Technological Center for Elimination of Poverty-Related Emerging & Neglected Diseases (TEND)

A Proposal for a Florida International University (FIU)-led alliance with Industrial, Academic, and Developing Country Partners to provide Transformative Technological Platforms With Dramatic Health, Social, and Economic Benefits

Name and address of organization:
Florida International University
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Miami, Florida 33199

Type of institution: FIU is a public research university committed to learning, research, entrepreneurship, innovation, and creativity.

Eligibility Information: FIU is a qualified U.S. university as described in Section III of the RFA.

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Program Concept Note

Introduction

Health and poverty are interrelated, thus we focus on eliminating critical health problems to achieve development. Since the 1970s, medical experts have recognized over 40 significant, new emerging infectious diseases and there has been a reemergence of a number of diseases, including tuberculosis, cholera, dengue, yellow fever, diphtheria and meningococcal meningitis. Collectively these diseases cause an estimated 12 million deaths globally and represent seven of the top ten causes of death in children. Developing countries are also plagued by Neglected Tropical Diseases (NTD), which include illnesses such as lymphatic filariasis, onchocerciasis, trypanosomiasis, leishmaniasis, Chagas, and schistosomiasis. NTD cause approximately 534,000 deaths each year and produce extensive morbidity in the form of millions of cases of serious non-fatal illnesses. An estimate based on 2002 data that excluded HIV, Tuberculosis, and sexually transmitted diseases, demonstrated that Emerging Infectious Diseases (EID) and NTD collectively contribute to an annual loss at least 278,381,000 Disability-Adjusted Life Years (DALYs), and have tremendous impact on trade, tourism, and the economy.

Problem Statement

Nearly all (95%) of the 12 million deaths from EID and NTD are in poverty-stricken developing countries. Climate change and the shifting patterns of human habitation are major contributors to the increasing incidence of EID and NTD. These diseases have emerged and persisted for social and economic reasons that enable the vectors, zoonotic hosts, and pathogens to take advantage of changes in the behavioral and physical environment. There is a critical need for research, technology, and strengthening of the health system to address what is perhaps the largest public health threats of the 21st Century. Key areas of focus should include:

- **Effective Surveillance**—Successful control of EID and NTD outbreaks depends on early detection. Current methods suffer a number of weaknesses; most importantly they are only as good as the reporting and response system of the endemic country. Addressing this issue will depend on the convergence of biotechnology and informatics. For example, microarrays that detect multiple pathogens combined with near real-time alerts over existing systems such as social media may provide more timely and effective notice of emerging public health threats;

- **Health System Strengthening**—Response to emerging public health threats also depends on the development of infrastructure and human resources to respond to outbreaks and endemic public health threats. Capacity needs to be built or enhanced for scaling-up known interventions and the application of newly discovered technologies and solutions once these have been assessed to be useful (cost-effective and practical) in field conditions. This new capacity will leverage new standards for public health reporting and be easily extendable to new reportable conditions and threats.

- **Operational and Program-centered Research**—Public health research is also critical for optimizing current strategies and tools and facilitating new ones by linking epidemiological, operational, behavioral, social, health systems, health economics and policy research with basic research for drug and diagnostic discovery.

We address these issues through the establishment of a **Technological Center for Elimination of Poverty-Related Emerging & Neglected Diseases (TEND)** an FIU-led consortium serving as a network node and supporting crosscutting research collaborations between FIU colleges and schools, industry, and civil society, to address the threat of emerging and neglected diseases. The Center’s objectives are:
1. Create and implement a global biological event detection and tracking capability using social and other media that provides early warning alerts and facilitate response;
2. Catalyze innovation and technology transfer by industry and academia in the fields of geospatial analysis, epidemiological modeling, bioinformatics, communications, and molecular diagnostics among others;
3. Develop and operate joint graduate and certificate programs, internships, and exchanges in infectious disease for students, postdoctoral fellows, and health providers in low and middle income country (LIMC) partner nations and the U.S.; Build faculty exchanges with USAID and partner institutions and
4. Using resources developed during the initial phases of the grant, plan and oversee a Dengue eradication program in the Dominican Republic and Columbia, where FIU has strong collaborations. This will demonstrate the effectiveness of the consortium in addressing this important public health threat with more than 100 million cases annually.

