HYDROLOGY & WATER SECURITY PROGRAM
The UNIVERSITY of OKLAHOMA

HWS: Water Education, Research and Outreach

http://hydro.ou.edu

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OU Hydrology and Water Security Program

Maximizing and Excelling OU Water Education, Research and Outreach/Service

1. **Vision:** To develop internationally recognized research and graduate education programs in *Hydrology and Water Security* at the University of Oklahoma that produce society's future leaders *in the realm of understanding complex issues of water resources, including effective and equitable management strategies for high-impact water-related hazards such as flooding and droughts*.

1. **Mission Statement.** The Mission of the HWS graduate program is to provide unique opportunities for graduate-level learning, research and engagement at the nexus of water, weather, climate, agriculture, energy, policy, and sustainability.

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OU HWS Program: Online Education

The Hydrology and Water Security Program at the University of Oklahoma is a partnership between:

Four Departments

- The School of Civil Engineering and Environmental Science
- The School of Meteorology
- The Department of Geography and Environmental Sustainability
- ConocoPhillips School of Geology and Geophysics

Three Colleges

- Gallogly College of Engineering
- College of Atmospheric and Geographic Sciences
- Mewbourne College of Earth and Energy

Two Tracks

- Hydrology
- Water Security

To Create ... **One Program**

... Focused on the critical issues involving water in all forms and impacts on society and the environment. Faculty are comprised of experts across multidisciplinary hydrologic experience which provides a unique perspective for industry professionals that cannot be found in other graduate programs.

Online M.S. in Environmental Science: Hydrology & Water Security

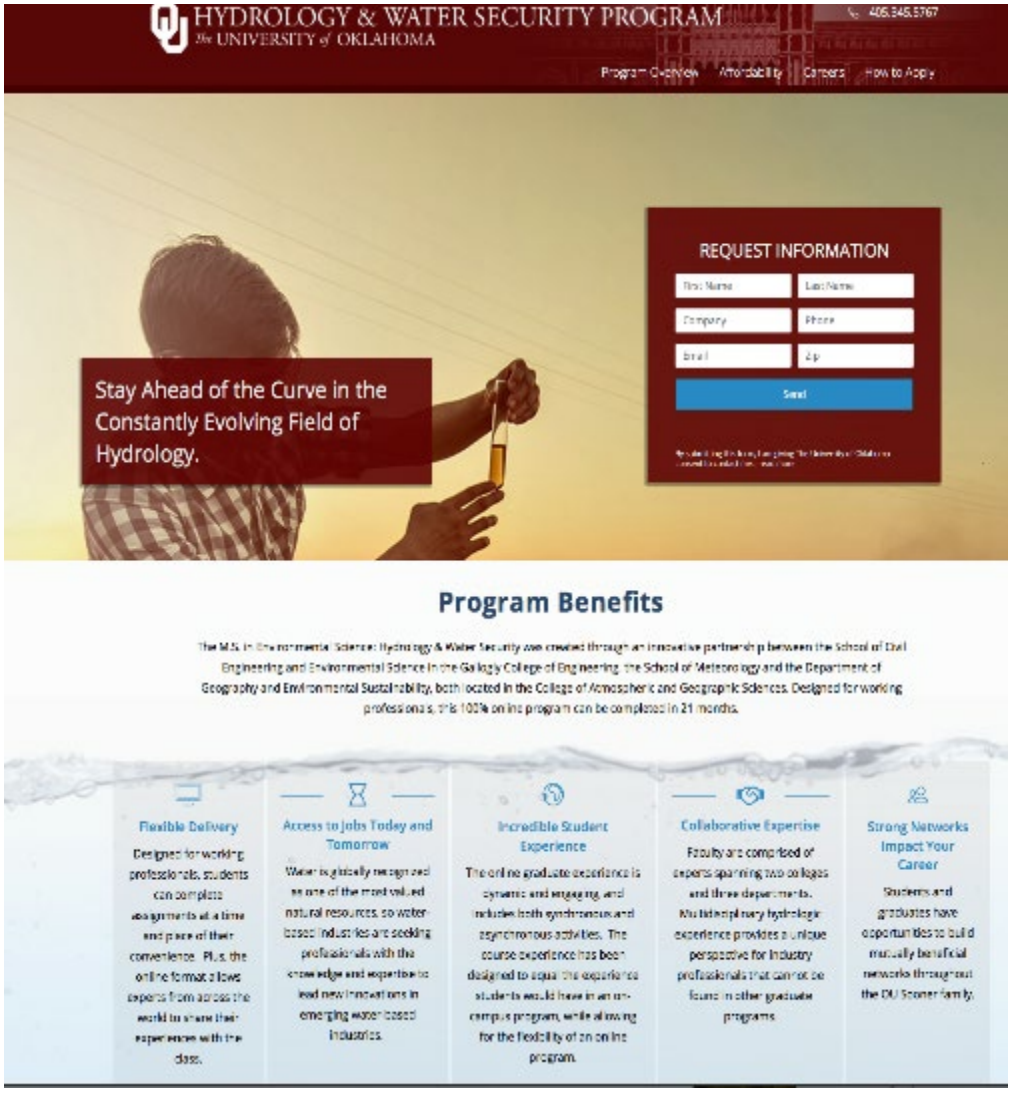
- The Online M.S. in Environmental Science: Hydrology & Water Security is a 32 credit-hour program, designed to be completed in 21 months while working full-time.
- The program offers an interdisciplinary lens to various issues related to water and water security.
- Students who graduate with a B.S. in a field related to Hydrology, including Civil & Environmental Engineering, Geology, Physics, Computer Science, Environmental Science, or another non-Hydrology B.S. are encouraged to apply.
- Students can pursue one of two degree track options: (1) Hydrology and (2) Water Security.

