Infectious Disease Emergence and Economics of Altered Landscapes (IDEEAL)

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III. Executive Summary

Disease emergence is driven by complex socioeconomic and environmental changes, which include land use changes due to deforestation, agricultural expansion and habitat degradation. EcoHealth Alliance (EHA) has spent the last 40 years addressing these complex environmental and social challenges through multidisciplinary collaborative international networks. These include long-term partnerships within Malaysia, such as our 15-year old partnership with the Malaysian Government to tackle Nipah virus (the Henipavirus Ecology Research Group) which has now been formalized at the Ministerial level by an MOU among EHA, and the Malaysian Ministry of Health, Dept. of Veterinary Services, and Wildlife and National Parks (PERHILITAN). For the IDEEAL project, we will leverage our experience building successful partnerships, developing outreach programs, and our specific expertise in modeling disease emergence and its economic implications to address the challenge in this RFA.

Our modeling strategy will draw on existing datasets curated by EHA, datasets identified through partners and government agencies in Malaysia, and new data collected through the DEEP FOREST project, managed by EHA. Using a Bayesian statistical framework, we will examine how changes in land cover and land-use has affected the incidence of disease over the last few decades. We will calculate the value of damages from past disease outbreaks, and construct a model for expected damages under different land use scenarios, and different severity of outbreaks. We will parameterize our models with data that explicitly measure the different rates of exposure to disease by men and women (of all ages) attributable to gender-specific roles in society. To address gender issues effectively, we will solicit the direct participation of women and children in our behavioral surveys to clarify the implications of gender-specific roles.

We will develop a center of excellence for economic analysis of land use change and health outcomes. The Center for Development and Health (CDH) will be an international resource for the science and policy of land use change and the cost of disease emergence and will be based at the School of Business and Economics at the Universiti Malaysia Sabah (UMS). The CDH will be a forum for a state-of-the-art multi-disciplinary think tank composed of experts from the fields of economics, disease ecology, agriculture, forestry, wildlife conservation, and health as well as industry experts involved in land development in Sabah. We will collaborate with these experts to develop outreach materials and strategies, and the CDH will serve as a platform from which we will disseminate information and toolkits that provide all relevant stakeholders—community members, private industries, researchers, government officials, and policy makers—the ability to translate the science into action, with particular consideration for gender sensitive issues.

At the end of the project period, we will have produced four main deliverables that satisfy the proposed IRs and sub-IRs. They are: 1) quantitative models of land use change and disease emergence to use in local and regional decision making and that can be generalized or modified for other applications 2) the Center for Development and Health at UMS to serve as a permanent Center of Excellence and platform for continued research and training, stakeholder engagement, and as a regional and national source of information on the economic relationships of land use change, disease emergence, and subject area gender-related issues, 3) gender-sensitive health impacts toolkits for promoting best practice approaches and translate project findings to ensure gender equality benefits, and 4) scientific translation communications toolkits that translate research and modeling results to be useful for policy makers, private companies and government organizations, and civil society stakeholders.

IV. Goal and Objectives

Overall aim: In partnership with the Universiti Malaysia Sabah School of Business and Economics, the Sabah Wildlife Department, and other governmental and non-governmental stakeholders, we will develop a functional, field-trialed, quantitative set of models which capture gender sensitive emerging infectious disease-related health savings as a function of land use; produce actionable model outputs and analyses to help promote reduced-impact land utilization by governments, private sector stakeholders and civil society; build alliances amongst a diverse range of stakeholders; integrate cross-disciplinary approaches in gathering, analyzing and disseminating information; and establish a training, learning, and resource sharing platform in Sabah to sustain program impacts after the project.

Models will be parameterized using empirical data from our extensive collection of datasets as well as other existing datasets and new data generated by USAID investments including EPT PREDICT and our DEEP FOREST project. We will create a Center of Excellence in Sabah to act as an outreach resource for key stakeholders in Sabah, Malaysia, and USAID. The Center will disseminate our findings and actively communicate them to local stakeholders including women's groups and indigenous communities who may be directly impacted by land use change. We will work directly with government partners in Sabah and industry stakeholders to translate the outputs of our models into policy-level actions and corporate sustainability strategies that will reduce the risk and mitigate the impact of land-use and climate associated zoonotic disease outbreaks, with particular attention to reducing gender-based adverse health events. This project will be scalable and will serve as a prototype for similar national and regional initiatives in other parts of Asia or the world that are particularly vulnerable to EIDs.

V. Narrative: Section A - Technical Approach

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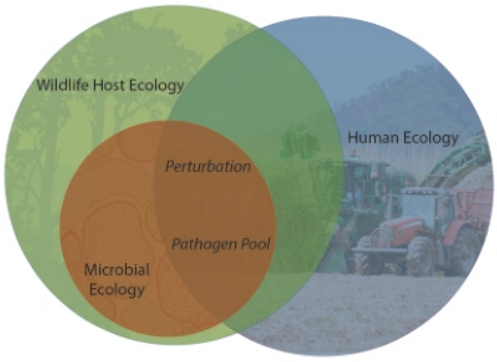
Disease emergence is driven by socioeconomic, demographic and environmental changes which include deforestation, agricultural expansion, habitat degradation and other land use changes. These changes are particularly important for zoonotic diseases, which account for ~ [redacted] of all EIDs, and almost all recent pandemics (Taylor *et al.*, 2001; Woolhouse & Gowtage-Sequeria, 2005). Land use change is the most significant driver of disease emergence. Analysis of our database of all known EIDs (from Jones *et al.*, 2008) shows that around one-fifth of EID events, an even higher proportion of zoonotic diseases, and most emerging pandemics were associated with land use changes, including agricultural conversion, deforestation and activities associated with the extractive industries (e.g., mining, logging). The importance of land use change in the process of disease emergence make it a key target for control strategies (Patz, Daszak *et al.*, 2004; Jones *et al.*, 2008; Keesing *et al.*, 2010; Burnside *et al.*, 2012). However, to create effective control measures requires: 1) a detailed mechanistic understanding, supported by field data, of how land use change drives disease risk; and 2) a strategy to control this problem that will be supported by local stakeholders (industry, government and local communities) because these stakeholders play a role in promoting, legislating or engaging in activities that lead to land use change, and are vulnerable to their adverse consequences, including disease emergence.

Our extensive previous work on modeling EID dynamics; on the emergence Nipah virus, West Nile virus, SARS and avian influenza; and our current work in USAID EPT PREDICT (including the DEEP FOREST project) provide strategic direction for this proposed. We have shown that land use change leads to disease emergence by increasing opportunities for contact and pathogen spillover between wildlife and humans and by perturbing host-pathogen ecological dynamics that promote cross species transmission (Patz, Daszak *et al.*, 2004; Murray & Daszak, 2013) (Figure on right). These factors act either together or independently, and because of the diversity of reservoir hosts, vectors, and human behavior in a region, they create a complex, dynamic system.



To understand this complexity requires collection and analysis of data on all of the processes involved in land use change that affect disease risk. For example, road building or other economic development activities in intact forests usually involve movement of people into previously uninhabited areas, which increases their contact with wildlife and their exposure to the novel pathogens they carry, as well as vectors such as mosquitoes. Different sectors of the community tend to have different types and degrees of contact with wildlife, and this also varies with age and gender. In addition, land use change modifies existing habitat with often dramatic impacts on the abundance of disease reservoirs and vectors (Norris, 2004; Patz & Olson, 2006; Olson *et al.*, 2010). All of these factors can alter disease risk. Once a pathogen has spilled over into a single person, or established itself in a community, the risk of spread depends on the amount and type of contact among people, and their movement into and out of the interface where spillover happened. Finally, assessing the role of disease emergence in the economic cost/benefit analysis of land use change requires specific information on the frequency of disease emergence and outbreaks, and their impact on individuals, on communities and on production,

trade and travel. Our approach for the IDEEAL Project brings together these components to produce actionable information to local and regional stakeholders for informed decision-making.

Cross-Disciplinary Approaches

EcoHealth Alliance (EHA) has spent the last 40 years addressing complex environmental and social challenges by building multidisciplinary teams via collaborative international networks. These include long-term partnerships within the region, such as our 15-year old partnership with the Malaysian Government to tackle Nipah virus (the Henipavirus Ecology Research Group) which has now been formalized at the Ministerial level by an MOU among EHA, and the Malaysian Ministry of Health, Dept. of Veterinary Services, and Wildlife and National Parks (PERHILITAN). Our team has provided multi-disciplinary training, research support, and policy guidance to Sabah Wildlife Department since 1988. Our work in the region includes consortia that we founded such as the One Health Alliance of South Asia, a partnership of SAARC country government agencies for health, agriculture and the environment, and the Consortium for Conservation Medicine, set up in 1997 to link leading US institutions of public health, wildlife health, environmental sciences, medicine and veterinary medicine. Official affiliated partners of EHA (www.ecohealthalliance.org/partners/all_partners) include key government departments in the USA (e.g. CDC, NIH, USDA), in Malaysia (e.g. Dept. Veterinary Services, Sabah Wildlife Dept.) and globally (e.g. OIE, FAO, WHO, and IUCN). We work closely with leading corporations involved in agricultural development in the region (e.g. Cargill, Mars, PepsiCo) and leaders of industry globally (e.g. Bayer, Exxon). Our economics research includes partnership in the NIH-NIGMS MASpread project which analyzes the economic impacts of disease on trade. Our outreach programs include multidisciplinary training programs such as EcoHealthNet, which provides disease ecology training in more than 10 countries. Finally, EHA is one of four partners in USAID EPT PREDICT, with specific responsibility for zoonotic disease surveillance in Malaysia, leadership in all PREDICT modeling activities, and the DEEP FOREST project.

For this project, we will leverage our experience building successful collaborative programs, in public outreach, and our expertise in modeling disease emergence and their economic implications to address the challenge in this RFA. We have already established close working partnerships with experts from the fields of wildlife health, economics, conservation biology, public health, and social advocacy in Sabah, including the Sabah Wildlife Department's Wildlife Health Unit (our DEEP FOREST team), The Danau Girang Field Centre, HUTAN, the Sabah Department of Health, the Malaysian Palm Oil Council,and the School of Business and Economics at the Universiti Malaysia Sabah (UMS).

We plan to create a center of excellence for land use change and health (the Center for Development & Health (CDH) based in the School of Business and Economics at UMS. This will engage experts in agricultural science and policy from within UMS, including the Department of Sustainable Agriculture, and State government experts in economic planning and development from the Sabah Economic Development and Investment Authority (SEDIA) as well as several other local NGOs and government agencies. The CDH will link key departments within the university to private and public institutions in Sabah whose members can provide real-world insight into the challenges of development. It will create training and educational opportunities for men and women, which provides students with a multidisciplinary framework that links environmental and ecological science with economics, social science, and political science. This will provide long-term sustainability by producing a generation of graduates ready to address the challenges of responsible land development in Malaysia and the broader region.

Modeling strategy
We propose a 3-phase approach, with each phase informing the next: 1) model the relationship between land cover/land-use change and the likelihood of pathogen spillover, disease outbreaks and emergence, utilizing available data and novel data from DEEP FOREST; 2) develop an avoided damages model to understand the economic consequences of these linkages; and 3) examine potential for integration of these models into a total ecosystem value model. Although the focus of this proposal is #1 and #2, we will evaluate the potential to achieve #3 in the early stages of the project. Progress in #3 will place the goals and results of the current RFA in broader context of ecosystem use and contribute to future policy and planning efforts.

1. **Modeling the relationship between land-use change and disease outbreaks/emergence**
This objective will be achieved by analyzing and modeling data from two domains: 1) A detailed analysis of available data; and 2) analysis of newly generated data primarily from DEEP FOREST. The first domain uses a correlative approach and provides insight from a very broad range of data sources while the second focuses in on the mechanisms of disease emergence (primarily contact rate and host-pathogen ecology) to provide novel insights on the links between land-use change and disease emergence.

Available data: Our first step will be to examine how changes in land cover and land-use has affected the incidence of disease over the last few decades. We will focus on a range of disease outcomes, including localized spillover events, small outbreaks, larger scale outbreaks and pandemic emergence. We will assess how land use has changed from pristine conditions using historical data on land cover, and we will match this with recent historical data on disease outbreaks and emergence that we have already amassed as part of EHA's modeling program, as well as from other sources. **For land use data**, we will use our datasets on land cover/land use for natural systems, croplands, grasslands, urban areas and areas used for livestock, originally sourced from FAO, HYDE-IMAGE, GLOBIO3, European Commission, USGS, NASA and others, but that have undergone subsequent processing for our applications in studying disease emergence processes. Our spatial database also includes current state, forecasts (2050) and back-casts (1700) of land cover/land use. These datasets are highly variable in spatial resolution, ranging from country level to 500 m of resolution (e.g., classified land cover MODIS-Terra). We have access to downscaled scenarios of land use and climate change under various projected policy frameworks from Rio+20 (e.g., business as usual vs aggressive policy changes). We have also gathered, vetted and produced a series of socio-economic and ecological variables thought to drive disease outbreaks, including global human population density (GPW & GRUMP), gross domestic product (World Bank), mammal diversity (IUCN), human conflict (Political Instability Task Force), climate (WorldClim) and others. Currently we are in the process of designing methods to downscale some of the country level data to finer spatial resolution models, which in pilot analyses significantly enhances our ability to detect trends among noisy and biased datasets. **For disease data**, we will use EHA's online EID database (the 'Sicki Project' – www.ecohealthalliance.org/programs/35-the_sicki_project), which serves as a platform to enter information on EIDs, including standardized pathogen taxonomy, bibliographical references and spatial information. We will build a database of outbreaks and other relevant information (e.g., drivers of outbreaks) relevant to this RFA. To do this, we will ingest data from public databases such as GIDEON, the WHO Disease Outbreak News reports and from reviewing the literature.

In conjunction with our Malaysian partners and the Center of Excellence, we will also identify relevant local and regional datasets (e.g., government reports or articles in local languages, such as Bahasa-Melayu, Bahasa-Indonesia, Mandarin and Cantonese).

To account for temporal variability in emergence, we will perform analyses at different temporal and spatial scales. For the temporal analysis, 10-year intervals will be used. We will also investigate the possibility that there is a time lag between land cover/land use changes and the emergence of new infectious diseases. In this scenario, a change in land use may gradually alter population dynamics of a wildlife reservoir, so that after a period of time, some wildlife become much more common, and their pathogens have an opportunity for spillover. The spatial analysis will include a multi-scale analysis focused on regional (Southeast Asia) and local (within Sabah) spatial scales. This framework of analysis will allow us to separate drivers of EIDs operating at different scales.

New data: For the second component of this objective, we will leverage the theory, methodology and results of the DEEP FOREST project to bolster and support the current proposal. Spillover of pathogens due to land use change is an ecological process based on the community ecology of pathogens within wildlife populations, and their interactions and disease-relevant contact with people. Contact rates are notoriously difficult to acquire during disease outbreak situations. However, the EHA-led DEEP FOREST project is tasked with specifically measuring disease-relevant contact among people, livestock and wildlife across an urban-to-rural gradient in Sabah. It also will capture data on the community ecology of wildlife hosts over this gradient.

We will use data obtained by the DEEP FOREST team to inform the likelihood of EID spillover within specific regions undergoing land use change. In Borneo, the DEEP FOREST project sites are in the region of Sukau near one section of the Kinabatangan River. The sites are distributed along a disturbance gradient from highly disturbed (near the town of Sukau) to largely pristine and intact (Gomantong Forest Reserve). Here, wildlife sampling and surveys of human contact with wildlife are taking place at 9 sites along the gradient (3 sites in each of three levels of the gradient). These surveys provide samples that are being fed into our PREDICT pathogen discovery program to provide information on the prevalence/incidence of known pathogens and completely novel pathogens from viral families which are known to contain zoonotic agents. DEEP FOREST human contact surveys will provide critical information on how likely a person is to make contact with wildlife directly, indirectly or inadvertently, and depending on age, occupation and gender. This gender specificity may be critical because some occupations consist of mainly male workers (e.g. palm oil plantations, hunters), and we expect exposure rates to differ significantly both quantitatively and qualitatively between men and women.

These data will inform our model of the likelihood of pathogen spillover for a given contact pattern, corrected for the patterns we expect to see in the viral pool across the land-use change gradient. This means that we will be able to compare the likelihood of an individual hunted animal being positive for a pathogen at any site along the gradient, and of a specific risk behavior occurring there. Finally, to calibrate the likelihood of such a scenario leading to infection of a person, we will use data from published studies of zoonotic spillover for various model viruses. **This level of predictive capacity has never been achieved before, and is uniquely possible by a group that brings together expertise in modeling EIDs and has access to the unique datasets that DEEP FOREST will produce.**

Statistical framework: We will evaluate and compare regression models used to analyze count data (e.g., negative binomial, Poisson, zero-inflated under a hierarchical Bayesian framework) while controlling for other factors (including research bias) that influence disease detections. We will make use of the following general Bayesian model:

$$Y_i \sim \text{Poisson}(\mu_i) \text{ or } Y_i \sim \text{Binomial}(\mu_i)$$
$$g(\mu) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \varepsilon_i$$
$$\varepsilon_i \sim N(0, \sigma_\varepsilon^2)$$

where $g(\mu)$ is a link function (see below), β_0, β_1, etc., are parameters to be estimated and ε is an error term with a normal distribution. Link functions are used to indicate whether the predictor variable (Y_i) represents a Poisson distribution (e.g., outbreak counts) or a Binomial distribution (e.g., presence or absence of a new disease). Links are defined as $g(\mu) = \log(\mu)$ for count data (e.g., number of outbreaks) or as $g(\mu) = \log\left[\frac{\mu}{(1-\mu)}\right]$ for presence/absence data (an EID event.

Bayesian analysis has the advantage over frequentist methods under some circumstances for its ability to specify *prior* probabilities to parameters (e.g., through literature reviews and consultation of experts). We will assign prior probabilities using two different approaches: 1) Uninformative prior: an inverse gamma distribution will be assigned for each parameter. An uninformative prior approach will help us develop a generalizable model and make it relevant for other parts of the world where disease-related data may be scarce. 2) Informative prior: to achieve greater specificity and regional relevance, we will investigate the use of additional sources of information for integration into this framework. For example, we may be able to leverage a range of data sources from the literature, from our DEEP FOREST project, and EID emergence and outbreak databases. Bayesian models with informative priors can help make the most of available data, narrow parameter estimates, reduce uncertainty in those estimates, and reduce new data requirements (i.e., sample sizes) in order to achieve equivalent statistical power for inference. For example, they will give us the advantage of being able to incorporate system-specific data that we have collected under our other programs in order to produce a tailored Bayesian model for regional and local conditions. Markov Chain Monte Carlo (MCMC) methods with a Gibbs sampler algorithm (i.e., each randomly sampled value is conditional to the previous value) will be used to estimate the posterior probability of the mean and percentiles.

