BENNETT, RPI

DHS Coastal Resilience Center

Research Project Work Plan

1/1/2016 – 12/31/2017

1. **Project Title**: Establishment of a Remote Sensing Based Monitoring Program for Performance Health Assessment of the Sacramento Delta
2. **Principal Investigator**: Victoria Bennett, Rensselaer Polytechnic Institute
3. **Other Research Participants/Partners**:
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   - Cathleen Jones, NASA/Jet Propulsion Laboratory;
   - Joel Dudas, Department of Water Resources, Sacramento, CA;
   - Mike Sharp, USACE, Vicksburg, MS
4. **Short Project Description**:

   As climate change progresses in the form of continuous land subsidence and rising sea water level, the integrity and reliability of flood-control infrastructure become ever more essential components to homeland safety. This project will employ a sensor-based (remote sensing with in-ground instrumentation for validation) and model-aided approach to provide engineers and decision makers with systematic tools to assess the health and provide early warning of deteriorating levees in the Sacramento Delta. The modeling tool integrates the use of measured data with the concept of performance limit states to effectively achieve a performance-based, network-level health assessment of the levee system.
5. **Abstract**:

   As climate change progresses in the form of continuous land subsidence and rising sea water level, the integrity and reliability of flood-control infrastructure (i.e., earthen dams and levees) become increasingly essential components of homeland security. The failure of such systems due to natural or man-made hazards such as hurricanes, floods, earthquakes, deterioration, or terrorist attacks may have monumental repercussions, sometimes with dramatic and unanticipated consequences on human life and the country's economy. The failure of levees during Hurricane Katrina in 2005 is a highly illustrative example of the criticality of this type of infrastructure. The national flood-control infrastructure is aging and its structural health is deteriorating. The ASCE's 2013 Report Card for America's Infrastructure gives the condition of our nation's dams a grade of D and levees a grade of D- (unchanged since the 2009 Report Card). The situation is further complicated by the massive amount of flood-control infrastructure to inspect. This system comprises over 5,600 km of levees. Furthermore, 43 percent of the U.S. population lives in counties with levees designed to provide some level of protection from flooding. Some are as old as 150 years. Assessing the health, predicting the failure and implementing countermeasures are challenging tasks for any civil infrastructure in

view of the complexity of the associated processes of long-term environmental degradation and wear. To efficiently maintain this infrastructure, managing engineers should have access to fully automated programs to continuously monitor, assess the health and adaptively upgrade these systems. *A validated remote sensing-based (i.e., satellite or airborne radar) approach will be used to assess the health of this spatially distributed system in order to identify weak sections and impending failures that can be used to help prioritize maintenance and upgrade efforts.* Through preliminary successes in a limited testbed, this project highlights the potential of a remote sensing-based monitoring system and health assessment tools that will enable early identification and warning of vulnerable levee or dam sections enabling prioritized repair work.

The proposed project will be sensor-based and model-aided to provide engineers and decision makers with systematic tools to assess the health and provide early warning of deteriorating levees, dams, navigation waterways and other similar flood-control infrastructure. The innovation of the proposed research approach may be summarized as follows:

i. Use of a remote sensing monitoring program for network-level assessment of the Sacramento Delta levees, with in-ground instrumentation for validation of remote measurements at two high-risk field sites;
ii. Provide field engineers with a health assessment tool for effective management of flood control infrastructure and efficacy of alternative remedial measures. The new tool integrates the use of measured data with the concept of performance limit states to effectively achieve a performance-based, network-level health assessment of the flood-control infrastructure.

Even with the achievement of these advances, a remote sensing approach to the management of critical infrastructure on a network level will only be fully accepted by the engineering community if it can be presented in a relevant and practical manner. Toward this end, the *interdisciplinary effort* presented herein is necessary. The proposed research will focus on monitoring levees in the Sacramento Delta but, *from a broader impacts viewpoint*, the technological advances from this research will benefit other infrastructure networks of urban cities (transportation network, slope stability hazard, coastal erosion, etc.). The resulting levee deformation dataset will be a unique resource not only for the purpose of developing improved understanding of long-term levee performance, particularly in the face of anticipated environmental changes in the delta region, but also for calibration and validation of levee performance models that can be applied nationwide, including coastal regions.