Two Tracks for Online MS:

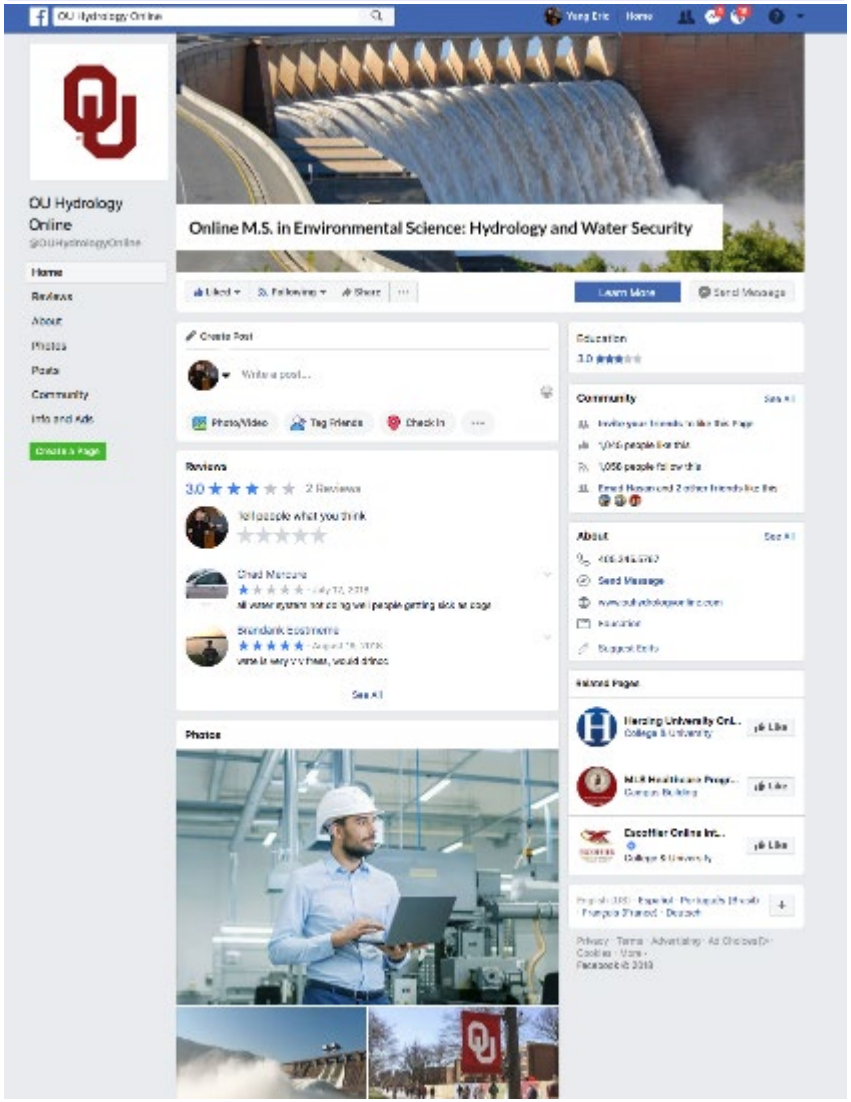
A. Hydrology Track (more technical) - launched Fall 2018; First cohort ~20 online students. 32 credit hour degree can be completed in 21 months.
B. Water Security Track (more conceptual science and policy/management) kick off Spring 2019.
C. By 2019 Fall, 75-100 Graduate Students

Online Master Program HWS: Hydrology & Water Security

Webpage: https://www.ouhydrologyonline.com;



