support: DTRA
Total Award Amount: $4,848,483 Total Award Period Covered: 10/01/2019 - 07/31/2024
Location of Project: USA, Tanzania
Person-Months Per Year Committed to the Cal: 1.0 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Reducing the threat of Rift Valley Fever through Ecology, Epidemiology and Socio-Economics

Source of Support: DTRA
Total Award Amount: $4,988,526 Total Award Period Covered: 06/01/2019 - 05/31/2024
Location of Project: USA, South Africa
Person-Months Per Year Committed to the Cal: 2.0 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Understanding filovirus diversity in bat reservoirs and implications for human outbreaks in West Africa

Source of Support: NIH
Total Award Amount: $7,307,869 Total Award Period Covered: 03/01/2020 - 02/28/2025
Location of Project: Global
Person-Months Per Year Committed to the Cal: 2.0 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Reducing the Threat from high-risk pathogens causing febrile illness in Liberia

Source of Support: DTRA
Total Award Amount: $4,912,818.06 Total Award Period Covered: 01/01/2020 - 12/31/2024
Location of Project: USA, Liberia
Person-Months Per Year Committed to the Cal: 1.5 Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Peter Daszak	Other agencies (including NSF) to which this proposal has

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Reducing the Threat of Middle East Respiratory Syndrome Coronavirus (MERS) and Avian Influenza (AI) in Jordan & Strengthening Regional Disease Surveillance Capacity (current proposal)

Source of Support: DTRA
Total Award Amount: $4,975,681.29 Total Award Period Covered: 01/01/2020 - 12/31/2024
Location of Project: USA, Jordan
Person-Months Per Year Committed to the Cal: 2.0 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
CNH2: Land-use change and microbial spillover as a coupled human-Resilience

Source of Support: NSF
Total Award Amount: $1,599,738 Total Award Period Covered:
Location of Project: EcoHealth Alliance and Malaysia
Person-Months Per Year Committed to the Cal: 0.50 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Understanding Risk of Zoonotic Virus Emergence in EID Hotspots of South East Asia

Source of Support: NIH
Total Award Amount: $7,573,721.35 Total Award Period Covered: 3/1/2020 – 2/28/2025
Location of Project: EcoHealth Alliance and International Field and Lab Locations
Person-Months Per Year Committed to the Cal: 3.0 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
One Health Workforce – Next Generation

Source of Support: USAID
Total Award Amount: $5,000,000 Total Award Period Covered: 10/1/2019 – 9/30/2020
Location of Project: EcoHealth Alliance and International Field and Lab Locations
Person-Months Per Year Committed to the Cal: 1.44 Acad: Sumr:

Support: ☐ Current ☐ Pending ☒ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Strategies to Prevent (STOP) Spillover

Source of Support: USAID
Total Award Amount: $100,000,000 Total Award Period Covered: 8/31/2020 – 8/30/2025
Location of Project: EcoHealth Alliance and International Field and Lab Locations
Person-Months Per Year Committed to the Cal: 3.0 Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.