2. Avoided damages modeling

Our preliminary analyses and other studies strongly suggest that deforestation and other land-use practices contribute to disease emergence and outbreaks. Intact forests can thus be considered a 'public good' from a disease emergence perspective – that is, they provide a service to society through protection against infectious disease outbreaks. Unlike harvesting natural products for use or profit, this service does not involve society's direct use of the ecosystem, making the valuation of this public good a challenge. One way to measure the benefits of disease regulation from intact forests is to *value the damages that are avoided* by keeping the ecosystem intact (Groot *et al.*, 2010). In practical terms, we expect that the costs of disease control will increase with deforestation, i.e. with decreasing forested area, and we will examine this relationship in the proposed work.

Calculating the Expected Damages of Disease Outbreaks

Our approach is based on work EHA has developed within our MASpread project in which we are examining the anthropogenic impacts that contribute to the spread of disease and their

associated costs. This involves adapting the concept of hedonic pricing models (models that decompose the price of an item into separate components) to value EID damages. We use a set of well-studied emerging diseases each with different characteristics representing typical impacts from disease emergence – i.e. those causing spillover vs. human-to-human transmission vs. pandemic outbreaks. Our damage functions are assessed by teasing apart the wide range of potential outcomes of these diseases into their morbidity, mortality, and impacts on travel and trade – i.e. factors that have already been valued in separate studies. Our strategy is to then use that function to predict the damages of other diseases that have similar characteristics to different members of this subset based on the same explanatory variables.
A general description of this model takes the form of:

$$D_i = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_n X_{ni} + \varepsilon$$

Where:

D_i=Damages from disease i in 2013 US dollars
X_{1i} to X_{ni}= Morbidity, mortality, loss of worker days, duration trade restrictions, etc.
β_1 to β_n are estimated parameters representing the effect size of each variable (X) on the damages
ε = error term

Our categorization of EIDs by type of economic damages, and derivation of a different damage function for each category make our estimates more robust. Using the results from the count data model (see 1 above), we will examine the expected damages under three different scenarios: 1) business-as-usual (current rate of land use conversion extrapolated forward), 2) increased rates of deforestation, and 3) no deforestation. We will link these scenarios to the new Millennium Ecosystem Assessment policy scenarios.

We will tailor damages from the above formula (listed in 2013 US dollars) to the unit with the most impact for the system and stakeholders we are addressing (e.g., USD, Thai Baht or Malaysian Ringgit). Generally speaking damages will include the direct costs associated with human health impacts and mortalities, as well as other costs such as impacts on travel and trade.

Health impacts: We will quantify the 'value' of health, healthiness or the perception of healthiness using a value of statistical life (VSL) and value of a statistical life year (VSLY) framework, i.e. typical inputs into cost-benefit analyses (CBA). VSL is the marginal dollar value attributable to a human life, while VSLY is the annualized equivalent (value of a year of healthy life). VSLY will be particularly relevant here because damages are often non-fatal and this measure encapsulates loss due to disability or other reduction in quality of life over a fixed time period. As a starting point, we will work from previous estimates of these parameters. These exist mainly for high-GDP countries in Europe, North America and elsewhere and we will therefore adapt them to local conditions. A previous review (from Australia) suggests a mean VSL of ~A$9.4 million (median of $6.6M), and a mean VSLY of A$433,437 (median of A$119,589). These mean figures are also affected by sector, e.g. health (A$4.0 million), transport ($7.9 million), 'other' (consumer choice, crime and fire safety – $8.5/$6.0 million), environment ($11.2/$8.1 million) and occupational safety ($11.1/$7.4 million), highlighting the need to understand the human population in the area of study if we are to attribute economic values to disease emergence due to land use change.

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Healthy life is a unique and valuable commodity, which does not fit easily into more traditional economic benefits frameworks. For this reason, several metrics have been developed that can attribute costs to specific subcategories (e.g., infectious diseases). These include fatalities averted/life-years saved (LYS), and several quality of life metrics (QoL e.g., DALY – disability adjusted life years, and QALY – quality adjusted life years). Both DALYs and QALYs incorporate mortality and morbidity components. DALY valuation is the preferred approach here due to its extensive use in previous studies and because a pre-existing framework based on expert weights of various health states is available. A DALY value of 0 equates to perfect health, such that DALYs are already in the form of something to be averted.

Other damages: The economic impact of a disease outbreak often extends beyond losses from morbidity and mortality. SARS claimed 774 lives out of 8,096 infected, but the majority of the economic burden (perhaps as high as US$30-50 Billion) resulted from losses in the travel and trade sectors (Keogh-Brown 2008). For each outbreak, depending on its scope (local, national, multi-country), we will gather data on a variety of other indicators that contribute to the overall economic burden of the disease. These may include treatment costs, the number and value of livestock culled in control measures, travel and trade restrictions and other relevant costs.

3. Total Ecosystem Value Modeling

Although the RFA does not call for quantification of the total ecosystem value (TEV), the avoided costs calculated in our model could be incorporated into other models to determine the economic and societal value of converting land (adapted from Barbier, 2009). This will have particular relevance to policy makers in Malaysia and elsewhere in Tropical regions under pressure for development.

$$\max_{c(t)} V = \int_0^{\infty} [R(D) - C(c) - B(A) - O(A)]e^{-rt}dt$$

Where:

R – rent from converted land
C – cost of conversion of intact land to developed land
B – benefit from intact ecosystem
D – developed land
c – area of land converted in each period
A – undeveloped/intact land
O – avoided cost of disease outbreaks

$O'(A)) < 0, O''(A)) < 0$ as intact land decreases, the cost of an outbreak increases at an increasing rate.

Generalizability

We anticipate that the results generated from our approach will represent a significant addition to the state of the knowledge on the value of a specific ecosystem's disease regulating services. The tools that we develop above will have the potential for widespread adoption, providing it is correlated to local conditions. We will therefore develop a checklist to accompany the tools that will contain information on how to tailor the models to different regions and different types of

ecosystems based on our recent research on the spatial drivers of emerging diseases. For example, we have analyzed all previous 450 EID events to assess the relative role of land use change in driving their emergence, and how this varies in importance in different regions globally. These data were published in our paper on biodiversity and health in *Nature* (Keesing *et al.*, 2010) and will be made available with the tool. Similarly, for our models to have relevance to other regions (e.g. South America, Africa), data will be required on how human contact and pathogen diversity patterns vary with land use change in these regions. Data from DEEP FOREST Uganda and DEEP FOREST Brazil, as well as our IDRC-funded project in Southern Brazil, will be available to make these correlations.

Gender Specification

Men and women experience the risks and costs of infectious diseases differently. This likely has specific relevance to land use change, especially with regards to extractive industries, with manual labor health costs, and the economic benefits of work largely falling to men and social and environmental costs falling to women. In many regions, gender also determines one's access to resources, particularly land. The DEEP FOREST Human Contact (DFHC) surveys are providing information we can use to assess gender specific risks and costs of disease along a land-use change gradient. These surveys were designed as part of a collaborative project between EPT PREDICT and PREVENT and are being rolled out at our DEEP FOREST sites in Sabah, Brazil and (in the first year of this project) in Uganda. In Sabah, we hypothesize that the specific costs of disease to individuals, as well as to the economy, will be gender-specific. For example, although men and women often work in the same places, women are often concentrated in distinct sectors or are responsible for distinct activities exposing them to different risks compared to men. Division of labor, recreational activities and occupations related to animals (hunting, butchering, caring for domestic animals, etc.) are also influenced by social factors. Similarly, men are often engaged in manual labor activities in areas away from urban centers. For example, in Sabah there is a strong bias towards male workers in oil palm plantations, which may expose them to specific hazards associated with this form of land-use change.

Our working hypothesis will be that men and women have different rates of exposure to diseases that may be attributable to gender-specific roles in society. To address gender issues effectively, we will solicit the direct participation of stakeholders including women to clarify gender roles and their implications in project activities. Quantitative data collected from the contact surveys will be disaggregated by gender to highlight the differences in traditional roles and learned behaviors of men versus women based on gender attributes. Gender-specific analyses will also take into account other variables including income, race, ethnicity, and other social characteristics, as well as explicitly address the specific differences between young girls and boys, and adult women and men. To assess the effect of both gender and age on relative risk of infectious disease emergence, the following sub-groups have been chosen to survey as part of the DEEP FOREST project: Adult women (age 18 and older); Adult men (age 18 and older); Boys (age 10-14); Girls (age 10-14). We will liaise closely with the USAID EPT PREVENT team that is conducting this work collaboratively with EHA in Borneo.

Using gender-relevant information from the DEEP FOREST surveys, we will examine: Knowledge, beliefs, and perceptions; what beliefs and perceptions shape gender identities and norms; human practices and distribution of labor – what are the gender roles that dictate the activities in which men and women participate; how men and women engage in different activities relevant to land use change and rates of exposure to different animals; and time and

space – how women and men spend their time. Understanding the role of gender in disease risks and costs will be fundamental in planning the prevention, detection and treatment of illness.

In addition to the gender specified data collected from the human contact surveys, additional data will be collected from stakeholders and used to inform the gender-sensitive health impacts toolkit to be produced. Additional data may include: local legal and cultural frameworks with regard to land ownership, community leadership; possible impact on local gender relations; barriers and facilitators of gender sensitive data collection; and levels of female participation in decision-making structures. Additional data collection methods may include community mapping, stakeholder analysis, focus groups, and key informant interviews with women, local government, and representatives from the private industry.

Outreach

Stakeholder engagement

We will develop a stakeholder engagement program around the principle that decisions on land use management that minimize EID spillover risk can contribute to widely distributed health savings. These occur due to averted disease control and containment costs; avoided costs of individual health care; avoided costs to livestock health and productivity, trade and tourism status, financial markets stability; and the preservation of individual, gender-sensitive livelihoods and earnings potential. Our engagement will build upon 1) existing partnerships established in Malaysia (and Sabah in particular) through EHA's work with our DEEP FOREST project, the USAID EPT PREDICT program, and our 11-year partnership with the Malaysian Govt. and other agencies; 2) the organizations we have identified and contacted for the purposes of developing this proposal, and 3) organizations working with the above agencies and partners on other related programs. Stakeholders will include government agencies (both Sabah State and Federal) for wildlife, forestry, agriculture, development, tourism, public health, and social development. Para-governmental and Non-governmental organizational stakeholders will include Yayasan Sabah (Sabah Foundation), the Malaysian Palm Oil Council, Forest Research Centre Sabah, Sabah Women's Action-Resource Group, and the Sabah Tourism Association, The LEAF (Lowering Emissions in Asia's Forests) Program and its relevant partners such as The Centre for People and Forests. Additional private sector stakeholders will be identified by existing partners, their industry organizations (such as above) and those working in communities surrounding project activity sites (e.g. tourism companies, logging companies, plantation managers and owners, livestock and small-holder farmers, health clinics, shop owners, restaurant owners, lodging and logistics, etc.). University stakeholders will include Universiti Malaysia Sabah and the members of the Malaysia One Health University Network (MYOHUN).

The goal of our stakeholder engagement will be (in both phases of the project) to improve relevant data (knowledge) acquisition and to establish target audiences and users of the project so that we can disseminate data and findings, models, tool kits and handbooks, organizational platforms, and other deliverables. Early in Phase 1 of the project, stakeholders will be identified, briefed on project goals and invited to participate. In partnership with the Sabah Wildlife Department, following the release of the RFI, we have already held an initial informational meeting to identify interested parties and discuss the concept of the center of excellence. This has allowed us to better understand the stakeholder landscape and to identify potential sources of data for use in our modeling activities. If funded, we will organize our first formal meeting(s) of stakeholders within 4 months of project initiation, and schedule regular (quarterly) meetings and

sub-group meetings out of that initial gathering. Stakeholder identification and inclusion will continue through the life of the project. We will use facilities at the Universiti Malaysia, Sabah to arrange and hold stakeholder meetings (see Center of Excellence).

Table of partner organizations in Sabah

Organization Name	Role	Key contacts / names
Sabah Wildlife Department	Provide data on biodiversity, land use, DEEP FOREST	(b)(6)
Department of Agriculture	Data on land conversion, crop production	Director
Sabah Forestry Department	Data on Forest cover and historically cleared land	Director
Sabah Parks	Data on protected land	Director
Yayasan Sabah	Timber concession data and educational outreach expertise	(b)(6)
Malaysian Palm Oil Council	Coalition of large-scale Oil Palm Plantations	
Malaysia Palm Oil Board	Malaysian Govt. Agency overseeing Oil Palm industry	Director
School of Business and Economics, University of Malaysia, Sabah	Center for Development and Health	(b)(6)
SEDIA (Sabah Economic and Development Investment Authority)	State agency responsible for development and economic growth	Director
World Wildlife Fund - Malaysia	Conservation NGO	(b)(6)
HUTAN	Conservation and social responsibility NGO	

Public-Private partnerships

We plan to develop a powerful public-private partnership that produces multiple initiatives of mutual benefit – whereby industry advises our model building on the details of land-use change projects, and we advise industry and our government agency and other private partners on risk of disease outbreaks and emergence. EHA has extensive experience working in exactly this role in the region and we have developed working or growing relationships with government

authorities, academia, the private sector (e.g. the Malaysian Palm Oil Council http://www.mpoc.org.my/, and the relevant regulatory/watch-dog groups, such as the Roundtable on Sustainable Palm Oil http://www.rspo.org/) and local government agencies such as the Sabah Department of Health and the new Sabah Wildlife Department Health Unit, which EHA helped build in 2012. We will leverage these partnerships in both Phase 1 and Phase 2 of the project and have garnered letters of support from our main partners.

Collaborating with the private sector is essential to any initiative that hopes to influence policy and community involvement. It is particularly important in this project because government and industry partners are both involved in the activities that drive EIDs and also suffer from their impacts. Engaging industry partners such as the palm oil sector from the beginning will allow us to draw on their expertise and minimize potential conflicts as new activities and policies evolve. EcoHealth Alliance, in partnership with Chatham House and USAID, recently facilitated a roundtable discussion with key extractive industry stakeholders to present the current state of science linking natural resource industries and infectious disease emergence. We found that industry representatives were highly receptive to our characterization of disease emergence scenarios, in particular where they create health threats to their worker, and negative public perception of the industry. Similarly, our experience consulting for other global industry leaders including the food sector (e.g. Cargill, Mars, PepsiCo), the agricultural sector (e.g. Bayer Crop Science) and consultancy services (e.g. McKinsey & Co.) demonstrates that industry is a willing partner in initiatives that produce a fair evaluation of risk, particularly when we can advise companies directly on health threats to their workers, or threats to the public perception about their business. We have used these experiences to develop our engagement strategy. For this project, we will aim to garner financial support and in-kind contributions from the private sector to assist in the longterm sustainability of the project outreach. At EHA, our approach to this has been to build a relationship with the companies, trade groups and other private sector institutions of relevance, and assist them in developing their corporate sustainability programs in a way that benefits people on-the-ground in regions where they have active production facilities. This is the approach we have used previous with Bayer, PepsiCo, Exxon, Cargill and others, and our initial discussions with Malaysian Palm Oil Council have been encouraging about their financial support of projects that would fit under the IDEEAL program.

Utilizing the Center of Excellence in Sabah (discussed below) we will host regular roundtable events for key players in the region from major commercial agricultural industries such as palm oil (the Malaysian Oil Palm Council, IOI Corp, TH Group, Kwantas Corp and Selangor Agriculture Development Board) rubber, (the Rubber Industry Board, Rubber Settlement Scheme) and cocoa (Malaysian Cocoa Board, Tech Guan Cocoa company). At these meetings, we will leverage relationships with our current partners including Mars, Cargill, PepsiCo and others that are active in Southeast Asia to develop projects that incorporate data on EID threats to their workers, and on their activities in the region. We will mutually develop plans with private partners to trial out our toolkits, and develop small-scale on-the-ground tests of our approaches. We envisage that this will include working with data on population exposure to wildlife at sites where individual partner companies are actively working and developing. These partnerships will help ensure long-term sustainability of both data collection, research, and implementation of best practices, and the continued development or the proposed center of excellence. We will also investigate in collaboration with key government and industry stakeholders the potential for leveraging other market-based initiatives that could strengthen the protection of carbon stocks, biodiversity, health and other social objectives (e.g., REDD+).

Center for Development and Health (CDH)

We will develop a center of excellence for economic analysis of land use change and health outcomes. The Center for Development and Health (CDH) will be an international resource for the science and policy of land use change and the cost of disease emergence and will be based at the School of Business and Economics at the Universiti Malaysia Sabah (UMS). The CDH will be a forum for a state-of-the-art multi-disciplinary think tank composed of experts from the fields of economics, disease ecology, agriculture, forestry, wildlife conservation, and health as well as industry experts involved in land development in Sabah. Scientific experts and policy makers will hold roundtable discussions with industry leaders and discuss project findings and current land use practices in order to create guidelines on how to reduce the risks of disease emergence as a consequence of land use change and development.

By generating robust quantitative models of the cost of disease emergence and interventions and serving as a repository for data related to development and land use change, the Center will aim to establish a reputation for being an international leader on this subject. In order to translate the findings of this project into actionable policy, the CDH will develop communication and outreach strategies, including a website and social media, and we will work with local public and private partners to disseminate project findings to stakeholders in Sabah. We will create long-term sustainability by providing mechanisms for advanced multi-disciplinary training at UMS by offering short courses and seminars to graduate students and professionals related on the subjects of sustainable land use, conservation, disease ecology, economics, and global health.

Phase one of this project will entail establishing the center at UMS and identifying local stakeholders who will be engaged in center activities. On May 14, 2013 EcoHealth Alliance and Sabah Wildlife Department convened a meeting of potential stakeholders in Kota Kinabalu (see table of potential stakeholders). In attendance were representatives from Sabah state government such as the Department of Veterinary Services, the Sabah Wildlife Department, and the Department of Health. Also in attendance were members of academia and local NGOs including the University of Malaysia, Sabah School of Business and Economics, HUTAN, WWF Malaysia, LEAP (Land Empowerment, Animals, People) and the Danau Girang Field Center. We are currently working with the Dean and several faculty members of the Business school to link the modeling team from EcoHealth Alliance with faculty to construct economic models based on a scenarios approach of disease emergence. We will also work with UMS and Sabah Wildlife Department to identify and regularly convene relevant stakeholders from Sabah who will participate in the meetings held at the CDH. We have also engaged the Malaysian Palm Oil Council and SEDIA (Sabah Economic and Development Investment Authority) to ensure that we include private sector and business interests that are driving land use change in Sabah. Phase 1 will also include data acquisition from available government and academic sources as well as the USAID PREDICT DEEP FOREST project. We have begun to compile a list of available data and will continue to identify data sources during the first few months of this program. Graduate students from the Business school will be identified to participate in model development.