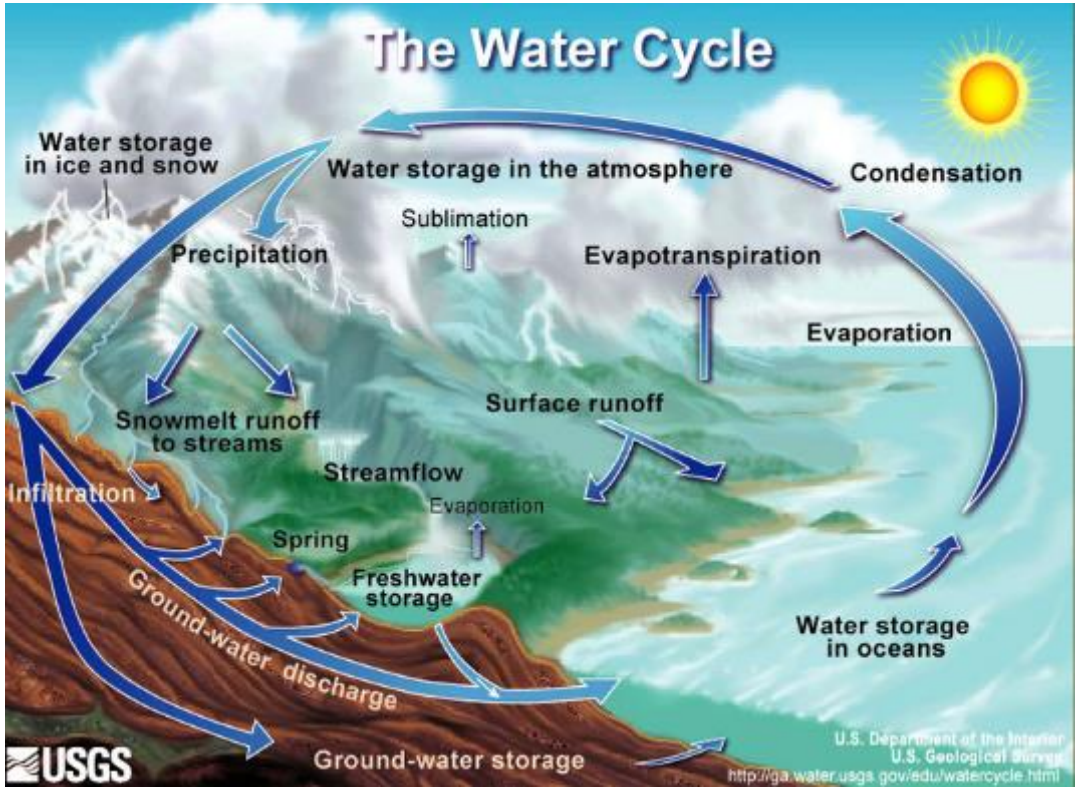
Facebook: https://www.facebook.com/OUHydrologyOnline



The Hydrology and Water Security: Research

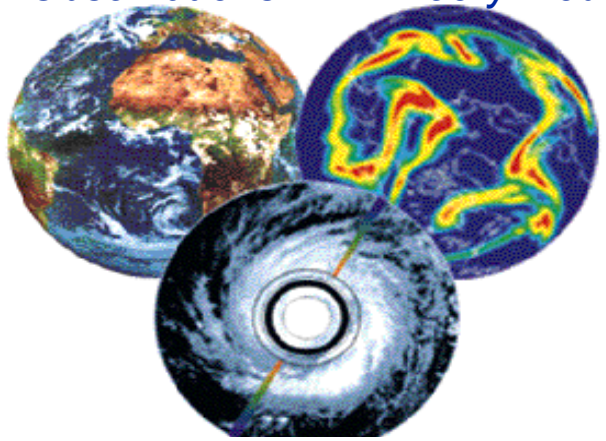
Research Vision/Grand Challenge

To observe, understand and predict the storage, movement, and quality of water across space-time scales under changing climate



An End-to-End Framework

1. Observations *2. Theory/Models*



3. Prediction → Societal Benefits

OU Hydrology & Water Security Core Research Competencies

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- Synergy of remote-sensing, water, weather, and climate
- Observing and modeling at local, state, regional and global scales

- Competencies
  - Hydrology and Water Resources/Hydrological System Analysis
  - Natural Hazard Prediction, Disaster Risk Research (e.g. Flooding, Droughts, Landslides)
  - Measurement, Retrieval, Validation, and Applications of Precipitation, Soil Moisture, and Evapotranspiration
  - Hydrometeorology/Radar Meteorology/Radar Hydrology
  - Data Assimilation Systems for Water and Climate Prediction
  - Water Availability and Hydrologic Extremes
  - Environmental Resources and Sustainable Development

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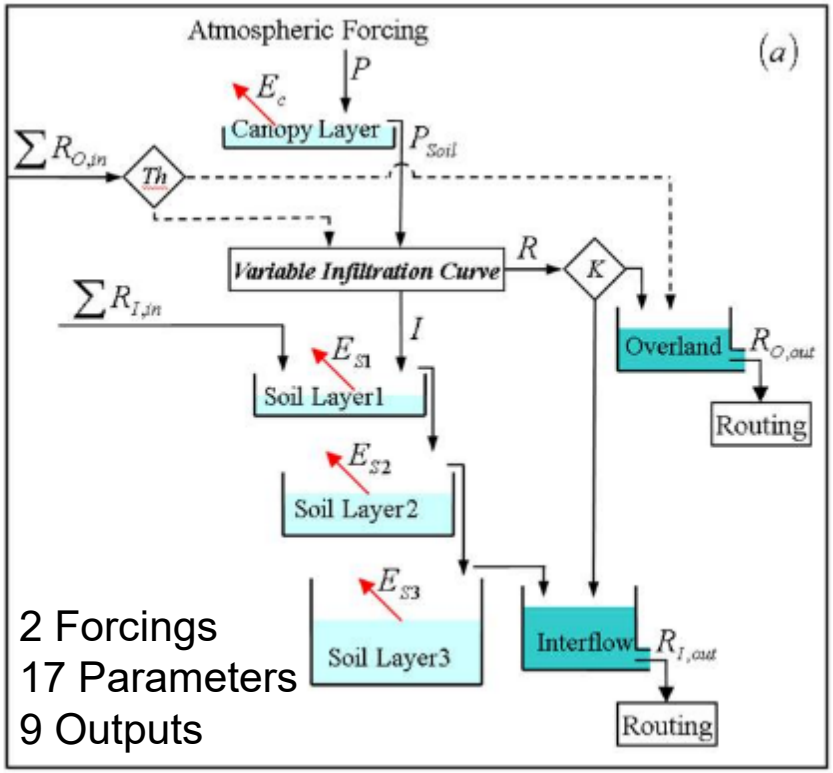
HWS Research Projects