Mission Statement

The Technological Center for Elimination of Poverty-Related Emerging & Neglected Diseases (TEND) at Florida International University will:

1. Create and leverage a virtual network of leading experts and communities of practice to address the public health threat of emerging and neglected infectious diseases.
2. Develop a hyper-connected communications hub that will initially serve LIMC in the Americas to facilitate the monitoring and control of emerging and neglected diseases, for information on EID and NTD from health agencies whose activities the Center would help coordinate;
3. Cultivate in-country partnerships with sharing of human, material and technological resources that will facilitate the incubation of new technologies and interventions for the control of EID and NTD; engage students and create new approaches for development.
4. Facilitate exchanges and training of healthcare professionals, first responders, and other public health professionals through mutually developed certificate and graduate programs; and
5. Facilitate the creation of innovative technology that is cost effective, transferable, extensible, and sustainable with a multi-disciplinary collaboration between FIU Departments and Colleges of Engineering and Computer Science, Medicine, Public Health, and Arts and Sciences and IBM research division that address the needs of LIMC partners enabling improved health system response to EID and NTD.

Partnerships and Collaborations

TEND will be an FIU-led collaboration with the following partnerships and collaborations:

FIU Partnerships:

a. **The Herbert Wertheim College of Medicine** will connect experts in EID and NTD from FIU to collaborating departments, schools, institutions and LIMC partners. They will also coordinate education and training exchanges;
   i. **The Department of Molecular Microbiology & Infectious Diseases** will perform biological research on pathogenesis and diagnostic tools, teaching support, coordination with host nations;
   ii. **Green Family Neighborhood HELP** (Health Education Learning Program) will place medical, nursing, social work, and FIU students in education, training and services exchanges with partnering LIMC;
iii. The Department of Humanities, Health & Society will coordinate data collection services for TEND projects;
iv. The Division of Research & Information/ Data Coordinating Center will provide benchmarking capabilities for demographic analysis;

b. The College of Engineering and Computing provides important resources for the development of technology and innovative solutions to surveillance and control of EID and NTD including:
   i. TerraFly Geospatial Data Management System that will facilitate EID and NTD analysis and control including vector identification and demographic and geospatial data analysis;
   ii. Bioinformatics and Data Mining for synchronizing and coordinating seamless data gathering and analysis;
   iii. The Eclipse SpatioTemporal Epidemiological Modeler (STEM) is an open source tool developed and supported by IBM Research. It is designed to support rapid development of mathematical models of emerging disease and to predict the effects of interventions and vaccination strategies. STEM will be integrated with the TerraFly system by IBM Research and FIU TerraFly teams.
iv. Motorola Nanofabrication Research Facility will coordinate the development of nanosensors; and
v. Affective Social Computing and eHealth Agents will help with patient interaction and facilitate patient care in the field as well as provide “ground-truth” regarding disease prevention, treatment, and progression.

c. The College of Arts and Sciences will share important linkages and integration with LIMC partners particularly in the Americas. The schools providing these linkages include:
   i. The School of International Public Affairs: Latin American and Caribbean Center offers needed understanding of indigenous cultures and disease and coordinate on economic stabilization and infrastructure development;
   ii. Biological Sciences will deliver expertise on mosquito microbiology and provide translational research applicable to the control of vector-borne diseases;
   iii. School of Environment, Arts, and Society will evaluate environmental factors and coordinate linkages to local, national, and international partners dealing with the impact of environmental factors on infectious disease;
   iv. Geographic Information Systems and Remote Sensing Center has tools and expertise in geospatial technologies and data analysis;
   v. Global Water for Sustainability Program will provide expertise on the impact of water management strategies and sanitation on infectious disease;

d. The Applied Research Center (ARC) at Florida International University will provide mobile laboratories for the detection of vectors, infection, and water quality analysis;
e. College of Law (COL) at FIU: has expertise in international and comparative law as applied to public health programs and will facilitate assessment of the public health laws of partner nations to assure that all programs, projects, and educational plans are in harmony with the laws of partner nations. The COL will also facilitate development of local and intermediate-level in-country human and other resources that facilitates an autonomous and self-sufficient transfer of technological knowledge and resources.