Phase II will include the establishment of regular meetings at the CDH for stakeholders to synthesize project findings and generate public and policy outreach material. We expect that the center will grow over the 3-year timeline to include scientists and other experts from Sabah and the international community who wish to learn spatial analysis or economic modeling via short courses and student projects. The Center will be open to both male and female students and

community members from Sabah. We will engage graduate students from UMS and staff from SWD to train in the Center in order to develop local capacity and create long-term sustainability for the Center's activities.

Our proposed outreach will build on EHA's extensive experience producing policy-relevant analyses aimed at guidelines on best practice, as well as innovative tools that can be used in capacity-building programs and training. For this project, we will introduce innovative tools to the private sector in Malaysia which will include a risk assessment tool to audit industry practices with respect to the risk of negative health outcomes. These tools will give detailed instructions to private sector Environment, Health and Safety (EHS) Officers to ensure that the industry is aware of emerging infectious disease hazards in their facility or surrounding environment. It will then recommend specific mitigation and control strategies should the industry not already have specific measures in place. We will also aim to provide supplemental information to the International Finance Corporation's (IFC) guidelines on health impact assessments (HIA).

Included in the gender-sensitive health impacts toolkit, we will identify opportunities to promote women's leadership, communication propensity and community/familial participation in mitigating disease risks. We will produce printed and web-based materials and other educational outreach material on infectious disease risk in collaboration with the Malaysian Ministry of Health to be distributed to private partners, government agencies and other institutions. We will organize workshops for worker populations drawing on expertise from EHA, public entities (Department of Health) and private industries. The aim of these will be to improve understanding of and access to healthcare services and strengthen the skillset of the healthcare workforce. These workshops and interactions will provide iterative opportunities to refine and strengthen the toolkit throughout the life of the project, as well as to identify additional audiences that will benefit from the toolkit.

Data from the DFHC survey will provide private partners with information on relative risk of outbreaks and disease emergence, as well as cost of infection in men, women and children. Data from this survey could be used by private partners in collaboration with the Department of Health to inform the design of interventions to reduce the transmission of zoonoses by 1) providing standard estimates of rates of human contact with different animal species, 2) identifying populations and sub-groups with particularly high rates of contact, 3) determining which human activities are associated with particularly high rates of contact and 4) specifying other environmental and social issues that place people at increased risk of disease transmission.

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Section B - Proposed Outcomes/Results

The overall project outcome will be the development of an evidence-based model that values emerging infectious disease avoidance as a function of land use, and application of this model in real-world land use decision contexts to reduce risk of emerging infectious diseases and to mitigate climate change toward climate-resistant low emissions development. To achieve this, EcoHealth Alliance and its partners will generate two Intermediate Results and five associated Sub-Intermediate Results:

Intermediate results
Intermediate Result 1: Availability of field-trialed quantitative models capturing gender sensitive EID-related health savings as a function of land use. This will result will be generated through two sub-intermediate results:

Sub-IR 1.2: Data gathering required to run the quantitative model

Sub-IR 1.1: Development of quantitative algorithm assessing EID spillover likelihood and cost as function of land use.

Intermediate Result 2: Improved multi-channel availability of EID-focused quantitative resources amongst civil society advocates and government policy makers. This will result will be generated through three sub-intermediate results:

Sub-IR: 2.1. Establishment of a center of excellence (the Center for Development and Health (CDH)) for additional research, analysis, and cross-disciplinary partnerships

Sub-IR 2.2: Development of a gender sensitive tool kit for communicating the health impacts of differing land use options

Sub-IR 2.3: Improved outreach and communication of translated, quantitative resources to policy makers and civil society advocates.

The full objectives and sub-objectives, activities, measurable outcome or indicator, time frame, and responsible party are listed on the "Monitoring and Evaluation" table in Annex A.

At the end of the project period, we will have produced four main deliverables that satisfy the proposed IRs and sub-IRs (see Annex A). They are: 1) quantitative models of land use change and disease emergence to use in local and regional decision making and that can be generalized or modified for other applications (described in Section A of Narrative above, sub-IR 1.1 and sub-IR 1.2), 2) the Center for Development and Health at UMS to serve as a permanent Center of Excellence and platform for continued research and training, stakeholder engagement, and as a regional and national source of information on the economic relationships of land use change, disease emergence, and subject area gender-related issues (sub-IR 2.1), 3) gender-sensitive health impacts toolkits for promoting best practice approaches and translate project findings to ensure gender equality benefits (sub-IR 2.2), and 4) scientific translation communications toolkits that translate research and modeling results to be useful for policy makers, private companies and government organizations, and civil society stakeholders (sub-IR 2.3).

The final products of the modeling components have been previously described in Section A of the Narrative.

The creation of the Center for Development and Health (CDH) at UMS will sustain the Project's impacts beyond the project period. The CDH will provide an environment for experts to continually update data, refine models, and sustainably understand the impact of land use change on economic parameters. The Center operationalizes concepts developed by EcoHealth Alliance and its partners under the One Health approach, bringing together a multidisciplinary team to discover new information about the intersection of human and animal health, disease risk assessment, and ecology. By creating the Center within the Business School at UMS, we promote collaboration and innovation across disciplines and the formation of effective non-traditional partnerships.

The team at EcoHealth Alliance will work with the Center for Development and Health to develop communications toolkits and strategies for disseminating scientific findings to policymakers and key partners in industry, government and the public. The aim of these strategies is to translate the our scientific analyses into actionable policies and practices for decision makers so that they can more formally integrate infectious disease and economic considerations into land use change planning and decision-making. One example of a near-term opportunity that our team will take if this proposal is successful, is to provide input to the Sabah Economic Development and Investment Authority which has developed a blueprint for development called the Sabah Development Corridor (SDC) – coordinated multi-sectoral development roadmap through 2025. SEDIA has made a commitment to responsible development, and has called for public input into the SDC. We would have an opportunity during the first year of this program, to provide input to SEDIA for the SDC regarding considerations of the cost of health impacts of land alteration. As we develop our models, we would continue to provide information to SEDIA regarding the costs associated with potential disease outbreaks.

In addition to working with Sabah government, we will develop outreach materials for the public, focusing on gender-specific health and economic impacts of land conversion relevant to local communities where land use change activities are planned or are currently underway. Our local partners such as SWD, UMS, LEAP (Land Empowerment, Animals, People), and HUTAN have a long history of working with local communities on conservation and social welfare issues, and we will leverage their expertise and relationships with local communities to implement educational outreach strategies. This outreach strategy will significantly enhance the scientific knowledge base around ecosystem services valuation of benefits derived from intact ecosystems, especially with regard to disease risk assessment. Thus, the generation of knowledge in this area will allow for communication of evidence-based findings and actions. The policy and public outreach materials generated through the Center for Development and Health will be generalizable and adaptable to Malaysia-wide or regional policy considerations related to land use decisions.

The gender sensitive health impacts toolkit will include practical "how-to" methodologies, tools, and guides designed to facilitate the integration of gender issues into health policies and programs. It is designed for government policymakers, private industry, program managers, and community health workers to explore different strategies, media, and messages about gender and to communicate the EID-related human health impacts and economic implications of potential land use decisions.

The toolkit will provide a roadmap for translating the results of the quantitative model into actionable practices and policies. It will be designed to communicate disease risk assessment results effectively, with specific attention to unique considerations of women and their disease exposure risks. It will enable such diverse groups as civil society advocates, private industry, and government policymakers, to operationalize gender sensitive policy communication strategies. Finally, because mainstreaming gender falls under the third Millennium Goal of gender equality, and aligns with USAID goals and policies, the toolkit will highlight the importance of incorporating women into leadership and planning capacities related to land use change decisions.

The scientific translation communications toolkits for scientific findings will disseminate and translate scientific findings into actionable policies and practices for decision makers to more formally integrate infectious disease and economic considerations into land use change planning and decision-making. This outreach strategy will tie into the generation of the findings from the models, which will drastically enhance the scientific knowledge base around ecosystem services valuation of benefits derived from intact ecosystems, especially with regard to disease risk assessment. Thus, the generation of knowledge in this area will allow for communication of evidence-based findings and actions. Toolkits and/or outreach materials will be tailored to the various stakeholder audiences described above in Section A of the Narrative. Tools will also be generalized and adapted for integration in landscape land use decisions regionally and globally.

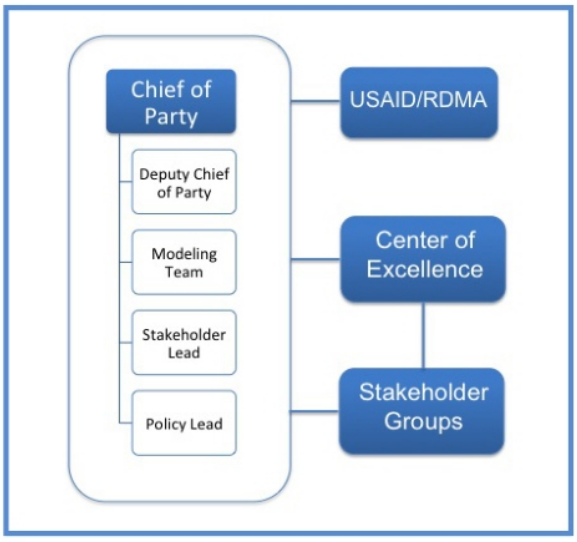
Section C - Management Plan and Key Personnel

Management Plan

EcoHealth Alliance, by charter, is structured as an alliance of partner organizations and agencies collaborating to achieve multi-disciplinary and mutually agreed upon outcome. As such, EHA's

standard operational approaches are particularly well suited for managing this program. To significantly reduce both start-up time and project costs, EHA will assign current key staff and utilize existing partnerships in the region to manage and implement the project. During the course of the project, additional local staff and partners will be identified and added with the goal of a local, sustainable center of excellence being functional by the end of the project.

Project oversight and administrative management will be provided by the EHA home office in New York and implementation of Malaysia-based activities will be managed by the Deputy Chief of Party and their team based in Kuala Lumpur and Kota Kinabalu, Malaysia. As the project will be based on a Cooperative Agreement, we envision that USAID/RDMA would also serve in providing advice and guidance to the project oversight and management team.



To facilitate this exchange of ideas, we are proposing a minimum of 1) 6-monthly in-person meetings between key project personnel and partners and USAID/RDMA staff to be held either in Bangkok or in Kota Kinabalu, 2) quarterly written reports to USAID/RDMA, and 3) monthly conference calls. These communication vehicles will also serve to augment monitoring and evaluation.

Proposed Key Personnel and their project duties are listed below. Resumes and references are provided in Annex B.

Chief of Party (CoP):
Project Responsibilities (Job Description): The CoP will provide overall management and coordination of program vision, direction and functional successes; and is responsible for the administration and integration of the entire program. To guarantee fiscal responsibility and responsiveness to the needs of the program, the CoP will review and approve budgets to ensure they are in line with the work proposed, consistent with applicable rules and guidelines and committing sufficient effort for project participants. The CoP will conduct periodic reviews with the Administrative Coordinator to assess ongoing budgetary needs and will call and lead meetings with the Senior Management Team (CoP, Deputy CoP, Stakeholder and Partners Lead, Policy Lead, and Administrative Coordinator) to assess the program's productivity and accomplishments with respect to its goals. He/she will request and conduct site visits as needed. The CoP will also directly oversee the Modeling Team and be responsible for ensuring modeling activities and products are integrated with other project components.

Proposed Individual: Dr. Peter Daszak is President of EcoHealth Alliance, a US-based organization that conducts research and outreach programs on global health, conservation and international development. Dr. Daszak's research has been instrumental in modeling, analyzing and predicting the origin and economic impact of emerging diseases. His achievements include producing the first ever global emerging disease 'hotspots' map, the design and implementation

of the DEEP FOREST Project, identification of the wildlife reservoir of SARS, identifying the causes of Nipah and Hendra virus emergence, and coining the term 'pathogen pollution'. He has 20 years' experience managing international research and outreach projects, including directing the Consortium for Conservation Medicine for 8 years, establishing EHA's formal partnership with the Malaysian Govt. 15 years ago (HERG), and launching the One Health Alliance of South Asia in 2008. Currently, Dr. Daszak leads the modeling team for the USAID EPT PREDICT program.

Deputy Chief of Party (DCoP):
Project Responsibilities (Job Description): The day-to-day management of the project in Malaysia will be the overall responsibility of the DCoP, performed with regular communications and assistance of the other key personnel, the administrative staff from the home office, the Center of Excellence in Sabah and other key partners. The DCoP will serve as the most frequent Point of Contact for USAID RDMA for programmatic matters, the Center of Excellence and key partners in Malaysia. The DCoP will divide his/her time between Sabah, peninsula Malaysia and Bangkok as needed to interact with partners and supervise activities.
Proposed Individual: (b)(6) is currently the Malaysian (b)(6) at EcoHealth Alliance. His responsibilities include setting up and running the Study of Zoonotic Infections among Persons Exposed to Wild Animals, a collaborative research project with Global Viral and the Malaysian Government. In Malaysia, (b)(6) has worked closely with partners from the Ministry of Health, the Department of Wildlife and National Parks, and the Department of Veterinary Services, over the last 8 years to develop personnel and laboratory capacity and establish sustainable disease surveillance systems for wildlife and people with high exposure to wildlife. In the last two years (b)(6) has established the EHA Deep Forest Project in Sabah, a study of the effects of land use change on viral diversity. In 2010, (b)(6) became the PREDICT Malaysia (b)(6) for USAID's Emerging Pandemic Threats program. The aim of this research is to integrate wildlife disease surveillance into the public health infrastructure in order to create an early warning system for potential zoonotic disease spillover into domestic animals and humans. In Malaysia, (b)(6) is working closely with partners from the Ministry of Health, the Department of Wildlife and National Parks, the Department of Veterinary Services, Sabah Wildlife Department and local universities.

Stakeholder Coordination Lead (SCL):
Project Responsibilities (Job Description): The SCL will work with Malaysian National and State government authorities and private sector parties to identify, engage and maintain working relationships with relevant stakeholders throughout the life of the project. The SCL will ensure high level integration of project activities and products with stakeholder and partner needs and priorities, help develop and implement workshops with the DCOP and the Center for Development and Health, provide consistency in approaches across the project, and provide the oversight for sustainable transition of relevant activities to partners by the end of the project.

Proposed Individual: (b)(6) of Conservation Medicine at EcoHealth Alliance where he has managed projects on the emergence of Nipah and Ebola virus, SARS, MERS, and other zoonotic diseases within Asia and Africa. (b)(6) has directed US government-funded EHA programs in Malaysia since 2003 including a study of the ecology of Nipah virus, and is currently the (b)(6) for PREDICT. He has brought together diverse stakeholders, including government agencies, universities and NGO's

across multiple countries in South Asia to lead the One Health Association of South Asia, and currently directs two other multi-disciplinary and multi-stakeholder groups, EcoHealth Net and the Consortium for Conservation Medicine.

Policy Leader (PL):
Project Responsibilities (Job Description): The PL will be responsible for identifying opportunities and strategies for program outcomes to serve as guidance for policy and best practices among government and non-governmental stakeholders in Sabah, Malaysia, and regionally as appropriate. The SL will meet with high-level government agency representatives to share finding and discuss opportunities for policy engagement. The SL will also share findings and policy opportunities with international and inter-governmental organizations and agencies such as the World Bank, WHO, FAO, OIE, CGIAR, and bi-lateral aid agencies

(b)(6)

Proposed Individual: (b)(6)
at EcoHealth Alliance.
(b)(6) serves on the World Health Organization's (WHO) International Health Regulations Roster of Experts focused on the human-animal interface and wildlife health. He also serves as the president of the World Animal Health Organization (OIE) Working Group on Wildlife Diseases and also chairs the International Union for the Conservation of Nature (IUCN) Wildlife Health Specialist Group, a network of wildlife and health experts around the world. Currently, (b)(6) for the USAID Emerging Pandemic Threats PREDICT program.

Proposed Key Technical Personnel

Center of Excellence Director: (b)(6)
(b)(6)

Center of Excellence Associate: (b)(6)
(b)(6)

Sabah Wildlife Department Chief Liaison to IDEEAL: (b)(6)
(b)(6)

Economic Modeler: (b)(6)

(b)(6)

Social Science Lead: (b)(6)

(b)(6)

DEEP FOREST Liaison: (b)(6)

(b)(6)

Senior Modeler: (b)(6)

(b)(6)

Program Coordinator for Health and Policy: (b)(6)

(b)(6)

ANNEX A: Implementation Work Plan, Monitoring and Evaluation plan and Time Line

We will use the proposed (and negotiated) monitoring and evaluation (M&E) plan to provide the structure for project management oversight and determining adherence to timelines for activities and deliverables. In designing the M&E plan for this project, EHA and partners based in Sabah, Malaysia have combined relevant USAID agency indicators with our experience working on disease and economic modeling projects, as well as long-term stakeholder engagement in the state, to develop project indicators that quantitatively (employing numerical indicators, as well as binary classifications where appropriate) demonstrate how the proposed work plan will contribute to the two intermediate results, five sub-intermediate results, and the overall project outcome. The proposed performance-based M&E plan aims to be consistent with the evaluation requirement features outlined in the USAID Evaluation Policy. EHA will deliver a draft Performance Management Plan within sixty days following the award, during which it will work with USAID/RDMA to further refine the proposed M&E plan. The M&E plan will be revised as necessary with RDMA through the annual work plan development to ensure consistency with any changes to standard indicators.

EcoHealth Alliance will oversee M&E activities for the project. Monitoring systems will be established that enable regular tracking of indicators and will include compilation of information from quarterly reports of project activities and employment of project management systems to pair activities and indicators with timelines. Each activity will also be assigned a lead point of contact responsible for tracking the progress of the activity and helping to proactively identify and respond to any situations that could cause potential delays in meeting planned time frames. The project's Primary Investigators will also conduct monthly meetings with project personnel for updates on the progress of each activity. In addition, EcoHealth Alliance will submit quarterly reports to RDMA, and will provide verbal updates at semi-annual meetings at RDMA headquarters or at facility site visits. These opportunities will assist in providing additional assessment of progress towards meeting intermediary and overall objectives. All evaluation data generated from the project will be provided to USAID monitoring and evaluation systems as directed by the Agreement Officer's Technical Representative (AOTR).