- NSF PIRE (Partnership for International Research and Education): Taming Water in Ethiopia: An Interdisciplinary Approach to Improve Human Security in a Water-Dependent Emerging Region, $5.3M,
- NASA/USAID, Communicating and Forecasting Water-related Hazards in Africa,$600K
- NOAA: Develop Improved Prediction of Inland Flooding System, $1.5M
- NASA Earth Science Application Program-Disaster Decision Support: “Real-time Global Flood Analyses and Forecasts Using Satellite Rainfall and Hydrological Models”
- NASA Precipitation Measuring Mission Science Team: A Research Framework to Bridge GPM Core and Constellation Sensors using Polarimetric National Mosaic QPE (NMQ)
- NASA Precipitation Measuring Mission Science Team: Use of GV data to evaluate and improve uses of satellite-rainfall in hydrologic modeling of complex terrain basin floods
- NASA, Multi-sensor Precipitation and Reflectivity Retrievals for PATH Mission, $300K, PI,
- DOI/USGS and South-Central Climate Science Center: Impacts of Climate Change on Flows in the Red River Basin
- NASA Earth Science Application Program-Disaster Decision Support: “NFL (NMQ-FLASH-LANDSLIDE): Utilization of NASA Earth Observations into a NOAA Coupled Flood and Landslide Prediction System over the US”
- NASA: Incorporating NASA Spaceborne Precipitation Research Products into NOAA National Mosaic QPE Operational System for Improved Short-Term Weather Prediction at Colorado Basin River Forecast Center
- NASA: Advancing Multi-scale Landslide Hazard Prediction by Integrating High Resolution Remote Sensing Data and Subsurface In-situ Monitoring, $1.2M
- US Army Corps of Engineers: Utilization of Regional Climate Science Programs in Reservoir and Watershed Risk-Base Impact Assessments Pilot Study
- OTC: ” Decision Support System for Road Closures in Flash Flood Emergencies”
- NOAA: Climate Futures, Urban Floods, and Forecasting: Linking Severe Weather Impacts with Climate Variability

NASA Global Precipitation Measurement Mission Project: Integrating Space and Ground Networks

CREST/EF5: A Distributed Hydrologic Model designed to take advantage of global forcing data, applied to global and regional scale projects

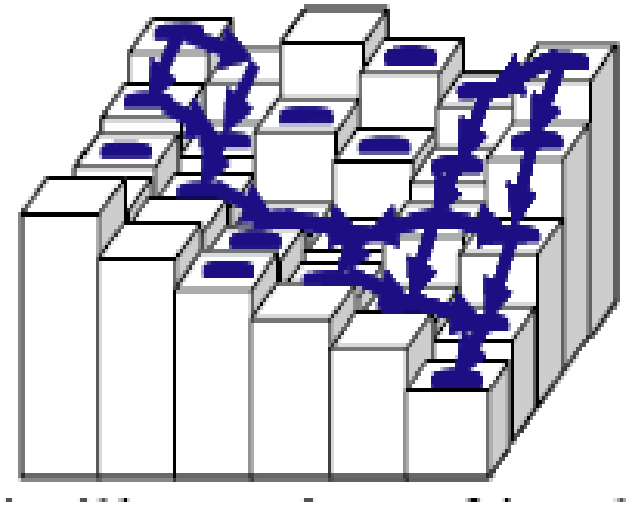
Wang and Hong et al. 2011



Coupled **R**outing and **E**xcess **ST**orage (CREST):

- Three soil layers.
- Distributed, fully coupled runoff generation and routing model
- Simulates water and energy fluxes and storage on a regular grid

Cell-to-Cell Flow Routing



Step I: Rainfall-infiltration Partitioning (distributed and time-variant)