Industry and Civil Society Collaborations:

There will be critical partnerships with industry and civil society that will enhance the capabilities of TEND including:

a. The Pan American Health Organization (PAHO) / World Health Organization (WHO) will be a critical partner in coordinating all aspects of the program with LIMC in the Americas;
b. **International Business Machines (IBM)** James Kaufman and Juan F. Caraballo will collaborate with TEND to adapt existing and create new software technologies to share information on disease outbreaks and predict how they will spread; IBM has committed to sharing Spatiotemporal Epidemiological Modeler (STEM) to enable predictions of how pathogens mutate to facilitate the development of drugs and vaccines; STEM will interact with the FIU TerraFly Geospatial technology and databases.

c. **Sanofi-Pasteur**: vaccines division has a candidate dengue vaccine which targets all four virus serotypes and is currently in Phase 3 clinical studies in adults and children in Latin America and will collaborate with TEND for Phase 4 Clinical studies.

d. **Sustainable Sciences Institute (SSI) at the University of California, Berkeley** will facilitate the transfer of Bimolecular Techniques to facilitate the identification and control of infectious diseases in LIMC; and

e. **National Science Foundation's Industry-University Cooperative Research Center for Advanced Knowledge Enablement at Florida International and Atlantic Universities and Dubna International University (Russia) (NSF I/UCRC-CAKE)**. I/UCRC-CAKE, an intra- and extra-FIU organization, will apply and evolve geospatial and health information technology it has developed to address challenges of TEND and broader US Aid needs.

f. **The United States Army Southern Command (SOUTHCOM)** will provide logistical support, medical teams, and transportation support to TEND;

Importance of Using Dengue Eradication as a Test of TEND Partnerships and Strategies

Dengue Virus (DENV) diseases are the first target because recent global socio-climatic, demographic, and economic changes have caused a dramatic rise in DENV infections and because DENV diseases are critically amplified by poverty.\(^{11,12}\) DENV incidence has increased 30-fold over the last 50 years, with increasing geographic expansion to new countries. The WHO estimates that over 40% of the world's population is at risk from dengue, with 50–100 million dengue infections worldwide each year. In 2010, in the Americas alone, there were over 1.6 million cases of dengue, of which 49,000 cases were severe dengue.\(^{13}\) DENV illness ranks fifth among the neglected tropical diseases in the Americas in terms of DALYs\(^{14}\)

TEND will focus on this important problem to demonstrate the power of multidisciplinary collaboration and innovative technology to eradicate as a public health threat a major source of mortality and morbidity in LIMC. The disease will be an important test of the consortium’s ability to collaborate, develop solutions and implement interventions impacting public health. Careful evaluation of the impact of the program will provide an impetus for further TEND efforts to address cholera, onchocerciasis, lymphatic filariasis, leprosy and other neglected diseases in the Americas and worldwide.

Budget Principles

The annual budget for TEND will be USD 2 million. The project will evolve to sustainable leave-behind capability handoff in year 5. The total 5-year direct budget for the project will be USD 10 million. A minimum of 20% of the total direct cost budget will be dedicated to implementation in target LIMC. FIU’s cost match will be 15%, contributed by Colleges. Leveraged investments of partners (PAHO/WHO, In-Country Tropical Medicine Centers, Industry) in this project will be about $10 million.