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
Structure project and establish management capacity	0.1 Secure core management staff	All Management staff hired and assigned to duty	EHA	X											
	0.2 Identify and secure core administrative staff	All Administrative staff hired and assigned to duty	EHA	X											
	0.3 Finalize and establish approved monitoring and evaluation plan with RDMA	Monitoring and evaluation plan approved and finalized	EHA	X											
	0.4 Set up of financial management systems	Accounts created with mechanisms for tracking expenditures		X											
	0.5 Quarterly	On-time submission of	EHA	X	X	X	X	X	X	X	X	X	X	X	X

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
	activities														
	0.6 Semi-annual review of program activities and progress at RDMA or during site visits to Sabah	Completion at RDMA headquarters or site visit	RDMA and EHA		X		X		X		X		X		X
Sub-IR 1.2: Required data gathered to run the quantitative model	1.2.1 Meet with relevant partners to identify data availability	Meeting held; list of available data assembled	EHA	X	X	X	X								
	1.2.2 Obtain available temporal, geospatial data of land use/land-cover	a. Temporal, geospatial land-use/land-cover data obtained	EHA	X	X	X	X								
		b. Disease data obtained	EHA	X	X	X	X								

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
	and disease data														
	1.2.3 Obtain available demographic and land planning data from relevant government sources and partners	Available demographic and land planning data obtained	EHA			X	X								
	1.2.4 Obtain available economic parameter/indicator data	Available economic parameter/indicator data obtained	EHA	X	X	X	X								
	1.2.5 Identify and obtain data to correct for reporting bias	Data to correct for reporting bias identified and obtained	EHA	X	X	X	X								

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
	1.2.6 Obtain new data, including DEEP FOREST human contact and disease data	New data obtained	EHA	X	X	X	X								
	1.2.7 Ensure gender-specified data is included in activities 1.2.2-1.2.6	Gender-specified data is included	EHA	X	X	X	X								
Sub-IR 1.1: Development of quantitative algorithm assessing EID spillover likelihood and	1.1.1 Estimate the likelihood of EID outbreaks	Bayesian, count-data models for different temporal and spatial scales developed	EHA		X	X	X	X							
	1.1.2 Determine the value of avoided damages from	Value of avoided damages determined	EHA		X	X	X	X							

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
cost as function of land use	past EID events														
	1.1.3 Create a model to predict expected damages of future disease events	Model to predict damages created	EHA			X	X	X							
	1.1.4.a. Determine rates of land-use/land cover change under 3 different scenarios—Business as Usual (BAU), Increased land-use change, halted land-use change	Three scenario models created	EHA			X	X	X	X						

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
	1.1.4.b. Use expected damages function to predict damages under deforestation scenarios	Expected damages under deforestation scenarios predicted	EHA			X	X	X	X	X					
	1.1.5 Investigate incorporation of avoided damages into total ecosystem services model	Integration with total ecosystem services model explored	EHA						X	X	X	X	X		
	1.1.6 Produce actionable model outputs and analyses for application in promoting	Models produced and scientific translation communications toolkit produced (see 2.3.2)	EHA					X	X	X	X	X	X		

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
	reduced-impact land utilization														
Sub-IR 2.1: Establishment of a center of excellence, for additional research, analysis, and crossdisciplinary partnerships	2.1.1 Establish Center for Development and Health (CDH) at the School of Economics and Business at University Malaysia, Sabah	a. Concept developed and agreed upon	UMS and EHA	X											
		b. CDH established	UMS and EHA	X	X										
	2.1.2 Select local or regional graduate students for involvement	Graduated students selected	UMS/CDH			X		X				X			
	2.1.3 Develop and oversee	Completed student projects submitted to the	UMS/CDH and				X		X		X		X		X

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
	student projects to promote use of spatial analysis, health outcome and economic models	CDH / UMS faculty	EHA												
	2.1.4 Develop short-courses around LUCDEP themes	Short-course developed	UMS/CDH and EHA							X	X	X	X	X	X
	2.1.5 Identify stakeholders for participation in the Center with help from UMS and SWD	Stakeholders identified	UMS/CDH, SWD and EHA	X	X	X	X	X	X	X	X	X	X	X	X
	2.1.6 Establish regular	a. Meetings held	UMS/CDH												

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
	meetings, including quarterly roundtables at the CDH for stakeholders for public dissemination of materials and information	b. Meeting schedule established	UMS/CDH	X	X	X	X	X	X	X	X	X	X	X	X
Sub-IR 2.2: Development of a gender sensitive tool kit for communicating the health impacts of	2.2.1 Conduct survey of differential gendered disease risk exposure pathways to inform toolkit development and dissemination	Survey(s) conducted	UMS/CDH and EHA		X	X	X								

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
differing land use options	strategies														
	2.2.2 Integrate findings from quantitative models and additional data		UMS/CDH and EHA						X	X	X	X	X		
	2.2.3 Generate draft toolkit	Draft toolkit developed	UMS/CDH and EHA							X	X				
	2.2.4 Conduct external review of toolkit by stakeholder representatives, including focus group involvement to generate feedback on	External review conducted and feedback compiled into broad themes and actionable modifications	UMS/CDH and EHA								X				

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
	gender sensitivity and utility to stakeholders														
	2.2.5 Finalize tookit	Incorporate feedback into tookit to generate final version	UMS/CDH and EHA								X				
	2.2.6 Develop an outreach plan to share gender-sensitive health impacts toolkit with the public as well as with government agencies, civil society, and the private sector (link to sub-IR	Outreach plan developed	UMS/CDH and EHA							X	X				

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
	2.3)														
Sub-IR 2.3: Improved outreach and communication of translated, quantitative resources to policy makers and civil society advocates	2.3.1 Establish regular meetings, including quarterly roundtables at the CDH for stakeholders engagement in design and production of outreach materials	a. Meetings held	UMS/CDH	X	X	X	X	X	X	X	X	X	X	X	X
		b. Number of unique stakeholder organizations	UMS/CDH	X	X	X	X	X	X	X	X	X	X	X	X
		c. Number of individual sectors	UMS/CDH	X	X	X	X	X	X	X	X	X	X	X	X
	2.3.2 Develop printed and web-based materials for	Scientific translation communications toolkit produced	EHA, UMS/CDH, SWD							X	X				

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
	dissemination to community leaders, industry leaders, and government partners														
	2.3.3 Develop dissemination strategy for outreach materials including scientific translation communications toolkit in consultation with stakeholders	Dissemination strategy developed	EHA, UMS/CDH, SWD							X	X				

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
	2.3.4 Disseminate outreach materials and toolkits to community leaders	a. Outreach materials and toolkits disseminated to communities	EHA, UMS/CDH, SWD									X	X	X	X
		b. Town hall meeting public fora held	EHA, UMS/CDH, SWD									X	X	X	X
	2.3.5 Develop website and social media platforms	Platforms developed; usage monitored by visits/followers	UMS/CDH and EHA			X	X	X	X	X	X	X	X	X	X
	2.3.6 Design and deliver short-term training programs (in person and/or online) to address immediate needs of	Per-session person counts (in-person counts, or IP address counts for online training)	UMS/CDH and EHA							X	X	X	X	X	X

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
	existing professionals to increase their knowledge and capacity in the area of land use change														
	2.3.7 Conduct workshops for SWD and other relevant local gove't staff in use of toolkits and other outreach materials	Number of workshop attendees	UMS/CDH and EHA							X	X	X	X	X	X
	2.3.8 Evaluate stakeholder awareness of issues of land use change, risk	Baseline and follow-up surveys conducted	UMS/CDH and EHA	X										X	

IDEEAL Work Plan and Time Line				Time line											
Objective / Result	**Activity**	**Measurable Outcome or Indicator**	**Responsible Party**	**Y1Q1**	**Y1Q2**	**Y1Q3**	**Y1Q4**	**Y2Q1**	**Y2Q2**	**Y2Q3**	**Y2Q4**	**Y3Q1**	**Y3Q2**	**Y3Q3**	**Y3Q4**
	of disease emergence, and gender implications														

IDEEAL Monitoring and Evaluation Plan					
Objective/Result	**Sub-IR**	**Activity**	**Measurable Outcome or Indicator**	**Time frame**	**Responsible Party**
Structure project and establish management capacity		0.1 Secure core management staff	All Management staff hired and assigned to duty	Y1 Q1	EHA
		0.2 Identify and secure core administrative staff	All Administrative staff hired and assigned to duty	Y1 Q1	EHA
		0.3 Finalize and establish approved monitoring and evaluation plan with RDMA	Monitoring and evaluation plan approved and finalized	60 days after award	EHA
		0.4 Set up of financial management systems	Accounts created with mechanisms for tracking expenditures	Y1 Q1	
		0.5 Quarterly reporting of overall program activities	On-time submission of reports	Quarterly	EHA
		0.6 Semi-annual review of program activities and progress at RDMA or during site visits to Sabah	Completion at RDMA headquarters or site visit	Semi-annually	RDMA and EHA
Objective 1: Creation of field-trialed	**Sub-IR 1.2: Required data gathered**	1.2.1 Meet with relevant partners to identify data availability	Meeting held; list of available data assembled	Y1	EHA

IDEEAL Monitoring and Evaluation Plan					
Objective/Result	**Sub-IR**	**Activity**	**Measurable Outcome or Indicator**	**Time frame**	**Responsible Party**
quantitative models capturing gender sensitive EID-related health savings as a function of land use	**to run the quantitative model**	1.2.2 Obtain available temporal, geospatial data of land use/land-cover and disease data	a. Temporal, geospatial land-use/land-cover data obtained	Y1	EHA
			b. Disease data obtained	Y1	EHA
		1.2.3 Obtain available demographic and land planning data from relevant government sources and partners	Available demographic and land planning data obtained	Y1 Q3 - Q4	EHA
		1.2.4 Obtain available economic parameter/indicator data	Available economic parameter/indicator data obtained	Y1	EHA
		1.2.5 Identify and obtain data to correct for reporting bias	Data to correct for reporting bias identified and obtained	Y1	EHA
		1.2.6 Obtain new data, including DEEP FOREST human contact and disease data	New data obtained	Y1	EHA
		1.2.7 Ensure gender-specified data is included in activities 1.2.2-1.2.6	Gender-specified data is included	Y1	EHA

IDEEAL Monitoring and Evaluation Plan					
Objective/Result	**Sub-IR**	**Activity**	**Measurable Outcome or Indicator**	**Time frame**	**Responsible Party**
	Sub-IR 1.1: Development of quantitative algorithm assessing EID spillover likelihood and cost as function of land use	1.1.1 Estimate the likelihood of EID outbreaks	Bayesian, count-data models for different temporal and spatial scales developed	Y1 Q2 - Y2 Q1	EHA
		1.1.2 Determine the value of avoided damages from past EID events	Value of avoided damages determined	Y1 Q2 - Y2 Q1	EHA
		1.1.3 Create a model to predict expected damages of future disease events	Model to predict damages created	Y1 Q3 - Y2 Q1	EHA
		1.1.4.a. Determine rates of land-use/land cover change under 3 different scenarios—Business as Usual (BAU), Increased land-use change, halted land-use change	Three scenario models created	Y1 Q3 - Y2 Q2	EHA
		1.1.4.b. Use expected damages function to predict damages under deforestation scenarios	Expected damages under deforestation scenarios predicted	Y1 Q3 - Y2 Q3	EHA
		1.1.5 Investigate incorporation of avoided damages into total ecosystem services model	Integration with total ecosystem services model explored	Y2 Q2 - Y3 Q2	EHA

IDEEAL Monitoring and Evaluation Plan					
Objective/Result	**Sub-IR**	**Activity**	**Measurable Outcome or Indicator**	**Time frame**	**Responsible Party**
		1.1.6 Produce actionable model outputs and analyses for application in promoting reduced-impact land utilization	Models produced and scientific translation communications toolkit produced (see 2.3.2)	Y2 Q1 - Y3 Q2	EHA
Objective 2: Improved multi-channel availability of EID-focused quantitative resources amongst civil society advocates and government policy makers	**Sub-IR 2.1: Establishment of a center of excellence, for additional research, analysis, and crossdisciplinary partnerships**	2.1.1 Establish Center for Development and Health (CDH) at the School of Economics and Business at University Malaysia, Sabah	a. Concept developed and agreed upon	Y1 Q1	UMS and EHA
			b. CDH established	Y1 Q1 - Q2	UMS and EHA
		2.1.2 Select local or regional graduate students for involvement	Graduated students selected	Y1 Q 3	UMS/CDH
		2.1.3 Develop and oversee student projects to promote use of spatial analysis, health outcome and economic models	Completed student projects submitted to the CDH / UMS faculty	Y1 Q3 - Y3	UMS/CDH and EHA
		2.1.4 Develop short-courses around LUCDEP themes	Short-course developed	Y2 Q3 - Y3	UMS/CDH and EHA
		2.1.5 Identify stakeholders for participation in the Center with help from UMS and SWD	Stakeholders identified	Ongoing	UMS/CDH, SWD and EHA

IDEEAL Monitoring and Evaluation Plan					
Objective/Result	**Sub-IR**	**Activity**	**Measurable Outcome or Indicator**	**Time frame**	**Responsible Party**
		2.1.6 Establish regular meetings, including quarterly roundtables at the CDH for stakeholders for public dissemination of materials and information	a. Meetings held		UMS/CDH
			b. Meeting schedule established	Quarterly	UMS/CDH
	Sub-IR 2.2: Development of a gender sensitive tool kit for communicating the health impacts of differing land use options	2.2.1 Conduct survey of differential gendered disease risk exposure pathways to inform toolkit development and dissemination strategies	Survey(s) conducted	Y1 Q2 - Q4	UMS/CDH and EHA
		2.2.2 Integrate findings from quantitative models and additional data	see next step	Y2 Q2 - Y3 Q2	UMS/CDH and EHA
		2.2.3 Generate draft toolkit	Draft toolkit developed	Y2 Q3 - Q4	UMS/CDH and EHA
		2.2.4 Conduct external review of toolkit by stakeholder representatives, including focus group involvement to generate feedback on gender sensitivity	External review conducted and feedback compiled into broad themes and actionable modifications	Y2 Q4	UMS/CDH and EHA

IDEEAL Monitoring and Evaluation Plan					
Objective/Result	**Sub-IR**	**Activity**	**Measurable Outcome or Indicator**	**Time frame**	**Responsible Party**
		and utility to stakeholders			
		2.2.5 Finalize tookit	Incorporate feedback into tookit to generate final version	Y2 Q4	UMS/CDH and EHA
		2.2.6 Develop an outreach plan to share gender-sensitive health impacts toolkit with the public as well as with government agencies, civil society, and the private sector (link to sub-IR 2.3)	Outreach plan developed	Y2 Q3 - Q4	UMS/CDH and EHA
	Sub-IR 2.3: Improved outreach and communication of translated, quantitative resources to policy makers and civil society advocates	2.3.1 Establish regular meetings, including quarterly roundtables at the CDH for stakeholders engagement in design and production of outreach materials	a. Meetings held	Quarterly	UMS/CDH
			b. Number of unique stakeholder organizations	Quarterly	UMS/CDH
			c. Number of individual sectors	Quarterly	UMS/CDH
		2.3.2 Develop printed and web-based materials for dissemination to community leaders, industry leaders, and	Scientific translation communications toolkit produced	Y2 Q3 - Q4	EHA, UMS/CDH, SWD

IDEEAL Monitoring and Evaluation Plan					
Objective/Result	**Sub-IR**	**Activity**	**Measurable Outcome or Indicator**	**Time frame**	**Responsible Party**
		government partners			
		2.3.3 Develop dissemination strategy for outreach materials including scientific translation communications toolkit in consultation with stakeholders	Dissemination strategy developed	Y2 Q3 - Q4	EHA, UMS/CDH, SWD
		2.3.4 Disseminate outreach materials and toolkits to community leaders	a. Outreach materials and toolkits disseminated to communities	Y3 Q1 - Q4	EHA, UMS/CDH, SWD
			b. Town hall meeting public fora held	Y3 Q1 - Q4	EHA, UMS/CDH, SWD
		2.3.5 Develop website and social media platforms	Platforms developed; usage monitored by visits/followers	Y1 Q3	UMS/CDH and EHA
		2.3.6 Design and deliver short-term training programs (in person and/or online) to address immediate needs of existing professionals to increase their knowledge	Per-session person counts (in-person counts, or IP address counts for online training)	Y2 Q3 - Y3 Q4	UMS/CDH and EHA

IDEEAL Monitoring and Evaluation Plan					
Objective/Result	**Sub-IR**	**Activity**	**Measurable Outcome or Indicator**	**Time frame**	**Responsible Party**
		and capacity in the area of land use change			
		2.3.7 Conduct workshops for SWD and other relevant local gove't staff in use of toolkits and other outreach materials	Number of workshop attendees	Y2 Q3 - Y3 Q4	UMS/CDH and EHA
		2.3.8 Evaluate stakeholder awareness of issues of land use change, risk of disease emergence, and gender implications	Baseline and follow-up surveys conducted	Y1 Q1 and Y3 Q3	UMS/CDH and EHA

ANNEX B: PERSONNEL

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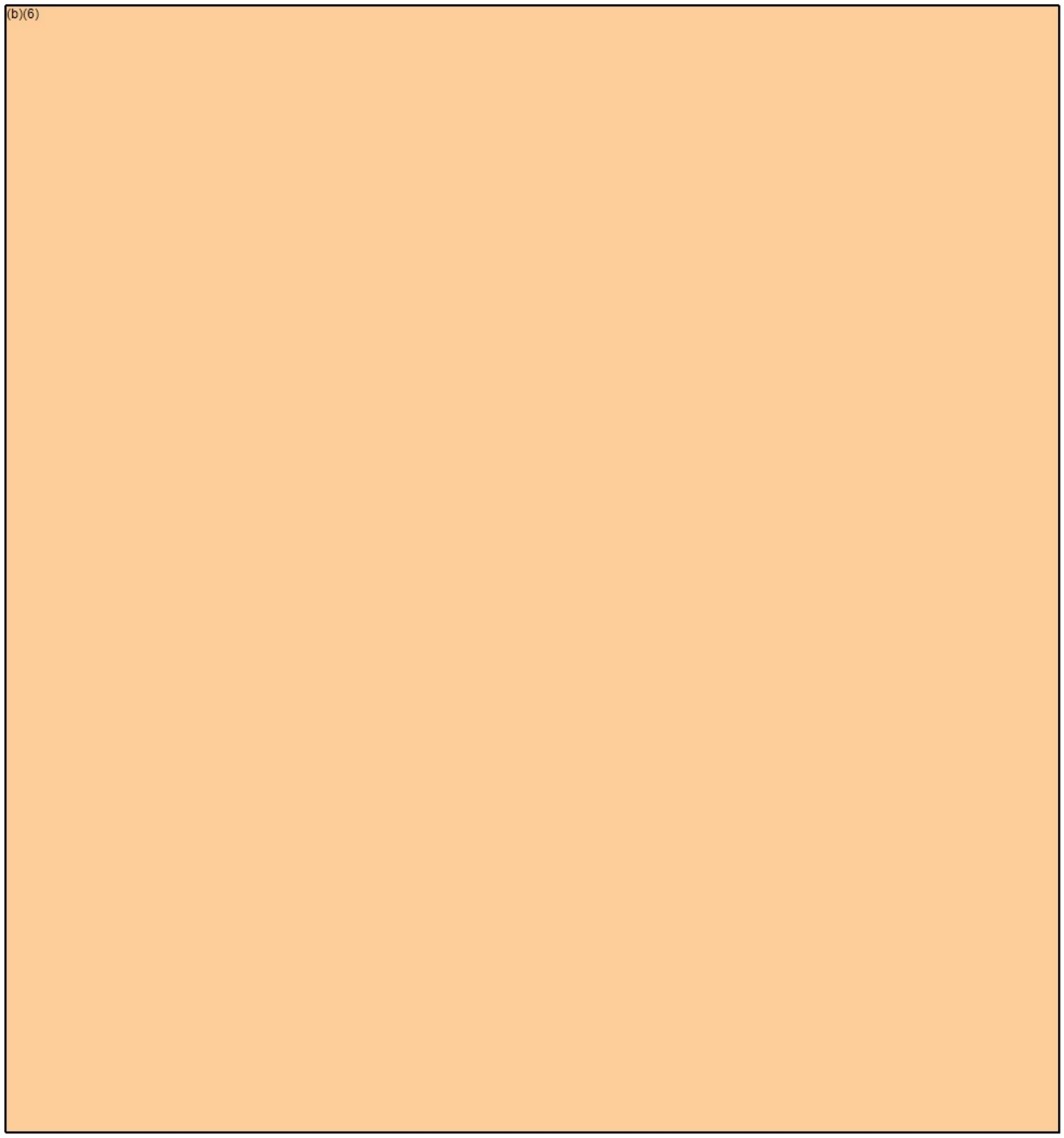