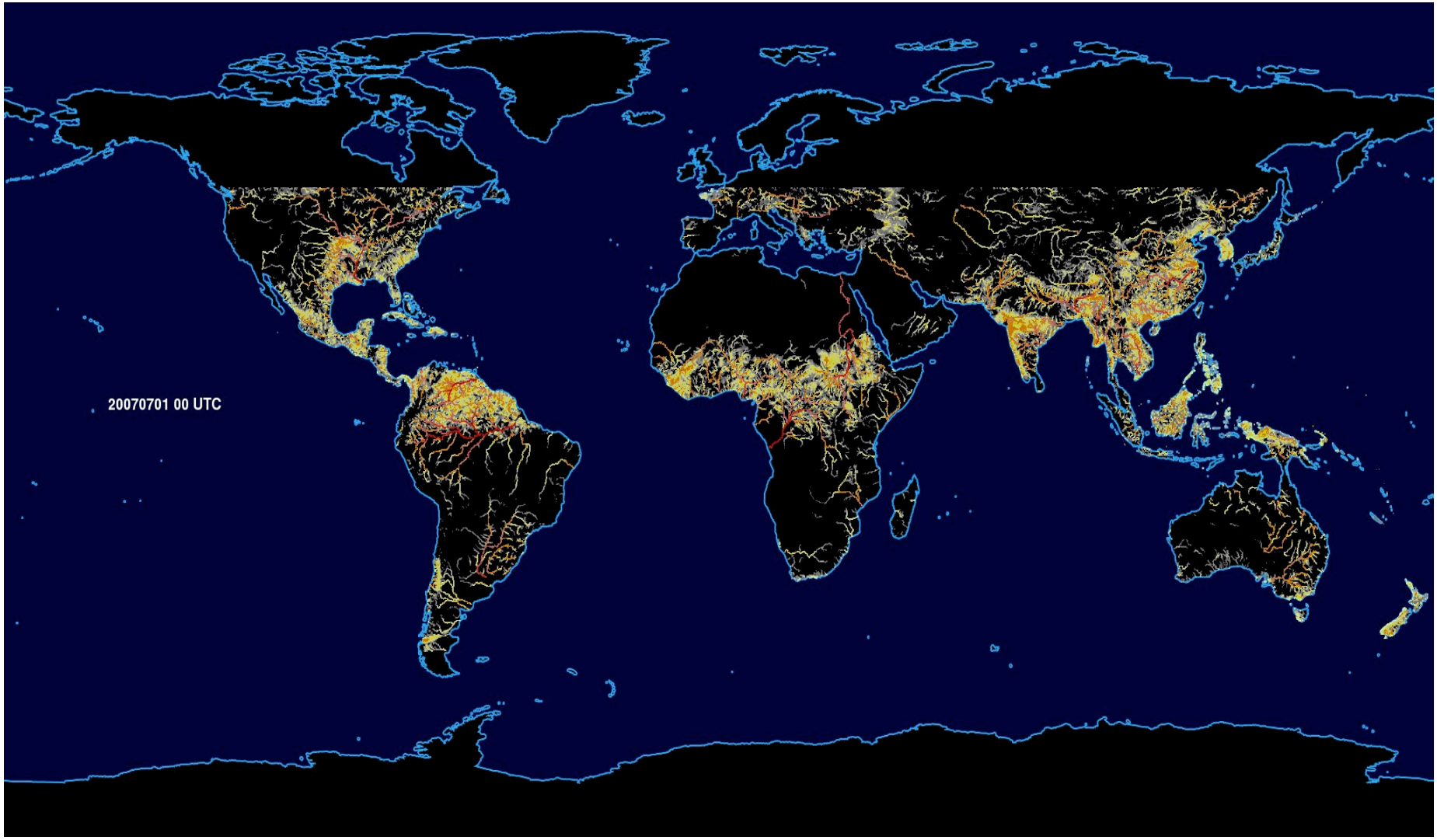
Step 2: Flow Routing using Macro-scale Cell-to-Cell Algorithm

Step 3: Grid Point Hydrographs--Flood Inundation Mapping

Global Hydrological Modeling

with CREST Model and Remote Sensing Forcing

Runoff Generation 5km; Streamflow Routing 1km



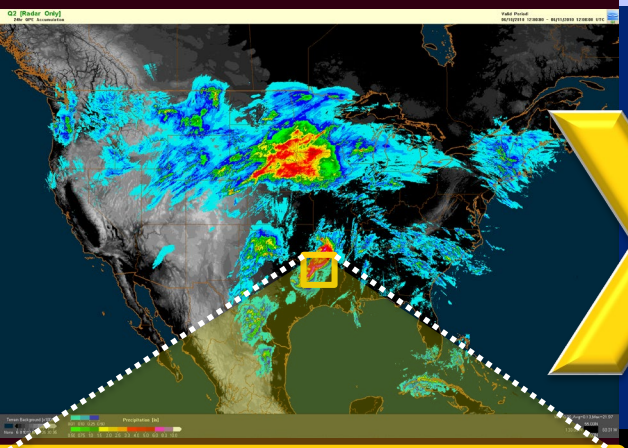
iCRESLIDE: USA NFL(National Flash Landslide) System

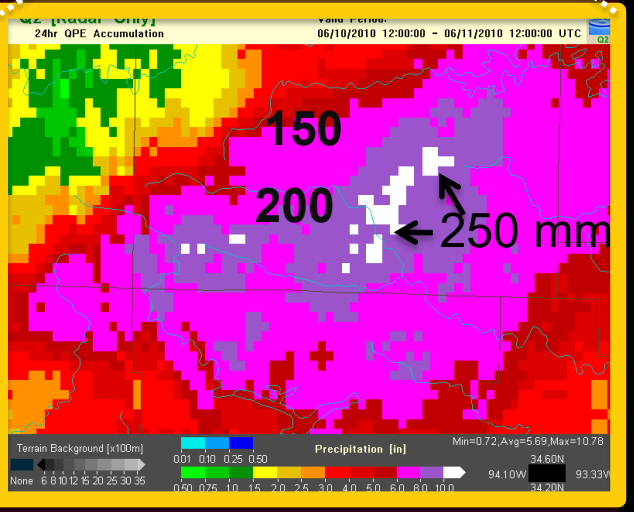
NMQ : National Mosaic and Multi-Sensor QPE (NMQ)

