STATEMENTS OF INTEREST
CALIFORNIAN CESU
NUMBER W912HZ-16-SOI-0027
PROJECT TO BE INITIATED IN 2016

Project Title: Evaluating Atmospheric Modeling to Predict Risk to Dams from Extreme Rainfall Events

Responses to this Request for Statements of Interest will be used to identify potential investigators for a project to be funded by the U.S. Army Corps of Engineers Risk Management Center which provides support for hydrologic program for the National Dam Safety Program, the Hydraulics and Hydrologic Community of Practice Lead at USACE Headquarters, and the Portland District. The estimated level of funding for FY16 is approximately $250,000.00. Additional funds of $250,000/yr for 4 additional years may also be available for follow on work providing the potential funding of $1.25M over 5 years to the successful Recipient/Awardee.

Background:
The standard approach to the estimation of maximum precipitation over a watershed has been applied in many regions of the world, but the assumptions in the standard precipitation estimation method remain arguable. Detailed investigation of historical extreme events in the country have deemed the linear separation of the orographic component from the moisture convergence component questions, given the Earth's atmosphere is a highly nonlinear system. It is also uncertain that the precipitation is linearly related to the precipitable water in the atmosphere, as is often assumed in the standard maximum precipitation methods. Additionally, it is unknown whether the precipitation distribution remains constant as the atmospheric moisture increases. The spatial representation of the precipitation field over a watershed may also cause significant uncertainty in the standard maximum precipitation estimation. To compute the maximum precipitation for a watershed, the climatologic spatial distribution of the precipitation is typically adopted, but such synoptic scale of precipitation dynamics may be unrepresentative for the watershed-scale precipitation estimates. Thus, it is necessary to develop a scientifically sound methodology that can systematically compute the upper physical bound of precipitation over a study watershed.

A numerical modeling approach that accounts for the various effects of the nonlinear atmospheric system in an orographic region may provide an objective maximization of precipitation without any assumptions and statistical linear relationships. Numerical atmospheric modeling methodology has been applied successfully to the estimation of maximum precipitation over American, Yuba and Feather River basins in California as well as watersheds in Europe and South America.

Recent advances in dynamical atmospheric numerical modeling have provided a foundation for making physically based assessments of precipitation associated with extreme storms. Dynamical models can be used to reproduce past storms with coverage that is spatially and temporally continuous, hence relies on far fewer subjective assumptions, approximations and transpositions than other traditional methods. Moreover, model simulations can directly represent non-linear atmospheric dynamics that may not be well represented by statistically and empirically derived relationships. The Weather Research and Forecasting model (WRF, www.wrf-model.org) has been used to simulate extreme precipitation (e.g., Leung et al., 2009; Jankov et al. 2007) and used more recently in PMP analyses (Ohara et al. 2011; Chen and Hossain, 2016; Sankovich et al.). Forced with initial and boundary conditions (IC/BC) from reanalysis weather data (fields from a global/regional atmospheric model constrained by observed patterns) for a historical period, past storms can be simulated across domains discretized at spatial resolutions as fine as 1 km. Furthermore, these modeling techniques can be applied to maximize precipitation by adjusting humidity fields and by spatially adjusting boundary conditions to manipulate moisture flux trajectories to a basin of interest.

Public Benefit:
Characterization of extreme storms for a dam safety risk assessment can result in millions of tax payer dollars spent or saved on dam remediation. The United States has thousands of impoundment structures with varying risk levels. Improvements to the methodologies used to reduce the uncertainty in the inflow design flood estimates that are firmly dependent upon the estimates of the extreme storms in a given region can improve the prioritization of dam remediation. The evaluation of these new dynamic atmospheric numerical modeling techniques to predict potential effects from extreme storm events will help ensure priority safety risks are addressed according to their risk level, resulting in greater protection of lives and property throughout the country.