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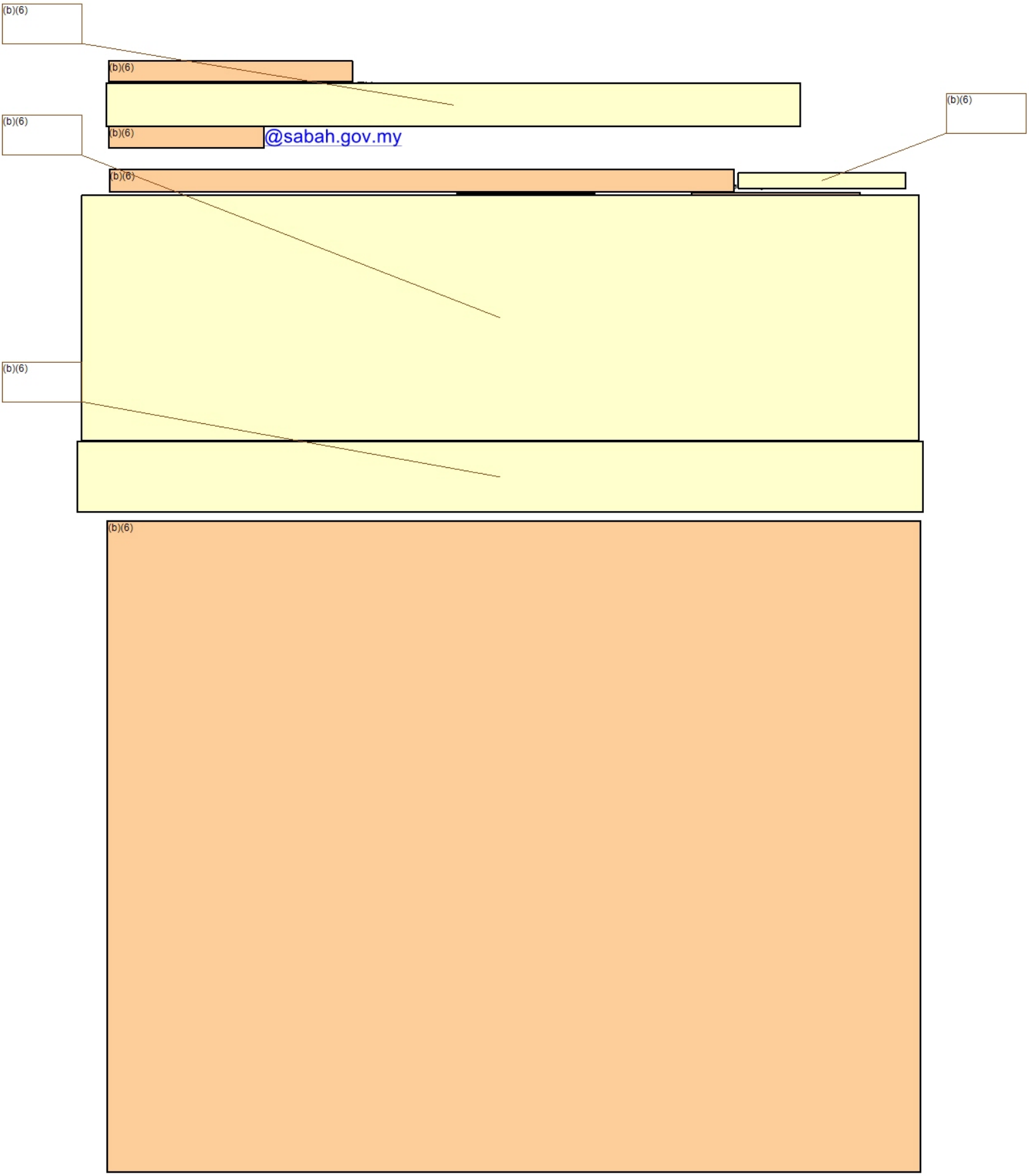
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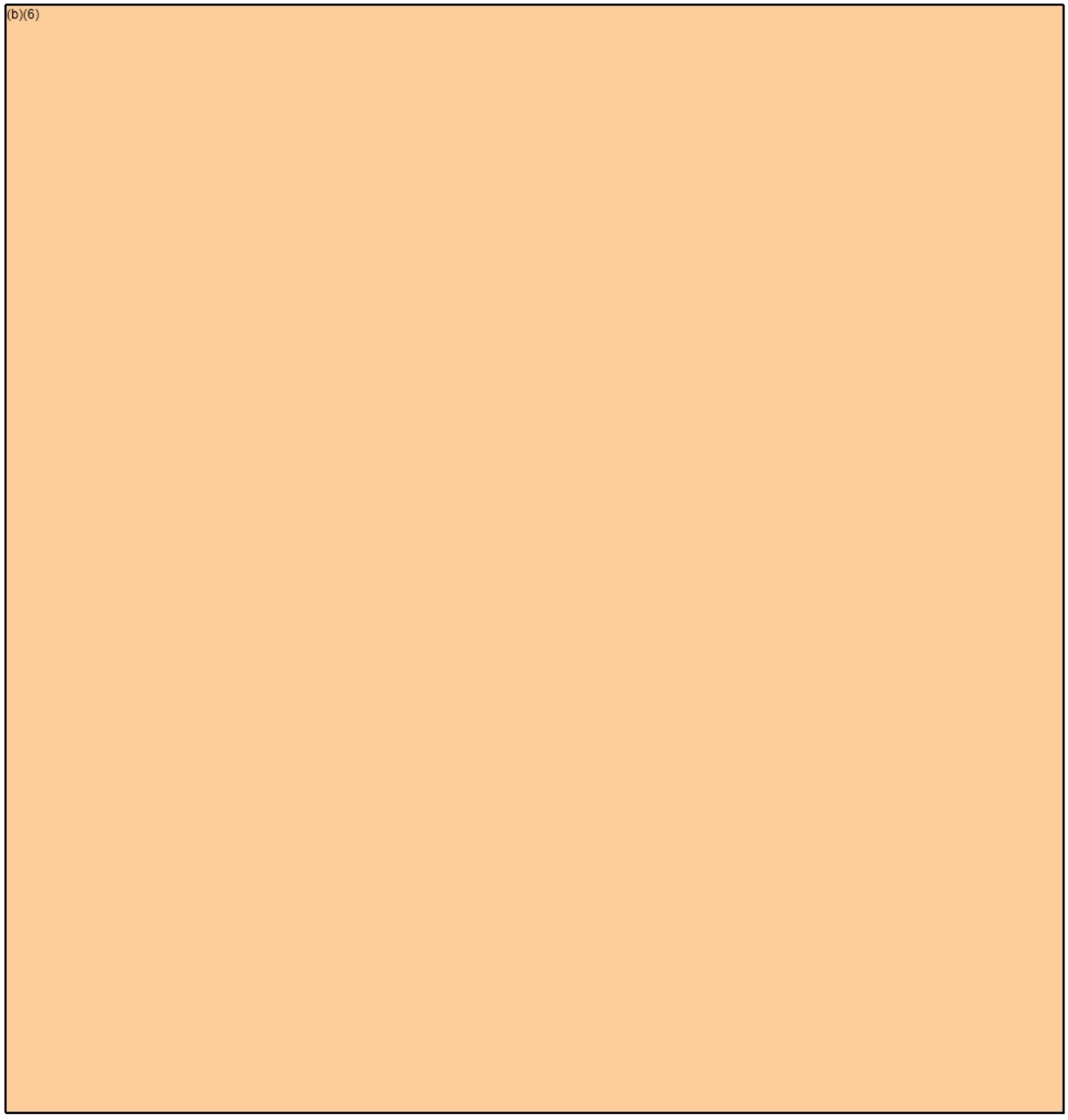

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Page 203 of 253

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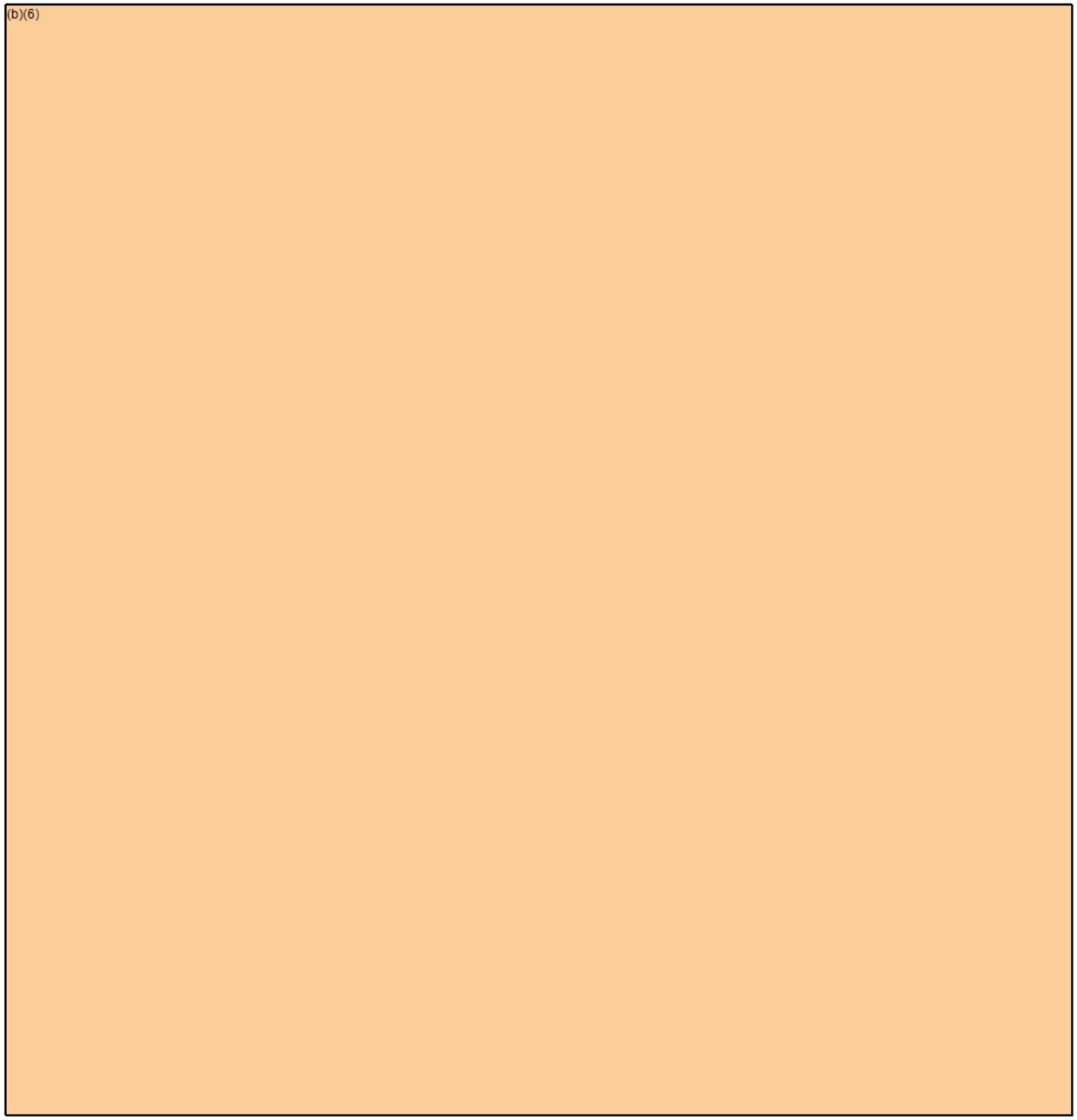

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Page 212 of 253

Withheld pursuant to exemption

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of the Freedom of Information and Privacy Act

EcoHealth Alliance

May 21, 2013

To Whom it May Concern:

I, Peter Daszak, hereby confirm my availability to serve as Chief of Party (CoP) within the same day following awarding of the proposed project for the USAID/RDMA Program entitled "Land Use Change and Disease Emergence: Promoting Valuation of Environmental Services in Furtherance of Public Health and Sustainable Landscapes". I intend to serve in this role for the entirety of the proposed project (three years following the start of the project). I agree to the compensation levels which correspond to the levels set forth in the cost application.

Sincerely,

Peter Daszak, PhD

President

EcoHealth Alliance

460 West 34th Street – 17th floor

New York, NY 10001

1.212.380.4473 (direct)

1.212.380.4465 (fax)

Daszak@ecohealthalliance.org

www.ecohealthalliance.org

EcoHealth Alliance integrates innovative science-based solutions and partnerships that increase capacity to achieve two interrelated goals: protecting global health by preventing the outbreak of emerging diseases and safeguarding ecosystems by promoting conservation.

EcoHealth Alliance

May 21, 2013

(b)(6)

To Whom it May Concern:

I, (b)(6), hereby confirm my availability to serve a [redacted] within the same day following awarding of the proposed project for the USAID/RDMA Program entitled "Land Use Change and Disease Emergence: Promoting Valuation of Environmental Services in Furtherance of Public Health and Sustainable Landscapes". I intend to serve in this role for the entirety of the proposed project (three years following the start of the project). I agree to the compensation levels which correspond to the levels set forth in the cost application.

Sincerely,

(b)(6)

– Malaysia

EcoHealth Alliance

(b)(6)

(b)(6), Kuala Lumpur, Malaysia.

(b)(6)

(b)(6)@ecohealthalliance.org www.ecohealthalliance.org

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EcoHealth Alliance

May 21, 2013

(b)(6)

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New York, NY 10001

(b)(6)

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EcoHealth Alliance

May 21, 2013

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EcoHealth Alliance

460 West 34th Street - 17th Floor

New York, NY 10001 USA

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UNIVERSITI MALAYSIA SABAH

Sekolah Perniagaan & Ekonomi
School of Business & Economics

CERTIFIED TO ISO9001:2000 CERT. NO: AR 3088

Ruj. Kami :

Tarikh : Wednesday, 22 May 2013

Peter Daszak
President, EcoHealth Alliance
460 West 34th Street – 17th floor
New York, NY 10001
USA

Dear Dr. Daszak,

I, and the School of Business and Economics will be pleased to collaborate exclusively on the application being led by EcoHealth Alliance to implement the USAID Land Use Change and Disease Emergence program should our team be chosen by USAID to conduct the work. Should EcoHealth Alliance be successful in its application, I have agreed to participate in activities associated with this project including acting as a resource for information and insight based on my expertise, helping to establish a communication and information sharing platform, and assisting in identifying and locating relevant and available data sets, to help achieve the aims of this project. I will also participate in occasional meetings at local partner institutions to discuss findings of this study, strategies for educational outreach and dissemination of findings, and advise or participate in graduate student training activities.

This letter conveys my interest and commitment to making this initiative a success. We look forward to working with EcoHealth Alliance, the Sabah Wildlife Department, and USAID on this important project.

Sincerely,

(b)(6)

22 May, 2013
Universiti Malaysia Sabah

UNIVERSITI MALAYSIA SABAH
Sekolah Perniagaan & Ekonomi
School of Business & Economics

CERTIFIED TO ISO9001:2000 CERT. NO: AR 3088

Ruj. Kami :

Tarikh : Wednesday, 22 May 2013

Peter Daszak
President, EcoHealth Alliance
460 West 34th Street – 17th floor
New York, NY 10001
USA

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This letter conveys my interest and commitment to making this initiative a success. We are excited to be involved in this effort to develop evidence-based tools for utilization in reducing deforestation, associated carbon emissions, and risk of disease emergence. We look forward to working with EcoHealth Alliance, Sabah Wildlife Department, and USAID on this important project.

Sincerely,

(b)(6)

22 May, 2013
Universiti Malaysia Sabah

JABATAN HIDUPAN LIAR SABAH
(SABAH WILDLIFE DEPARTMENT)
Blok B, Tingkat 5, Wisma MUIS
(Block B, 5th Floor, MUIS Building)
88100 SEMBULAN, KOTA KINABALU
TEL: 088-215353, 215330, 215167 FAX: 088-222476

Peter Daszak
President, EcoHealth Alliance
460 West 34th Street – 17th floor
New York, NY 10001
USA

21st May 2013

Dear Dr. Daszak,

I, and the Sabah Wildlife Department, will be very pleased to collaborate exclusively on the application being led by EcoHealth Alliance to implement the USAID Land Use Change and Disease Emergence program should our team be chosen by USAID to conduct the work. Should EcoHealth Alliance be successful in its application, I have agreed to participate in activities associated with this project including acting as a resource for information and insight, based on my expertise, including assisting in identifying and locating relevant and available data sets, to help achieve the aims of this project. I will also participate in occasional meetings at local partner institutions to discuss findings of this study, strategies for educational outreach and dissemination of findings, and advise or participate in graduate student training activities.

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(b)(6)

Sabah Wildlife Department
MALAYSIA

DADAH MEMBAWA KESENGSARAAN
PELIHARALAH KEHARMONIAN KELUARGA ANDA

References for Key Personnel

Dr. Peter Daszak

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- (b)(4)
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  Fax:

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  Phone: (b)(6)
  Fax: (b)(6)

ANNEX C – Institutional Capabilities/Partnerships
Project oversight and administrative management will be provided by the EHA home office in New York and implementation of Malaysia based activities will be managed by the Deputy Chief of Party and his/her team based in Kuala Lumpur and Kota Kinabalu. As the project will be based on a Cooperative Agreement, we envision that USAID/RDMA would also serve in providing advice and guidance to the project oversight and management team. Personnel Proposed and their project duties are listed below. Resumes and references are provided in Appendix B.