FLASH : Flooded Locations And Simulated Hydrographs

LANDSLIDE: SLope-Infiltration-Distributed Equilibrium Model

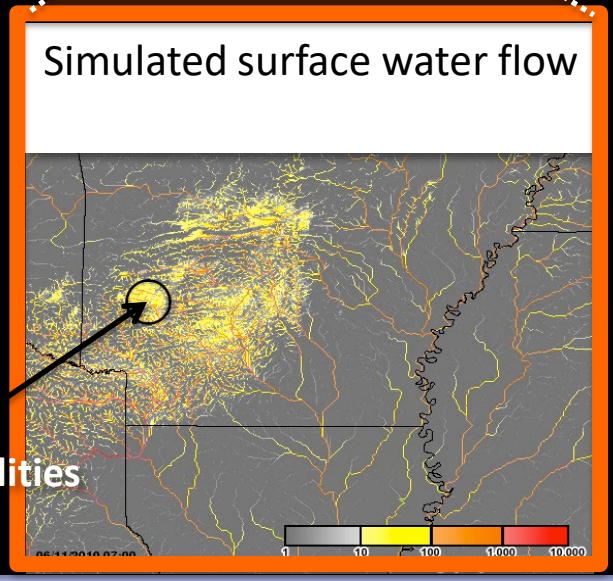
NMQ Radar Precipitation Observations *250 m/2.5 min*





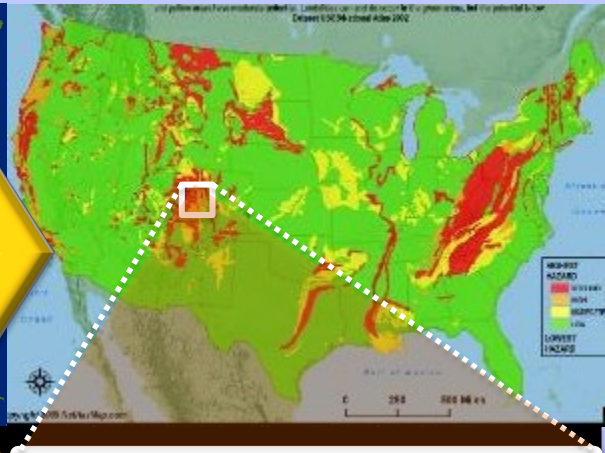
10-11 June 2010, Albert Pike Rec Area, Arkansas

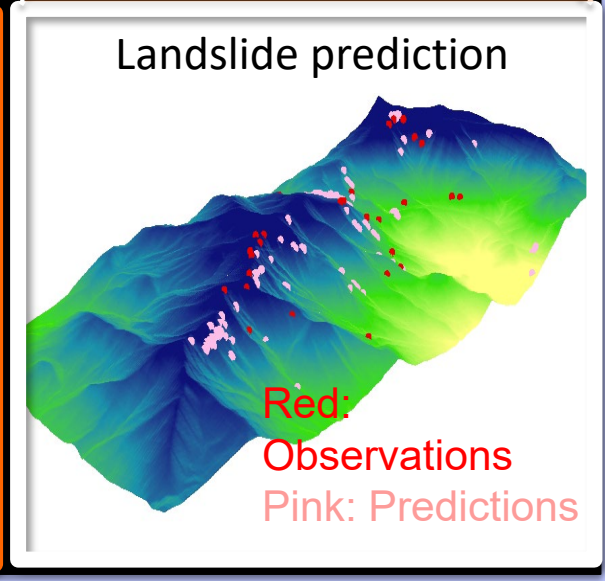
FLASH Distributed CREST Hydrologic Models