Brief Description of Anticipated Work:
In this study, the maximum precipitation will be estimated over the watershed of the Willamette Basin. To estimate the maximum precipitation, historical severe storm events will be maximized by means of a physically-based regional atmospheric model. Initial conditions and atmospheric boundary conditions of the regional atmospheric model will be adjusted based on those conditions of historical severe storm events. Then, the severest precipitation among the maximized results will be selected as the maximum precipitation over the study watershed. Historical severe storm events need to be selected for maximization. However, the number of observation stations in the study area and their recording periods are insufficient to select historical storm events from observation data. Therefore, the historical data going back to the mid-1850s will be reconstructed from the coarse-resolution NCEP/NCAR Reanalysis I atmospheric data by the regional atmospheric model. Then, the basin-average precipitation will be calculated over the study watershed from the reconstructed historical data. The basin-average precipitation for all analyzed water years will be used to differentiate storm events. Based on this reconstructed data, the most severe storm events over the study watershed will be selected for the physically-based maximization of precipitation. The selected severe storm events will be maximized by means of the regional atmospheric model.

Objectives:

1) Develop a suite of possible extreme storm temperature and spatial patterns each with associated temperature sequences for the Willamette Basin in western Oregon.
2) Calibrate the physical model with 10 or more extreme storms
3) Use the calibrated events as basis of the initial and boundary conditions of the extreme storms.
4) Maximize historical storms and the transposition of regionally-relevant historical storms to various maximizing and reasonable centerings in the Willamette Basin.

5) Prepare a summary report that evaluates the potential application of this new modeling approach to determine impoundment risk of failure due to extreme storm events

Vendor Requirements:
The candidate must be a non-Government member of the Californian CESU Unit and accept the negotiated indirect cost rate of 17.5% for CESU cooperative agreement studies.

Government Participation:
The USACE, Portland District Representatives will participate in study planning and providing case study data and information to the selected Vendor. The USACE, Portland District Representatives will participate in study site selection, field site visits as appropriate, and the review and selection of proposed methods and products. The USACE, Portland District Representatives will provide technical review of data and reports for presentations and publications that disseminate the results of accomplished work.

Materials Requested for Statement of Interest/Qualifications:
Please provide the following via e-mail attachment to:
Deberay R. Carmichael@usace.army.mil (Maximum length: 2 pages, single-spaced 12 pt. font).
1. Name, Organization and Contact Information
2. Brief Statement of Qualifications (including):
a. Biographical Sketch,
b. Relevant past projects and clients with brief descriptions of these projects,
c. Staff, faculty or students available to work on this project and their areas of expertise,
d. Any brief description of capabilities to successfully complete the project you may wish to add (e.g. computer equipment, etc.).
Note: A proposed budget is NOT requested at this time.

Review of Statements Received: Based on a review of the Statements of Interest received, an investigator or investigators will be invited to prepare a full study proposal. Statements will be evaluated based on the investigator’s specific experience and capabilities in areas related to the study requirements. Additionally, the evaluation method and selection criteria for research and development awards must be: (1) The Technical merits of the proposed research and development; and (2) Potential relationship of the proposed research and development to the Department of Defense missions.

Please send responses or direct questions to:
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Timeline for Review of Statements of Interest: Review of Statements of Interest will begin after the SOI has been posted on the CESU website for 10 working days.

References

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Ohara, N., Kavvas, M. L., Kure, S., Chen, Z. Q., Jang, S., and Tan, E. (2011). "Physically Based Estimation of Maximum Precipitation over American River Watershed, California." Journal of Hydrological Engineering, 16, 351-361.

Sankovich, V., Caldwell, R.J., and Mahoney, K. (2012) Green Mountain Dam Climate Change, Bureau of Reclamation, Dam Safety Technology Development Program Report DSO-12-03, 31 p.
http://www.usbr.gov/ssle/damsafety/TechDev/DSOTechDev/DSO-12-03.pdf