Chief of Party: Dr. Peter Daszak (16.6% time)
The CoP will provide overall management and coordination of program vision, direction and functional successes; and is responsible for the administration and integration of the entire program. To guarantee fiscal responsibility and responsiveness to the needs of the program, the CoP will review and approve budgets to ensure they are in line with the work proposed, consistent with applicable rules and guidelines and committing sufficient effort for project participants. The CoP will conduct periodic reviews with the Administrative Coordinator to assess ongoing budgetary needs and will call and lead meetings with the Senior Management Team (CoP, Deputy CoP, Stakeholder and Partners Lead, Policy Lead, and Administrative Coordinator) to assess the program's productivity and accomplishments with respect to its goals. He will request and conduct site visits as needed. The CoP will also directly oversee the Modeling Team and be responsible for ensuring modeling activities and products are integrated with other project components.

Dr. Peter Daszak is President of EcoHealth Alliance, a US-based organization that conducts research and outreach programs on global health, conservation and international development. Dr. Daszak's research has been instrumental in modeling, analyzing and predicting the origin and economic impact of emerging diseases. His achievements include producing the first ever global emerging disease 'hotspots' map, the design and implementation of the DEEP FOREST Project, identification of the wildlife reservoir of SARS, identifying the causes of Nipah and Hendra virus emergence, and coining the term 'pathogen pollution'. He has 20 years' experience managing international research and outreach projects, including directing the Consortium for Conservation Medicine for 8 years, establishing EHA's formal partnership with the Malaysian Govt. in 2001 (HERG), and launching the One Health Alliance of South Asia in 2008. Currently, Dr. Daszak leads the modeling team for the USAID EPT PREDICT program.

(b)(6)

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(b)(6) **(100% time or phased change-over from PREDICT duties as negotiated with USAID/RDMA)**
The day-to-day management of the project in Malaysia will be the overall responsibility of the performed with regular communications and assistance of the other key personnel, the administrative staff from the home office, the Center of Excellence in Sabah and other key partners. The will serve as the most frequent Point of Contact for USAID RDMA for programmatic matters, the Center of Excellence and key partners in Malaysia. The will divide his/her time between Sabah, peninsula Malaysia and Bangkok as needed to interact with partners and supervise activities.

(b)(6) is currently the Malaysian (b)(6) at EcoHealth Alliance. His responsibilities include setting up and running the Study of Zoonotic Infections among Persons Exposed to Wild Animals, a collaborative research project with Global Viral and the Malaysian Government. In Malaysia, (b)(6) has worked closely with partners from the Ministry of Health, the Department of Wildlife and National Parks, and the Department of Veterinary Services, over the last 8 years to develop personnel and laboratory capacity and establish sustainable disease surveillance systems for wildlife and people with high exposure to wildlife. In the last two years (b)(6) has established the EHA Deep Forest Project in Sabah, a study of the effects of land use change on viral diversity. In 2010, Tom became the PREDICT Malaysia (b)(6) for USAID's Emerging Pandemic Threats program. The aim of this research is to integrate wildlife disease surveillance into the public health infrastructure in order to create an early warning system for potential zoonotic disease spillover into domestic animals and humans. In Malaysia, (b)(6) is working closely with partners from the Ministry of Health, the Department of Wildlife and National Parks, the Department of Veterinary Services, Sabah Wildlife Department and local universities.

Stakeholder Coordination Lead (SCL): (b)(6) (8.3%)
Project Responsibilities (Job Description): The SCL will work with Malaysian National and State government authorities and private sector parties to identify, engage and maintain working relationships with relevant stakeholders throughout the life of the project. The SCL will ensure high level integration of project activities and products with stakeholder and partner needs and priorities, help develop and implement workshops with the DCOP and the Center for Development and Health, provide consistency in approaches across the project, and provide the oversight for sustainable transition of relevant activities to partners by the end of the project.

(b)(6) at EcoHealth Alliance where he has managed projects on the emergence of Nipah and Ebola virus, SARS, MERS, and other zoonotic diseases within Asia and Africa. (b)(6) has directed US government-funded EHA programs in Malaysia since 2003 including a study of the ecology of Nipah virus, and is currently the Asia Regional Coordinator for PREDICT. He has brought together diverse stakeholders, including government agencies, universities and NGO's across multiple countries in South Asia to lead the One Health Association of South Asia, and currently directs two other multi-disciplinary and multi-stakeholder groups, EcoHealth Net and the Consortium for Conservation Medicine.

Policy Leader (PL): (b)(6) (8.3% time)
The PL will be responsible for identifying opportunities and strategies for program outcomes to serve as guidance for policy and best practices among government and non-governmental stakeholders in Sabah, Malaysia, and regionally as appropriate. The SL will meet with high-level government agency representatives to share finding and discuss opportunities for policy engagement. The SL will also share findings and policy opportunities at a broader scale with international and inter-governmental organizations and agencies such as the World Bank, WHO, FAO, OIE, CGIAR, and bi-lateral aid agencies

(b)(6) at EcoHealth Alliance. He has over 25 years of international policy experience and has worked with the Sabah government since 1988. (b)(6) serves on the World Health Organization's (WHO) International Health Regulations Roster of Experts focused on the human-animal interface and wildlife health. He also serves as the president of the World Animal Health Organization (OIE) Working Group on Wildlife Diseases and also chairs the International Union for the Conservation of Nature (IUCN) Wildlife Health Specialist Group, a network of wildlife and health experts around the world. Currently, (b)(6) is the (b)(6) for the USAID Emerging Pandemic Threats PREDICT program.

Proposed Key Technical Personnel

Center of Excellence Director: (b)(6) at the School of Business and Economics at the Universiti of Malaysia Sabah. (b)(6) will work with Senior Personnel and local partners to establish the Center for Development and Health at UMS. She will also facilitate workshops and mentor graduate students working under this project. (b)(6) at the School of Business and Economics at the Universiti of Malaysia Sabah.

Center of Excellence Associate: (b)(6) (b)(6) at the School of Business and Economics at UMS. He will work with (b)(6) to develop workshops and facilitate stakeholder meetings at the university. He will also mentor graduate students from the business school and staff from partner agencies that work under this project.

Sabah Wildlife Department Chief Liaison to IDEEAL: (b)(6) is the (b)(6) of Sabah Wildlife Department, a position he has held since 2007. Prior to that, he was the (b)(6) from 1991. (b)(6) holds a BSc Degree (Zoology) from Southern Illinois University, USA, a post-graduate Diploma in Protected Landscape Management from Aberystwyth University, Wales, UK, and a PhD in Wildlife Management from Oxford University, United Kingdom. He also holds a professional post-graduate Diploma in Edible-Nest Swiftlet Conservation and Management from Cambridge Academy of Management (FCAM). He serves as the (b)(6) of CITES (Convention of International Trade of Endangered Species of Wild Flora and Fauna) Management Authority for the Sabah Government and an expert member of the IUCN Species Survival Commission (SSC) for Asian Rhinoceros, Bovidae, Crocodile, Asian Elephant, Primate and Swiftlet Specialist Groups.

Economic Modeler: (b)(6) (75% time)
(b)(6) will work to develop the avoided costs model and participate in the associated data collection. (b)(6) will work closely with the other Research Scientists to ensure the successful integration of other model components. She will document the processes and information needed to adapt the model to other contexts and ensure generalizability of the tool. (b)(6) investigates the economic costs associated with disease emergence. (b)(6) is involved with multiple projects, including a benefit cost analysis to determine whether captive-bred or wild-caught animals are a more economical choice for the pet industry, and an evaluation of a proposed tax on

internationally traded meat to generate revenue for global zoonotic disease surveillance. She is interested in the integration of economic theory with epidemiological models to study how the decisions people make affect the spread of infectious diseases.

Economic Modeler: TBD (33% time)
The economic modeler will work closely with the rest of the modeling and analytical team to support their activities in developing our analytical work and outreach. They will liaise closely with the DEEP FOREST team, and with partners in Sabah.

Social Science Lead: (b)(6) (16.6% time)
(b)(6) will work closely with the DCoP to assist in the supervision of the data collection, and connection of DEEP FOREST project data to the quantitative tools. She will work towards the integration of gender sensitive data for the models, and assist in the interpretation of the differential disease risks to men and women based on their daily activities.
(b)(6) brings a human dimension to EHA projects. An (b)(6) and (b)(6) by training, (b)(6) works to understand how human activities may be contributing to ecological changes and disease emergence. Her research interests lie within coupled social-ecological systems. Her current work examines the effects of forest fragmentation on mammal and viral communities, investigates the role of human behavior in disease risk, and she is a (b)(6) on EHA's Deep Forest projects in Brazil and Malaysia.

DEEP FOREST Liaison: (b)(6) (16.6% time)
(b)(6) will oversee the execution of the modeling strategy, collaborating with the other scientists and actively communicating and discussing the model developments with the CoP. (b)(6) will also draw on the project DEEP FOREST data and other data sources to assist with scenario building to project disease risks for different levels of land use change, and clearly communicate these findings to key stakeholders. (b)(6) is an (b)(6) with broad interests in biodiversity, evolution, behavior, and disease ecology. At EcoHealth Alliance, (b)(6) brings a diverse skill set and experience relevant to exploring the roles of biodiversity, land-use change, climate change and other socio-economic, demographic and environmental drivers in disease emergence and conservation. (b)(6) on EHA's Deep Forest projects in Brazil and Malaysia and is responsible for the coordination and alignment of Deep Forest project goals and methods across all three continents (South America, Africa and Asia).

Senior Modeler: (b)(6) (25% time)
(b)(6) will manage the disease and land cover geodatabases with particular attention to the assurance of data quality. The development of the statistical framework, and the use of Bayesian statistics to assess the likelihood of disease outbreak given differing levels of deforestation will be (b)(6) primary responsibility. (b)(6) (b)(6) is part of EcoHealth Alliance's modeling team, where he combines quantitative methods, spatial data and fieldwork to investigate the emergence of infectious diseases. He is interested in ecological niche modeling and applications of

Geographic Information Systems (GIS) technology for biodiversity research and conservation. He leads the GIS and modeling team for EHA's Deep Forest projects in Brazil and Malaysia.

Program Coordinator for Health and Policy: (b)(6) (16.6% time)
The Program Coordinator for Health and Policy will be actively involved in tracing the policy implications of the scientific findings. She will provide programmatic support for the project's health communication and policy outreach activities, including considerations around the social determinants of health as well as the formation of collaborations with non-traditional partners. She will also provide program evaluation expertise to assist in tracking achievement of project objectives. (b)(6) works with conservation, public health and medical communities to find synergies and opportunities to promote science-driven policy. Trained in public health, her work supports EHA collaborations with policy stakeholders at the international, national, and local level. Current projects include policies to consider health threats to biodiversity and practice-based prevention of EIDs.

Grants and Contracts Manager: (b)(6) (8.33% time)
The Grants and Contracts Manager will provide administrative oversight and support for the project's financial management, working closely with the CFO at EHA, and administrative staff funded through EHA core funds. She will ensure efficient transfer of funds to subrecipients, and financial reporting on all aspects of the contract. (b)(6) (b)(6) has worked for over 15 years as an administrative assistant, manager and grants and contracts officer in a leading US University, and for the last 5 years at EHA where she acts as (b)(6) for EcoHealth Alliance's USAID EPT PREDICT subcontract.

PART 2. **Institutional Capability**.

EcoHealth Alliance (EHA) is a science-based organization incorporated over 40 years ago, now working with local partners in over 30 countries at the nexus of public health, biodiversity conservation and international development. EHA has a staff of 35 at headquarters office in New York, including administrative staff (development, finance, marketing & communications), science staff (modelers, economists, social scientists, veterinarians, ecologists, analysts, IT researchers etc), outreach staff (educators, researchers, communication staff). EHA also has international staff of in-country field scientists, social scientists, program managers and country leads based in around 30 countries, including Malaysia (both peninsular and Sabah). EHA has an extensive record of publishing high quality, peer-reviewed papers, journals, briefing documents and reports. Given that a primary indicator of success in this project is based on utilization of data and findings by decision makers, EHA's demonstrated expertise in producing highly utilized and understandable science-based outputs will contribute significantly to achieving both project goals and provide objective methods for tracking project utilization of project findings.

Work experience with USAID EPT and DEEP FOREST

EHA is a core partner of the USAID EPT PREDICT project, and staff at EHA include the PREDICT (b)(6) component of PREDICT (Dr. Peter Daszak), (b)(6) (b)(6), the majority of the PREDICT modeling staff, (b)(6) (b)(6) (b)(6) EcoHealth Alliance formulated the concept and design of the PREDICT DEEP FOREST project, and is the implementation lead at our tropical forest sites along land use gradients in Sabah, Malaysia and Brazil. At these sites, EHA staff are sampling high-risk wildlife, co-ordinating surveys of human contact and behavior (in collaboration with EPT PREVENT), and managing viral testing and capacity building. The aims of DEEP FOREST have direct relevance to the current project, and are to understand how land-use change affects 1) patterns of biodiversity, 2) patterns of viral diversity and 3) patterns of human occupancy and behavior that influence contact rates with wildlife. The human behavioral data gathered includes gender-specific issues of relevance to EID risk, and, similarly, opportunities for gender empowerment and health savings. In addition, EHA scientists are currently working on the DEEP FOREST contact surveys, and other social science aspects of its projects such as our IDRC-supported 'Pontal' project in Brazil.

Work Experience in Modeling Land-use Change

EcoHealth Alliance is a leader in modeling and analyses of the emergence of new diseases. EHA staff led the development of analytical tools and models resulting in the "Hotspots of Emerging Diseases", have conducted extensive fieldwork on emerging diseases in tropical regions, and have led the thinking on the relationship of land-use change and disease emergence. Our portfolio of projects that model disease emergence risk, land-use change, and economic valuation is outlined in below. EHA is a global leader in developing the science, analytical frameworks and field studies to understand the relationship between land use change and disease emergence; in applying spatial analyses to understand drivers of emergence; in the theory of the drivers of zoonotic EIDs; in climate change modeling with respect to public health; in valuing the economic damages associated with EIDs; in understanding and estimating the global wildlife trade and their impacts on public health; and in understanding the ecosystem services associated with EIDs. EHA staff are members of the HEAL (Health and Ecosystems: Analysis and Linkages) project (www.onehealthcommission.org/en/resources/health__ecosystems_analysis_of_linkages_heal/); Dr. Daszak leads the DIVERSITAS ecoHEALTH project (www.diversitas-international.org/activities/research/ecohealth), both of which have specific goals of understanding the ecosystem services related to zoonoses.

Work Experience Modeling Disease Emergence

The thrust of this RFA corresponds directly with the analytical and modeling work EHA is conducting on understanding and predicting disease emergence. For example, EHA modelers have shown that the underlying drivers of disease emergence vary depending on region, but in the place where most zoonoses emerge (the Tropics, inclunding SE Asia) are primary land use change, agricultural intensification, or secondary factors associated with these (e.g. bushmeat), see **Figure 1**, below.

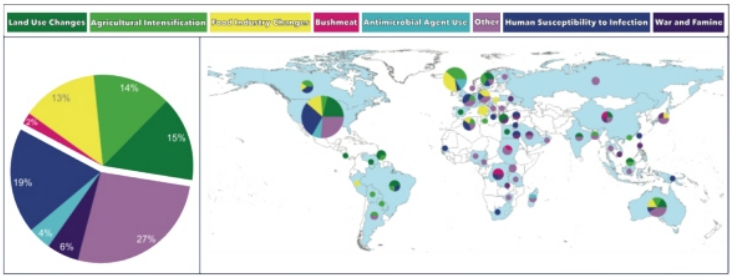


Figure 1: EHA modeling staff have analyzed the underlying causes of all EIDs since 1940. This figure shows that disease emergence in the Asian region, and the Tropics globally, is dominated by land use change, agricultural intensification, and secondary factors these lead to.

The best models require significant data inputs to parameterize. In the DEEP FOREST sites in Borneo and Brazil (and the 'Pontal' project in Brazil), EHA is generating data of direct relevance to the work described in this RFA, including: the relative abundance and diversity of bats, primates, and rodents; the relative intensity of contact among humans and wildlife; and the diversity of known and unknown zoonoses. The collection of these data is driven firstly by models and analyses that identify the most important issues to target. For example, in regions such as SE Asia, where land use change brings people into contact with wildlife reservoirs, EHA has identified the most important transmission pathways that pathogens have previously used to spillover into people (**Figure 3,** below).

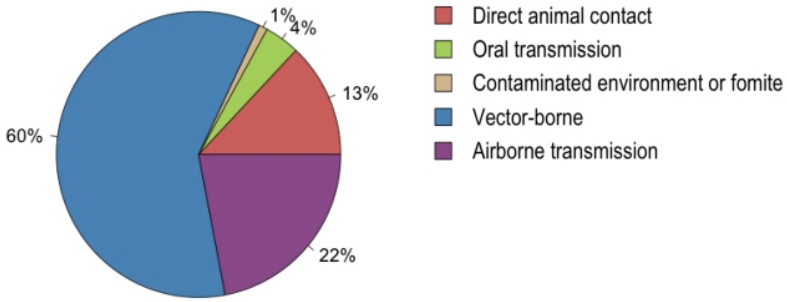
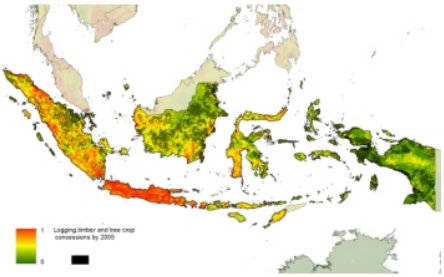


Figure 3: The most significant pathways that pathogens use to emerge in people in areas under intensive land-use change



Finally, EHA manages a portfolio of projects funded by NSF, NIH, DOD and other agencies which specifically analyze the risk of a range of zoonoses emerging in Tropical regions. These include models of how spillover events develop from stuttering chains of zoonotic spillover, then chains of small clusters of human cases, to epidemic, then pandemic spread. We are currently comparing models that involve direct wildlife to human exposure to models that involve domestic animals as intermediate hosts. We are looking into this for henipaviruses, influenza viruses, coronaviruses and other critical zoonoses.

Figure 4: Map of Logging, tree crop and timber concessions in Indonesia. EHA scientists are actively working on mapping these activities with respect to the emerging disease hotspots across tropical Asia, Africa and America.