Implementation Timeline

**Year One**: Conduct partnership building activities to create collaborations necessary to move TEND projects to research and implementation phase; Integrate STEM with TerraFly; demonstrate ability to visualize output from any model to TerraFly; recruit first exchange cohort for training of health professionals from LIMC and U.S and conduct the first certificate courses;
Year Two: Create and pilot a hyper-connected communications hub and a community of practice for LIMC and project partners for the eradication of EID and NTD; epidemiological modeling of Dengue in Columbia and the Dominican Republic with output to TerraFly;

Year Three: Geospatially map and analyze Dengue infections in Dominican Republic and Columbia, and conduct formative research on dengue eradication strategies; recruit additional cohorts for training of health professionals from LIMC and U.S and begin the first year of collaborative graduate degree programs; dengue model validation based on historical incidence (aggregate anonymized data) imported into TerraFly;

Year Four: Deploy and oversee dengue eradication strategies in Dominican Republic and Columbia; continue to expand and develop certificate and graduate degree programs; dengue intervention model running inside TerraFly; quantitative and visual evaluation and comparison of vaccination strategies; and

Year Five: Conduct economic evaluation and M&E on dengue eradication in Dominican Republic and Columbia and disseminate best practices; expand the graduate degree program to include a hyperconnected network of experts in detection and surveillance, diagnostics, prevention, innovation, and treatment of emerging, tropical, and neglected diseases; scale up architecture for cloud-based TEND system to support future vaccine and treatment trials and modeling of new diseases.

Conclusion

Poverty coupled with environmental degradation inescapably lead to increasing mortality and morbidity from EID and NTC in low-income regions of the world. The WHO estimates that diseases associated with poverty cause 45% of the total disease burden in developing countries. The focus to date has been on the control of major communicable diseases with high mortality rates, such as HIV/AIDS, tuberculosis, and malaria. Unfortunately, there is a growing public health threat from emerging and neglected diseases that has received little attention from governments and international civil society. The creation of a Technological Center for Elimination of Poverty-Related Emerging & Neglected Diseases (TEND) at Florida International University will be important in building multidisciplinary collaboration to address this important public health issue and catalyze the creation and transfer of technology and interventions that are critical to development and stability of LIMC.

Lawrence Summers at the U.S. Department of State put it succinctly when he said “Increasingly, as integration proceeds, the world is confronting a broad class of problems that cross borders and defy easy solution by individual governments and markets. Whether it is money laundering and financial crime, climate change, or reductions in global biodiversity -- the solutions to these problems will be global public goods, requiring concerted global cooperation.”

FIU occupies a unique niche in higher education as one of the largest minority majority institutions with strong ties to LIMC in Central and South America. Leveraging those resources could make a critical difference in addressing emerging and reemerging infectious disease—a goal that is important not only to LIMC but also to the USA, and to the world at large.

Creating a Technological Center for Elimination of Poverty-Related Emerging & Neglected Diseases (TEND) at Florida International University will have several important outcomes. First and foremost it will provide international educational opportunities for graduate students in medicine, public health, engineering, and social sciences. Second, it will enhance the stature of FIU as an institution involved with public health research and initiatives worldwide. Third, it will create educational opportunities for domestic and international students and promote the university’s importance among potential students abroad. Finally, it will solidify FIU’s position as an important institution that collaborates and partners with industry, government and civil society worldwide.
References Cited


Concept Note Budget Summary

We plan to request $2,000,000 per year from USAID. The total USAID request will be $10,000,000 over five years.

We plan to include the following cost-sharing:

- FIU Cost Sharing in the form of:
  - E&G-supported research time for the faculty members involved. The amount will include salary, fringe benefits, and imputed F&A costs.
  - E&G-supported graduate research assistants provided by the College of Medicine and the College of Engineering and Computing. The amount will include wages, tuition, fringe benefits, and imputed F&A costs.
  - Other?

- IBM Cost Sharing in the form of IBM-supported labor for the IBM staff members involved in the project.

- PAHO/WHO Cost sharing in the form of labor and supplies in country.

- Collaborating Centers Cost sharing of professors and staff.

We plan to include the following leveraging:

- IBM leverage includes over $10,000,000 invested in the technologies to be used in the system, including open source software plus the ecosystem around it that includes the German Federal Institute of Risk Assessment that is also contributing to and using the system.

- Sanofi-Pasture in the form of supplies, personnel, and data sharing.

- Sustainable Sciences Institute (SSI) at the University of California, Berkeley in the form of collaborative research.