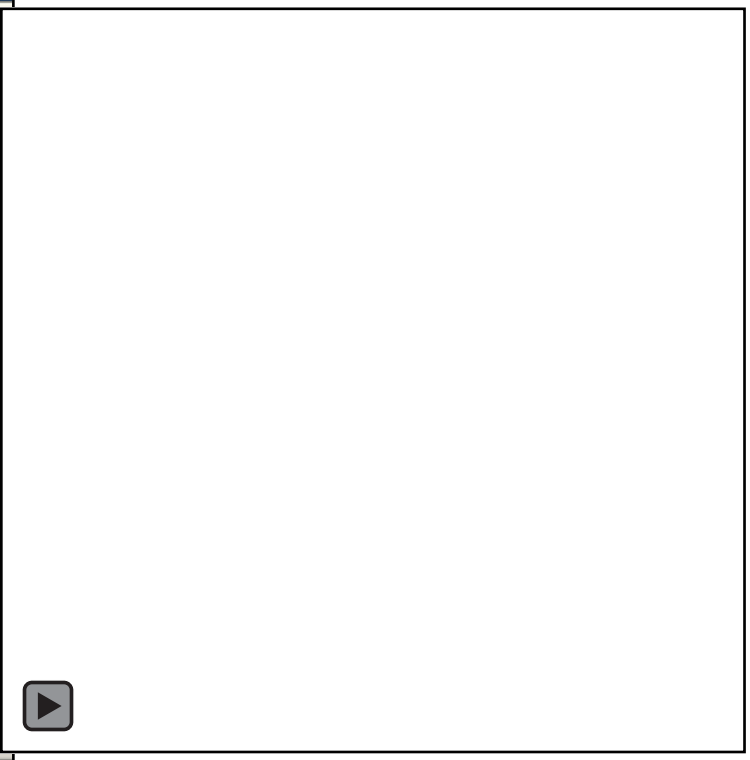


20 fatalities

LANDSLIDE Landslide Hotspot Models





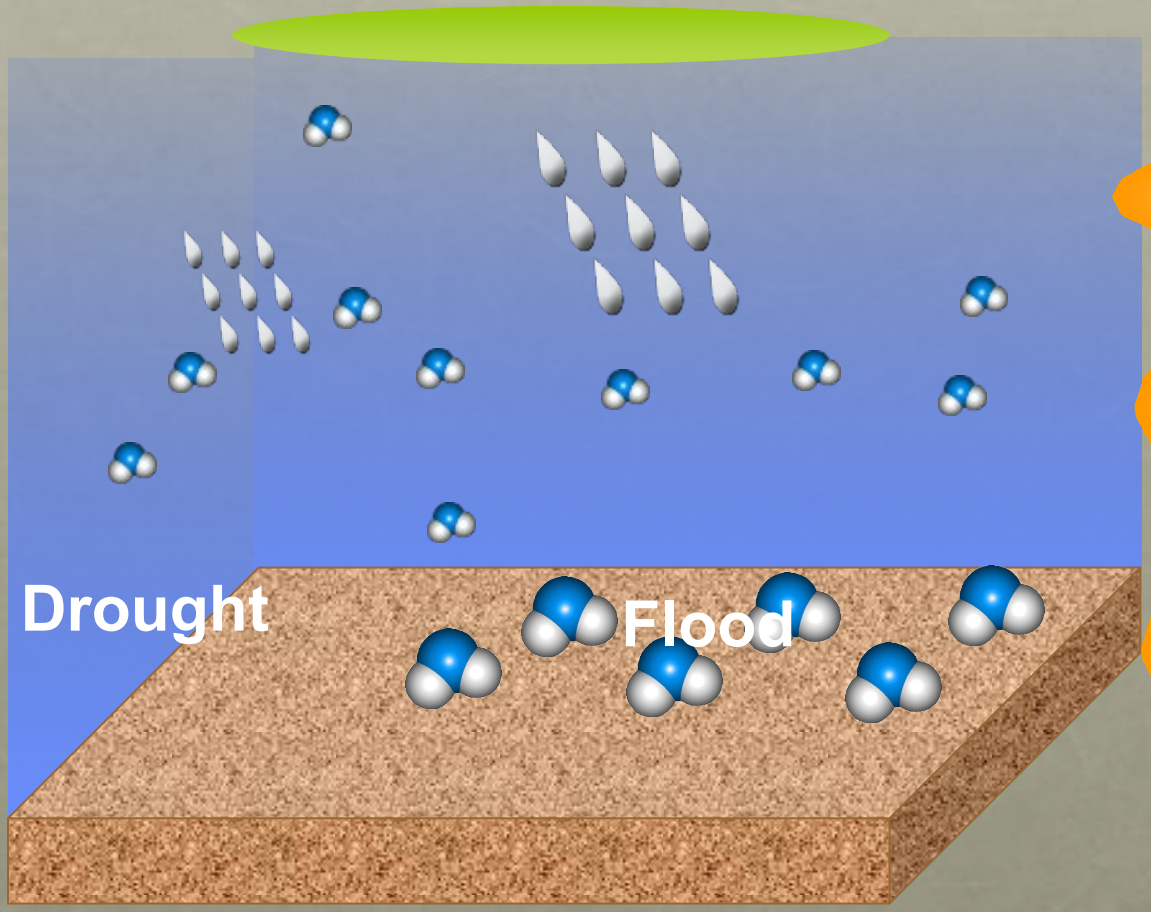


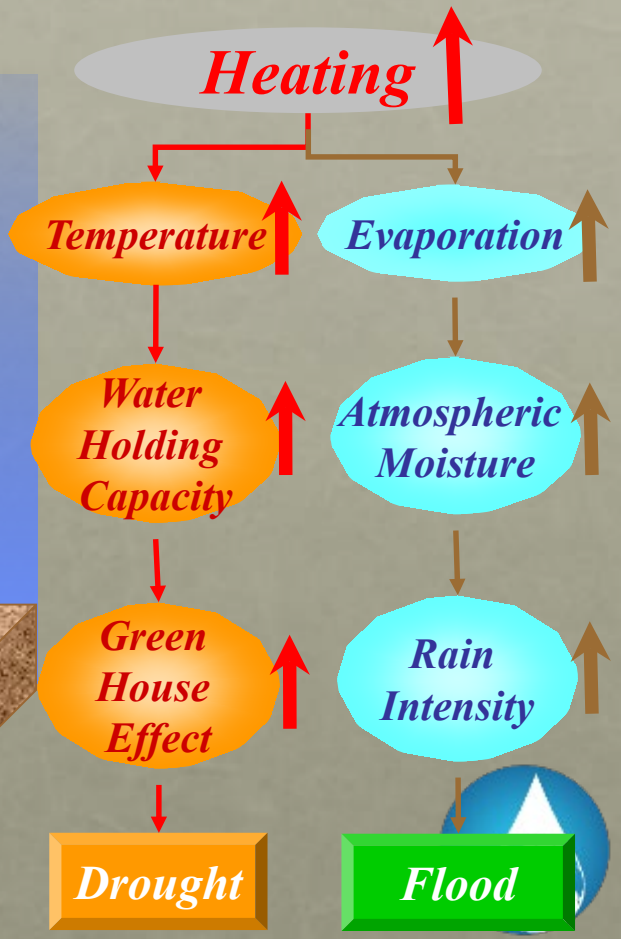
- 250m/5-min resolution of Q2 precipitation forcing and model outputs
- Addresses service needs in NWS; flash flooding is #1 weather-related killer
- 6/11 12:30am-4am 20 deaths: Little Missouri River Crested from 3 ft to 23.5 ft within 2 hours
- Include data assimilation and probabilistic products
- Readily incorporate dual-pol radar products (Q3) and stormscale ensemble forecasts