Work Experience in Economic Modeling

EHA has a program to understand the economic incentives that might be used to mitigate against globally emerging pandemics. Projects include modeling economic damages due to EIDs under different policy scenarios, the trade-offs between preserving ecosystems and the disease regulation services they provide, and cost-benefits of converting land for other productive activities. EHA leads the DEEED (Diversity, Economics, EcoHealth and Emerging Diseases) project that is part of the UNESCO-ICSU DIVERSITAS cluster. This project is actively engaged in:

1. Valuing the Ecosystem Services from forests within EID hotspots and comparing the benefits of preserving the ecosystem to those from converting the land for another productive purpose

2. Valuing the damages associated with disease emergence
3. Evaluating systems of "EcoHealth Credits" that might be traded alongside or integrated into the trading of carbon credits (e.g., as per biodiversity, REDD+).
4. Using contingent valuation methodology—an approach that can also be applied to assign a value to ecosystem services—to gather data on individuals' willingness-to-pay to avert a pandemic.
5. Understanding the global relevance of the 'Dilution Effect' by which biodiversity conservation may help regulate zoonotic disease risk.

This and other associated work by members of our team has resulted in scientific papers that argue the case for preventive rather reactive responses to EID and other risks (Murray *et al.,* 2012), use climate change (adaptation vs. mitigation) approaches to address pandemic threat (Pike *et al.*, in review), evaluate strategies to tax livestock production as a way to reduce pandemic potential (Elwood *et al.*, in review), and evaluate a credit trading system as a way to reduce the risk of pandemics (Tutunjian *et al.*, in review).

Just like climate change, the risk of disease emergence from regions like Sabah can be viewed as a global commons issue (in this case a public 'bad', rather than a 'good'), which can either be mitigated against, or adapted to. Here mitigation involves dealing with underlying causes of EIDs at source (e.g. the proposed work in this RFI) and adaptation involves reliance on current global surveillance, and drug and vaccine development. We have developed a stochastic dynamic model that examines the optimal timing in which to implement pandemic mitigation and/or adaptation policies (**Figure 5**, **below)**. We used real options methodology, data on the incremental rise in EIDs and their associated damages, and the cost of current global health systems, to optimize the delivery of global policies to reduce the damages from EIDs. Our model demonstrates that mitigation projects, which address the underlying causes of pandemics at source, more efficiently reduce the damages associated with pandemics than adaptation. This experience and modeling approach has a direct application to valuing ecosystem services as not only the current value of services should be examined, but also the ability of the ecosystem to maintain these services over time.

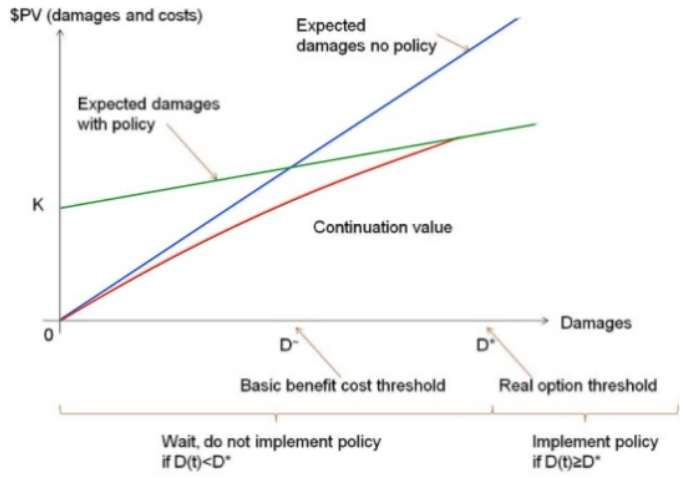


Figure 5: Stopping model for pandemic prevention. Y-axis: net present value of expected damages of an EID outbreak plus the cost, K, of a policy if implemented. X-axis: expected damages/time. Blue line: expected damages if policy is not implemented and the value of waiting (e.g. by more knowledge gained) is not considered. Green line: EID damages if a policy with cost, K, is implemented. If the value of waiting is ignored, D~ is the threshold at which a policy should be implemented. The red line, known as the

'continuation value', illustrates the expected damages under business as usual. The decision model simply takes the currently experienced damage, a point on the x-axis, and determines which of the three lines is lowest (has lowest expected present damages and costs). For damages less than D^* it is optimal to "continue" to wait. For all damages above D^* it is optimal to implement the policy. D^* is the optimal threshold. Our results show that the waiting time to implement a global EID mitigation policy is between 4 and 24 years, after which it will be too costly to reduce the inexorable rise in EID emergence.

Work Experience in Ecosystem Services

The first step to a successful project that provides incentives to reduce, change or otherwise affect commercial activities such as logging, agricultural development and mining is to provide an industry-specific economically viable case. EHA is currently involved in key activities of direct relevance to this RFA. Via subcontract from PREVENT, EHA led the analysis and provided the scientific case for a white paper on reducing EID risk in the extractive industries.

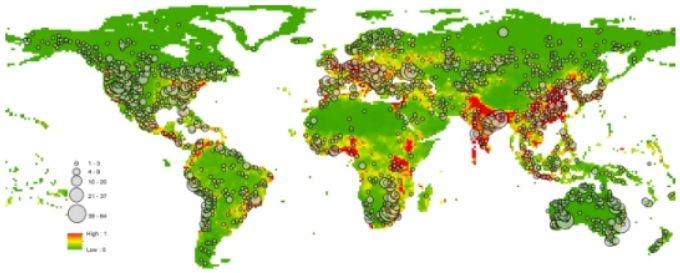


Figure 6: Global EID risk map, overlaid with data on timber concessions and active logging, mining and other extractive industry activities

We also co-hosted a meeting at Chatham House that brought numerous stakeholders from the extractive industries together around the issue of EID risk. This included producing global maps of EID risk and mining/logging concessions (**Figure 6**, above).

EHA staff members also sit on the EPT Extractive Industries Working Group. This group has developed tools to incorporate zoonotic EIDs into Health Impact Assessments, and assess potential risk in sites with active extraction. These include developing measures for risk prevention and management that reduce likelihood of exposure to potential health hazards, strengthening of systems for monitoring and responding to disease-related risks, and engagement of local health officials in risk control. In addition, EHA has active projects with other leaders in the extractive industries, chemical industries, agriculture/livestock, and palm oil production, which can be harnessed for the work in this RFA.

Work Experience in Social Science and Surveys

EHA is working closely with EPT partner PREVENT to develop a standard survey approach to assess and quantify the types and frequencies of human-animal contact in each of our DEEP FOREST sites. These contact surveys are adapted to the country, sub-population and setting in which they are implemented. Already, EHA has piloted over 100 surveys in settlement communities in the Atlantic Forest, Brazil. In each site, these surveys are being used to quantify human contact with potential wildlife reservoirs with particular attention to bats, rodents, and primates as well as other types of wild and domestic animals to which people are frequently exposed. Results from intensive

interviewing and behavioral characterization will determine how this fundamental but poorly quantified measure might vary with land-use practices and intensity of disturbance. Quantifying contact will also provide a basis for determining which populations are at higher risk and what types of behavior change might be needed for mitigation strategies. In 2013, EHA will implement the DEEP FOREST human-contact survey in our sites in the Brazilian Amazon. In Sabah, PREVENT will collect human-wildlife contact data in close coordination with EHA, and in Uganda PREVENT will collect similar data in coordination with EHA and UCDavis. Data from both Brazil and Malaysia sites will generate critical information on key risk interfaces and the potential risk of spillover for each defined ecosystem. We also have access to active extraction sites, through our contact with the SAFE project (Stability of Altered Ecosystems), which is conducting one of the world's largest ecological experiments to understand the ways in which logging, deforestation and forest fragmentation modify the functioning of tropical rainforests and impair their ability to deliver important ecosystem services.

Work Experience in REDD+ initiatives

EHA is engaged in a project to develop a trading system for 'EcoHealth Credits' that adapts to the features of REDD+. In its original form, REDD (Reducing Emissions from Deforestation and forest Degradation) was designed as a climate change mitigation tool based on the sale of carbon credits to encourage countries to reduce deforestation by selling the value of the carbon that would otherwise have been released. REDD+ is a more recent development that broadens the scope to include additional co-benefits of protecting carbon stocks, e.g., protecting biodiversity and improving livelihoods, after it was recognized that carbon investments could be manipulated to better achieve numerous targets for traditionally resource-poor but deforestation-related issues (e.g., biodiversity protection, livelihood enhancements) without compromising the overall efficacy of the program for climate change mitigation. It has also been suggested that optimization procedures could minimize the conflicts with other development goals, such as agricultural production and logging. Our analyses suggest that health could conceivably be considered as one of these additional co-benefits, which could influence the way that REDD+ funds are allocated or influence the perception or relative valuation of potentially conflicting development goals. The next step will be to develop ways that health benefits of intact forests can be integrated into a market-based instrument – something which is directly covered in this RFA, and which EHA has expertise in doing for EIDs.

Experience Implementing Projects in the Region

EHA has worked intensively in Malaysia since 1998, where it maintains an office. Our extensive partnerships and collaborations have led directly to implementation of a Zoonosis Technical Working Committee comprised of the Ministry of Health Malaysia, the Department of Veterinary Services, the Department of Wildlife and National Parks (PERHILITAN) and EHA as part of EPT PREDICT. This committee reports directly to the Malaysian government on the control of zoonotic diseases. In 2000, with our partners in the Dept. of Veterinary Services, the Veterinary Research Institute, Ministry of Agriculture, and the Department of Wildlife and National Parks (PERHLITAN) EHA scientists set up a large-scale international study on the ecology of Nipah virus. This has led to significant scientific outputs, changes to government regulations on pig farming, and regional approaches to zoonotic surveillance.

In 2012 we collaborated with our partners at Sabah Wildlife Department to create the Sabah Wildlife Health Unit that is dedicated to disease surveillance activities and to set up the Wildlife Health, Genetic and Forensic Laboratory. These partnerships have historically focused not only on scientific research, but capacity-building, training, and public outreach to communicate our science. In the past five years, we have expanded our collaboration to include the Ministry of Health and the National Public Health Laboratory (NPHL), under a program looking at the risk of zoonotic disease transmission to people highly exposed to wildlife.

EcoHealth Alliance has also continued to focus on conservation in Malaysia. EHA scientists have worked with PERHILITAN to reduce hunting pressures on flying foxes and to raise awareness of the importance of these animals. In order to preempt harassment of *Pteropus hypomelanus* bats due to their association with Nipah virus, an outreach strategy was developed for a local primary school, located near the site of EHA's long-term bat surveillance Nipah virus study on Malaysia's Tioman Island. The take home message from the talks, games and leaflet was that flying foxes play a crucial role in seed dispersal and the pollination of forest and commercial plants. Malaysian fruits including Durian *(Durio spp.)* and Petai *(Parkia speciosa)* depend on flying foxes for pollination as does much of the timber Malaysia exports, a fact of which many Malaysians were unaware.

In 2012, we partnered with the Malaysian Ministry of Health to develop outreach education material including fact sheets, and pamphlets on zoonotic infectious diseases to provide information on potential risks and biosafety measures, as well as common routes of disease exposure. We are also working closely with MOH to develop standard operating procedures for the Healthy Hunters program. To date, EcoHealth Alliance has trained over 110 members of the PREDICT team in Malaysia, including staff from PERHILITAN, VRI, several local universities and NGOs, and Sabah Wildlife Department. We have also transferred technologies to PERHILITAN, VRI, and SWD to run molecular diagnostic assays for viral family detection in wildlife samples as an initial screen for viruses with zoonotic potential.

Home-office backstopping and its purposes.

The finance department at EHA will manage the cash flow from USA to Malaysia. EHA is a certified USAID prime contractor and subject to federal audits, for which it is considered a low risk organization. The Sub-recipients for these funds – DCOP, Sabah Wildlife Department, University Malaysia Sabah, Department of Veterinary Services and Department of State Health Sabah are all know entities that EHA has worked with in the past. EHA will have their certified public accountant manage the project accounts with oversight from the Chief Financial Officer. The accounts for the project will be submitted for annual external audit. The EHA office will also be responsible for the scientific and technical review and will lead the modeling effort.

The (b)(6) has 8 years' experience managing large budgets and large field projects with multiple partners will receive funds from the EHA Finance Department. The DCOP will be responsible for the fiscal management of all funds in Malaysia associated with this contract to cover operating expenses and to support the activities of

stakeholders involved in this project. The DCOP will track project expenditures to ensure fiscal responsibility and prepare financial data for reporting. For stakeholders who may require regular financial support, such as to fund the running of the Center of Excellence we will establish at University Malaysia Sabah, a contract would be signed between DCOP and the stakeholder.

Sub-recipient capabilities and expertise

Univesiti Malaysia Sabah (UMS)

UMS strives to be an innovative university of global standing UMS strives to achieve academic excellence and international recognition through its attention to learning and teaching, research and publications, social services and balance in knowledge specialization. The university also prioritizes the personal growth of its students, resulting in greater innovation and productivity for the benefit of society and the nation as a whole. The School of Business and Economics, was established in 1995 with intention of fulfilling the country's need for managers and entrepreneurship in various areas of business to ensure that Malaysia achieves its objective to be an industrialized country by 2020. SBE seeks to ensure that its academic programs are update with the most recent research finding and by an understanding of contemporary business, government and management practices. As a result of its proactive policy, the school is capable of disseminating the recent development in knowledge in business and economics to its students and other audiences. The School has already earned recognition in providing quality MBA among profesional in the State and hopes to gain international recognition in the years to come.

UMS will be creating the Center for Development and Health under this project inline with it's other existing Centers of Excellence such as the Institute for Tropical Biology and Conservation. The ITBC works at various sections of the society including the traditional communities, government agencies, non-governmental organizations and relevant ministries, ensuring a fair bit information exchange, technology transfer, assistance and smart-partnerships. The institute has developed a tradition of working with many partners both within and outside Malaysia.

The Sabah Wildlife Department (SWD)

The Sabah Wildlife Department works under the authority of the Sabah Ministry for Tourism Development, Environment, Science and Technology. The Wildlife Department has its headquarter in Kota Kinabalu and it has a number of district offices, centers and stations throughout the state. Over 230 staff members work in the SWD. The department is responsible for implementation and administration of the Sabah Wildlife Conservation Enactment, 1997. Under this Enactment the department conserves and regulates wildlife utilization in Sabah and it manages a number of protected areas. The department also implements the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as well as contribute to the implementation of the international convention of Biological Diversity and to a number of other international, regional and bilateral agreements. The objective of the SWD is to manage the State's wildlife resources for the benefit of the people of Malaysia in general and of Sabah in particular. The SWD is the lead local partner for the USAID EPT program, working directly with both PREDICT and PREVENT. As such, they are also the key implementation partner for the DEEP FOREST project. For IDEEAL, SWD will serve to bring together relevant

stakeholders to participate in the efforts of the UMS Center for Development and Health to strengthen the center of excellence platform. SWD will also prove to be the key in liaising with other Sabah government departments for obtaining additional data and input for modeling and to engage in policy outreach efforts.

References for Annex C:

Elwood, S., *et al.* Evaluation of a levy on internationally traded meat to finance global disease surveillance. Emerging Infectious Diseases, in review.

Groot, R. D., *et al.* (2010). "Integrating the ecological and economic dimensions in biodiversity and ecosystem service valuation." The Economics of Ecosystems and Biodiversity (TEEB): Ecological and Economic Foundations

Murray, K. A., *et al.* (2012). "Cooling off health security hot spots: Getting on top of it down under." Environment International **48**(0): 56-64.

Pike, J., et al. (2013). "Economic optimization of a global stategy to reduce the pandemic threat." Nature, in review.

Tutunjian, C., *et al.* A credit trading system for pandemic prevention. EcoHealth, in review.

MPOC

Our Ref : 0199-05/13

23 May 2013

Dr. Peter Daszak
President, EcoHealth Alliance
460 West 34th Street – 17th floor
New York, NY 10001
USA.

Dear Dr. Daszak,

I, (b)(6) of Malaysian Palm Oil Council (MPOC) will be very pleased to collaborate on the application being led by EcoHealth Alliance to implement the USAID Land Use Change and Disease Emergence program should our team be chosen by USAID to conduct the work. Should EcoHealth Alliance be successful in its application, I have agreed to participate in activities associated with this project including acting as a resource for information and insight, based on my expertise, including assisting in identifying and locating relevant and available data sets, to help achieve the aims of this project. I will also participate in occasional meetings at local partner institutions to discuss findings of this study, strategies for educational outreach and dissemination of findings, and advise or participate in graduate student training activities.

This letter conveys my interest and commitment to making this initiative a success. We are excited to be involved in this effort to develop evidence-based tools for utilization in reducing deforestation, associated carbon emissions, and risk of disease emergence. We look forward to working with EcoHealth Alliance, Sabah Wildlife Department, and USAID on this important project.

Sincerely,

(b)(6)

for CEO MPOC

MALAYSIAN PALM OIL COUNCIL (192835-K)
2nd Floor, Wisma Sawit, Lot 6, 556, Jalan Perbandaran, 47301 Kelana Jaya, Selangor Darul Ehsan, Malaysia.
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88586 KOTA KINABALU
SABAH, MALAYSIA
Tel: 088-517555 Faks: 088-211999/318605
Laman Web: http://qeh.moh.gov.my

SIRIM
CERTIFIED MS ISO 9001 : 2008
Registration No. AR 3673

Ruj. Tuan :

Ruj. Kami :

Tarikh :

Peter Daszak
President, EcoHealth Alliance
460 West 34th Street – 17th floor
New York, NY 10001
USA

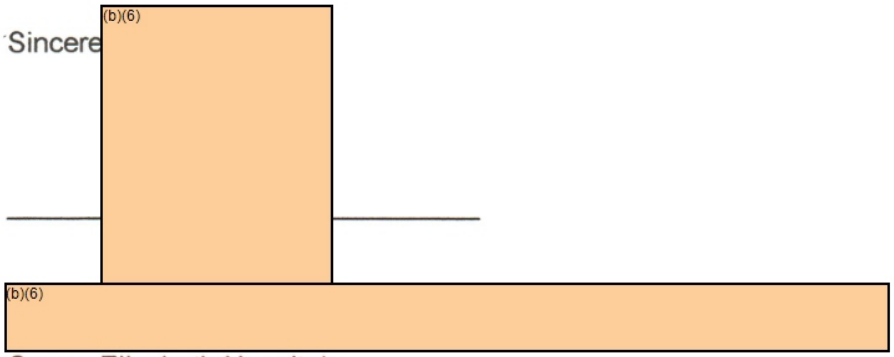
20 May 2013

Dear Dr. Daszak,

I, and the Infectious Disease Unit, Queen Elizabeth Hospital, Kota Kinabalu, Sabah, will be very pleased to collaborate exclusively on the application being led by EcoHealth Alliance to implement the USAID Land Use Change and Disease Emergence program should our team be chosen by USAID to conduct the work.
Should EcoHealth Alliance be successful in its application, I have agreed to participate in activities associated with this project including acting as a resource for information and insight, based on my expertise, including assisting in identifying and locating relevant and available data sets, to help achieve the aims of this project. I will also participate in occasional meetings at local partner institutions to discuss findings of this study, strategies for educational outreach and dissemination of findings, and advise or participate in graduate student training activities.

This letter conveys my interest and commitment to making this initiative a success. We are excited to be involved in this effort to develop evidence-based tools for utilization in reducing deforestation, associated carbon emissions, and risk of disease emergence. We look forward to working with EcoHealth Alliance, Sabah Wildlife Department, and USAID on this important project.

Sincere



Queen Elizabeth Hospital,
Kota Kinabalu
Sabah, Malaysia

HUTAN
Kinabatangan Orang-utan Conservation Programme

Peter Daszak
President, EcoHealth Alliance
460 West 34th Street – 17th floor
New York, NY 10001
USA

Dear Dr. Daszak,

This letter is to confirm that the Kinabatangan Orang-utan Conservation Programme run by the French NGO HUTAN will be very pleased to collaborate on the application being led by EcoHealth Alliance to implement the USAID Land Use Change and Disease Emergence program.

Should EcoHealth Alliance be successful in its application, I have agreed to participate in activities associated with this project including acting as a resource for information and insight, based on my expertise, including assisting in identifying and locating relevant and available data sets, to help achieve the aims of this project. I will also participate in occasional meetings at local partner institutions to discuss findings of this study, strategies for educational outreach and dissemination of findings, and advise or participate in graduate student training activities.

This letter conveys my interest and commitment to making this initiative a success. We are excited to be involved in this effort to develop evidence-based tools for utilization in reducing deforestation, associated carbon emissions, and risk of disease emergence. We look forward to working with EcoHealth Alliance, Sabah Wildlife Department, and USAID on this important project.

Sincerely,

(b)(6)

(b)(6)

Kota Kinabalu
15.05.2013

PO Box 17793, 88874 Kota Kinabalu, Sabah, Malaysia.
T: 6088 413 293 F: 6088 413 293 W: www.hutan.org.my

LEAP – Facilitating projects, partnerships & exchanges that provoke sustainable ecological co-existence

Peter Daszak
President, EcoHealth Alliance
460 West 34th Street – 17th floor
New York, NY 10001
USA

22 May 2013

Dear Dr. Daszak,

LETTER OF SUPPORT

LEAP (Land Empowerment Animals People) will be very pleased to collaborate with EcoHealth Alliance on its implementation of the USAID Land Use Change and Disease Emergence program should EcoHealth Alliance be chosen by USAID to conduct the work in Sabah, Malaysia.

We are happy to share our experience and expertise, provide input through meetings and workshops, and to help to connect EcoHealth to relevant stakeholders within our network.

This letter conveys our support for making this initiative a success. We are excited to be involved in this effort to develop evidence-based tools for utilization in reducing deforestation, associated carbon emissions, and risk of disease emergence. We look forward to working with EcoHealth Alliance, Sabah Wildlife Department, and USAID on this important project.

Sincerely,

(b)(6)

LEAP

Malaysian office – HG01B, Ground Floor, Waikiki Condo, Jalan Aru, Tanjung Aru, 88100 Kota Kinabalu, Sabah * 6.088.270705
U.S. office – 3378 Revere Avenue, Oakland, California 94605, USA * 1.310.429.2686
www.leapspiral.org * info@leapspiral.org

Cardiff School of Biosciences
(b)(6)

DANAU GIRANG FIELD CENTRE

Kota Kinabalu, 21 May 2013

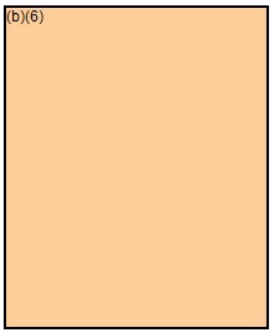
Peter Daszak
President, EcoHealth Alliance
460 West 34th Street - 17th Floor
New York, NY 10001, USA

Dear Dr Daszak,

I, and Danau Girang Field Centre, have been successfully working with EcoHealth Alliance for the last two years in Sabah. I am very pleased to continue this collaboration on this new application proposed by EHA to USAID to implement their Land Use Change and Disease Emergence program. Should EHA be successful in its application, I agree to participate in activities associated with this project including acting as a resource for information and insight, based on my expertise, and assisting in identifying and locating relevant and available data sets. I will also participate in occasional meetings at local partner institutions to discuss findings of this study, strategies for educational outreach and dissemination of findings. I will also be happy to advise or participate in graduate student training activities, as long as funding is provided for such activities.

This letter conveys my interest and commitment to making this initiative a success. I am excited to be involved in this effort do develop evidence-based tools for utilisation in reducing deforestation, associated carbon emissions, and risk of disease emergence. I look forward to continuing working with EHA, Sabah Wildlife Department and USAID on this important project.

Yours sincerely,



Danau Girang Field Centre, Sabah, Malaysia

DIRECTOR GENERAL OF VETERINARY SERVICES
Department of Veterinary Services
Ministry of Agriculture and Agro Based Industry
Level 2, Podium Block Lot 4G1, Wisma Tani
Persiaran Perdana, Precinct 4
62630 PUTRAJAYA
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moa INCORPORATED
KEMENTERIAN PERTANIAN DAN INDUSTRI ASAS TANI

Tel: 603-8870 2201
Fax: 603-8888 6051
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Email: kp@dvs.gov.my

Dr. Peter Daszak
President, EcoHealth Alliance
460 West 34th Street – 17th floor
New York, NY 10001
USA

Dear Sir

LETTER OF COMMITMENT FOR THE USAID LAND USE CHANGE AND DISEASE EMERGENCE PROGRAM

The Department Of Veterinary Services Malaysia will be very pleased to collaborate exclusively on the application being led by EcoHealth Alliance to implement the USAID Land Use Change and Disease Emergence program should our team be chosen by USAID to conduct the work.

2. Should EcoHealth Alliance be successful in its application, we have agreed to participate in activities associated with this project including acting as a resource for information and insight, based on our expertise, including assisting in identifying and locating relevant and available data sets, to help achieve the aims of this project. We will also participate in occasional meetings at local partner institutions to discuss findings of this study, strategies for educational outreach and dissemination of findings, and advise or participate in graduate student training activities.

3. This letter conveys the Department's commitment to making this initiative a success. We are excited to be involved in this effort to develop evidence-based tools for utilization in reducing deforestation, associated carbon emissions, and risk of disease emergence. We

look forward to working with EcoHealth Alliance, Sabah Wildlife Department, and USAID on this important project.

Sincerely,

Malaysia.

Cc. – 1.Deputy Director General Of Veterinary Services (Developement)
2.Deputy Director General Of Veterinary Services (Veterinary Health)
3. Director, Research Division, DVS Malaysia.

Annex D: Past Performance Information

PREDICT - Wildlife SMART Surveillance
PERFORMANCE REPORT - SHORT FORM
PART I: Award Information (to be completed by Prime)
1. Name of Awarding Entity: USDS AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID)
2. Award Number: GHN-A-00-09-00010-00
3. Award Type: Grant
4a. Award Value (or subagreement value): (b)(4)
4b. Annual amount received for each of last 3 years: (b)(4) ; (b)(4)
4c. Award beginning and end dates: 10/01/09-09/30/14
5. Problems: (if problems encountered on this award, explain corrective action taken): No significant problems encountered
6. Contacts: (Name, Address, Telephone Number and E-mail address)
6a. (b)(6) (b)(6) Washington, DC 20004, (b)(6) @usaid.gov
6b. Technical Officer (AOTR/COTR):
6c. Other:
7. Recipient: University of California-Davis/EcoHealth Alliance
8. Title/Brief Description of Product/Service Provided: PREDICT - Wildlife SMART Surveillance/PREDICT Project to pre-empt at the earlier stages possible, zoonotic diseases that impose significant threat to public health.
9. Information Provided in Response to RFA/RFP No.: USAID-RDMA-RFA-486-13-0000001 Land Use Change and Disease Emergence Program
10. Key project accomplishment and results to date: **Analyzing and predicting disease emergence** · Analyzed role of land use change as driver of disease emergence · Produced economic cost-benefit analysis of adaptation vs. mitigation to Pandemic Threats · Produced version 2 of EID Hotspots map · Developed online wiki for EID emergence data ("The Sicki Project") · Designed and launched the DEEP FOREST Project to assess disease emergence across land use gradient · Characterized risk interfaces & human contact potential for transmission in different social and ecological contexts · Produced predictive maps of Pandemic risk based on air travel/trade **Expanding the One Health Workforce** · Trained over 1,600 people in surveillance, diagnostics & outbreak response · Coordinating with 59 ministries in 20 countries · Partnering with US agencies & foreign governments to establish regional networks for wildlife health and laboratory diagnostics

Optimizing surveillance & response

- Standardized animal sampling protocols to ensure safe wildlife handling
- Improved cold chain access in remote areas
- Established scientifically-justifiable & practically implementable sampling goals to identify new viruses and evaluate diversity in regions & hosts
- Responded to deadly outbreaks incorporating animal & environmental best practices
- Identified efficient diagnostic paradigm for mystery diseases

Providing proof of concept

- Sampled 35,000 animals
- Discovered 200 viruses in genera or families known to cause zoonotic epidemics
- Built capacity for diagnostic testing in 20 labs
- Working toward sustainable improvements in 33 labs in total
- Used new viral data to help assess risk & respond to outbreaks
- Published 24 peer-reviewed scientific publications in high impact journals (*PNAS*, *Nature*, *The Lancet* etc.)

Risk of Viral Emergence from Bats
PERFORMANCE REPORT - SHORT FORM
PART I: Award Information (to be completed by Prime)
1. Name of Awarding Entity: NIAID Non-Biodefense Emerging Infectious Diseases
2. Award Number: 5R01AI079231
3. Award Type: Grant
4a. Award Value (or subagreement value): (b)(4)
4b. Annual amount received for each of last 3 years: (b)(4)
4c. Award beginning and end dates: 09/18/08-08/31/13
5. Problems: (if problems encountered on this award, explain corrective action taken): No significant problems encountered
6. Contacts: (Name, Address, Telephone Number and E-mail address)
6a. Agreement Officer: (b)(6), NIAID, NIH; (b)(6)@niaid.nih.gov, (b)(6) (b)(6)
6b. Technical Officer (AOTR/COTR):
6c. Other: (b)(6)@niaid.nih.gov, (b)(6)
7. Recipient: EcoHealth Alliance
8. Title/Brief Description of Product/Service Provided: 'Risk of Viral Emergence from Bats'/ Characterized the diversity of bat viruses globally; developed predictive models to look at areas of the globe at greatest risk from zoonotic bat viruses and identify the factors that drive cross-species transmission in bats; and estimating the unknown viral richness in bats globally.
9. Information Provided in Response to RFA/RFP No.: NIH PA-07-246
10. Key project accomplishment and results to date: **Targeted sample collection for bat viral discovery** • Collected over 2,200 samples from bats targeted by high-risk species and geography. • Globally, over 12,000 samples from ~100 bat species have been collected. 100s of novel viruses from 10 viral families have been identified. **Bat Viral Discovery and 'Deep Sampling'– Bangladesh Case Study** • Ran over 16,000 PCR assays for 12 viral families, and discovered 63 putative novel viruses in Bangladesh alone. • Non-bat viruses were detected in fruit bats as part of this study, including both avian and bovine coronaviruses. **Viral Discovery Curves – assessing total known and unknown viral diversity** • Viral discovery curves used to estimate total diversity of mammal viruses. • 63 novel viruses that include 11 new Paramyxoviruses and 28 new Adenoviruses have been identified. **Predicting risk of bat virus emergence** • Identified significant host and virus traits that predict whether or not a virus will be shared among bat species.

- Results showed that phylogenetic distance between bat host species is a strong predictor of viral sharing.
- Primates, rodents, bats and lagomorphs have significantly higher proportions of viruses shared with humans than other mammal Orders.
- Mapped global pandemic risk from the emergence of all direct- and vector-transmitted zoonotic viruses using airline travel data, zoonotic disease hotspot risk maps, and per capita health care.

Training and outreach

- Trained >230 people in-country in methods of bat capture, safe handling, species identification, proper use of Personal Protective Equipment (PPE), and minimally-invasive sample collection.
- Held a large hands-on training in Central Thailand for 32 people, which included veterinary and forest students from three universities in Thailand, staff and veterinarians from the Department of National Parks Thailand.
- EcoHealth Alliance with FAO co-edited and published a volume on best practices for investigating zoonoses from bats which is freely available online.
- Over 20 peer-reviewed papers have been published under this award.

HSD: Collaborative Research: Human Related Factors Affecting Emerging Infectious Diseases.
PERFORMANCE REPORT - SHORT FORM
PART I: Award Information (to be completed by Prime)
1. Name of Awarding Entity: National Science Foundation (NSF)
2. Award Number: BCS-0826779
3. Award Type: Grant
4a. Award Value (or subagreement value): (b)(4)
4b. Annual amount received for each of last 3 years: (b)(4)
4c. Award beginning and end dates: 10/01/08-01/31/12
5. Problems: (if problems encountered on this award, explain corrective action taken): No significant problems encountered
6. Contacts: (Name, Address, Telephone Number and E-mail address) Peter Daszak
6a. Agreement Officer: (b)(6) @nsf.gov
6b. Technical Officer (AOTR/COTR):
6c. Other:
7. Recipient: EcoHealth Alliance
8. Title/Brief Description of Product/Service Provided: 'HSD: Collaborative Research: Human Related Factors Affecting Emerging Infectious Diseases'/The goal of this project was to understand the process by which anthropogenic changes drive patterns of disease emergence globally, and the development of predictive models for disease emergence and pandemic spread.
9. Information Provided in Response to RFA/RFP No.: USAID-RDMA-RFA-486-13-0000001 Land Use Change and Disease Emergence Program
10. Key project accomplishment and results to date: • Produced first ever global disease hotspot map • Analyzed risk of disease emergence from agricultural production and food • Collated over 20 globally-gridded, largescale datasets on socio-economic factors involved in disease emergence • Published papers in *Science*, *Nature* and other high-impact journals.

EcoHealthNet: Ecology, Environmental Science and Health Research Network
PERFORMANCE REPORT - SHORT FORM
PART I: Award Information (to be completed by Prime)
1. Name of Awarding Entity: National Science Foundation (NSF)
2. Award Number: 0955897
3. Award Type: Grant
4a. Award Value (or subagreement value): (b)(4)
4b. Annual amount received for each of last 3 years: (b)(4)
4c. Award beginning and end dates: 07/01/10-08/31/15
5. Problems: (if problems encountered on this award, explain corrective action taken): No significant problems encountered
6. Contacts: (Name, Address, Telephone Number and E-mail address)
6a. Agreement Officer: (b)(6) , 4201Wilson Blvd., Natl. Science Foundation, Arlington, VA 22230; Tel (b)(6) Email (b)(6) @nsf.gov
6b. Technical Officer (AOTR/COTR):
6c. Other: (b)(6)
7. Recipient: EcoHealth Alliance
8. Title/Brief Description of Product/Service Provided: 'EcoHealthNet: Ecology, Environmental Science and Health Research Network'/Its aim is to provide multi-disciplinary training to graduate students and early career scientists from the US and abroad in the field of disease ecology.
9. Information Provided in Response to RFA/RFP No.: USAID-RDMA-RFA-486-13-0000001 Land Use Change and Disease Emergence Program
10. Key project accomplishment and results to date: • Bringing together experts from top academic, government, and non-governmental organization representing fields of ecology, veterinary medicine, medicine, GIS, mathematical modeling, and epidemiology together for a 1-week didactic and applied training workshop attended by 20 of the best and brightest graduate students competitively selected from programs around the world. • 10 funded applied research experiences for students each year which includes a mentored field placement for up to 3 months conducting research within a larger, funded ecohealth research project. • Trained over 100 students from more than 20 countries. • Workshops have included disease mapping and modeling, which was held at Johns Hopkins Bloomberg School of Public Health; Epidemiology and outbreak response co-hosted by the University of Wisconsin and the USGS National Wildlife Health Center, and this year will be at on Zoonoses and food safety at the University of Minnesota. • Past workshop attendees have stayed connected through an EcoHealthNet alumni network and many EcoHealth Net scholars have graduated and acquired jobs with science-based research organizations.

The Ecology, Emergence and Pandemic Potential of Nipah Virus in Bangladesh
PERFORMANCE REPORT - SHORT FORM
PART I: Award Information (to be completed by Prime)
1. Name of Awarding Entity: NIH-Fogarty International Center
2. Award Number: 2R01-TW005869
3. Award Type: Grant
4a. Award Value (or subagreement value): (b)(4)
4b. Annual amount received for each of last 3 years: (b)(4)
4c. Award beginning and end dates: 08/01/08-06/30/14
5. Problems: (if problems encountered on this award, explain corrective action taken): No significant problems encountered
6. Contacts: (Name, Address, Telephone Number and E-mail address)
6a. Agreement Officer: (b)(6) @nih.gov, Phone: (b)(6) (b)(6)
6b. Technical Officer (AOTR/COTR): (b)(6) @nih.gov, Phone: (b)(6)
6c. Other: N/A
7. Recipient: EcoHealth Alliance
8. Title/Brief Description of Product/Service Provided: 'The Ecology, Emergence and Pandemic Potential of Nipah Virus in Bangladesh'/Nipah virus is an emerging zoonotic virus carried by old world fruit bats that causes regular outbreaks of encephalitis with high mortality rates in people Bangladesh. This five-year program aims to study the dynamics of Nipah virus in its natural bat reservoir, as well as the spillover dynamics among bats, other animals, and people, in an effort to understand the risk of Nipah virus causing a global pandemic.
9. Information Provided in Response to RFA/RFP No.: USAID-RDMA-RFA-486-13-0000001 Land Use Change and Disease Emergence Program
10. Key project accomplishment and results to date: • Multidisciplinary collaboration set up among veterinarians, epidemiologists, physicians, anthropologists, ecologists and virologists at EcoHealth Alliance and ICDDR,B • Thousands of bats sampled across Bangladesh • Systematic study of viral and antibody prevalence in populations across Bangladesh. • Large-scale case-control study of people in villages across Bangladesh to characterize environmental and behavioral risk factors associated with human spillover. • Identified over 10 clusters of Nipah virus infection in people in Bangladesh • Published over 25 papers in high profile scientific journals

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Infectious Disease Emergence and Economics of Altered Landscapes

Quarterly Report

Year 1 Quarter 1 – October 15, 2013 to January 14, 2014

Submission Date: February 21, 2014

[Contract/Agreement] Number: AID-486-A-13-00005
Activity Start Date and End Date: October 15, 2013 to October 14, 2016
(b)(6)

EcoHealth Alliance

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