CLIMATE/WATER RESOURCES

Hydrologic cycle is intensifying due to warming climate:

Expect more Flooding / Drought / Heat Waves / Ice Storms / Natural Hazards?





URBAN FLOODING AND CLIMATE CHANGE - VISUALIZING THE IMPACTS

Flood in Oklahoma City, Oklahoma, May 23, 2015
(Photo by Jim Beckel / The Oklahoman)

Urban Flooding

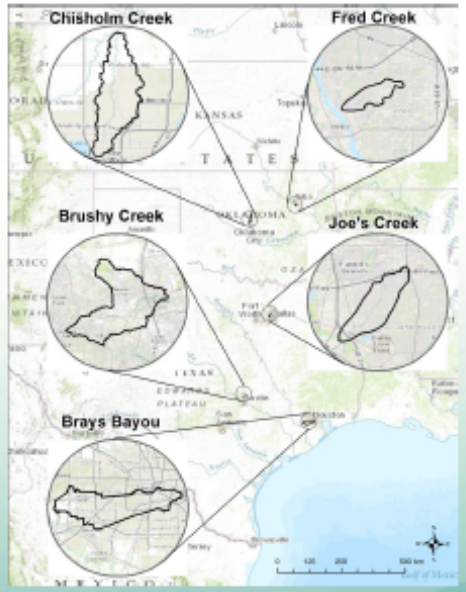
Urban flooding is a naturally-occurring hazard that affects cities and regions around the world, and is expected to become even more damaging in the future. Damages from floods are also increasing as are the number of people who are affected by them. While the 10-year average of recent flood damages was about $20 billion, some bad years can run as high as $40 billion. The devastating floods in Oklahoma and Teas in May, 2015 are likely to push the total cost even higher.

Climate Change

The recent U.S. National Climate Assessment reported that heavy rainfall events will increase, which are expected to increase the potential for flash flooding in the Southern Plains. Moreover, land cover, flow, water-supply management, soil moisture, and channel conditions are important and must be considered in projections of future flood risks. The NCA stated that to provide decision-makers with more timely, concise, and useful information, a sustained assessment process would include both ongoing engagement with public and private partners and targeted, scientifically rigorous reports that address concerns in a timely fashion.

Adapting to Changes in Climate and Urban Flooding

Researchers at the University of Oklahoma designed and carried out a project that meets the NCA goals for helping decision makers adapt to an increase in urban flooding caused by a changing climate. The team wanted to find out if visual animations of watersheds subject to increased flooding would be a preferable way to convey information to local decision makers. First, the research team adopted a stakeholder-based protocol that engaged local floodplain managers and watershed stakeholders in five cities in Oklahoma and Texas: Oklahoma City and Tulsa, OK, and Austin, Dallas, and Houston, TX.



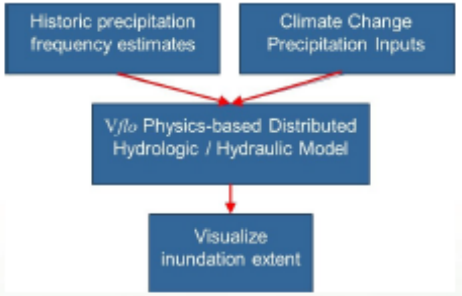
— Engage Local Stakeholders

The research team contacted the urban floodplain manager in each city and asked him to select a watershed for study.

The OU team then analyzed the selected watershed and made a presentation to the floodplain manager and his staff. Upon completion of the analysis of the watershed, which was animated for presentation, the floodplain manager distributed a web-based survey to a small group of key stakeholders.

— Modeling

In their analysis of each watershed, the research team followed a series of analytic steps that incorporated the key physical characteristics of the watershed, its hydrology, and projected climate changes.



— Visualization

Both historic and projected flooding events were visualized as an animation using Google Earth as geographic template.

HWS Outreach: Capacity Building, Workshop and Training

Researchers and graduate students have transferred our technology and systems to build local capacity by providing remote assistance, on-site workshops, and hands-on training in:

- Africa (Kenya, Namibia, Rwanda)
- South Asia (Pakistan, Nepal, Bhutan)
- Central/South America (Panama, Colombia)

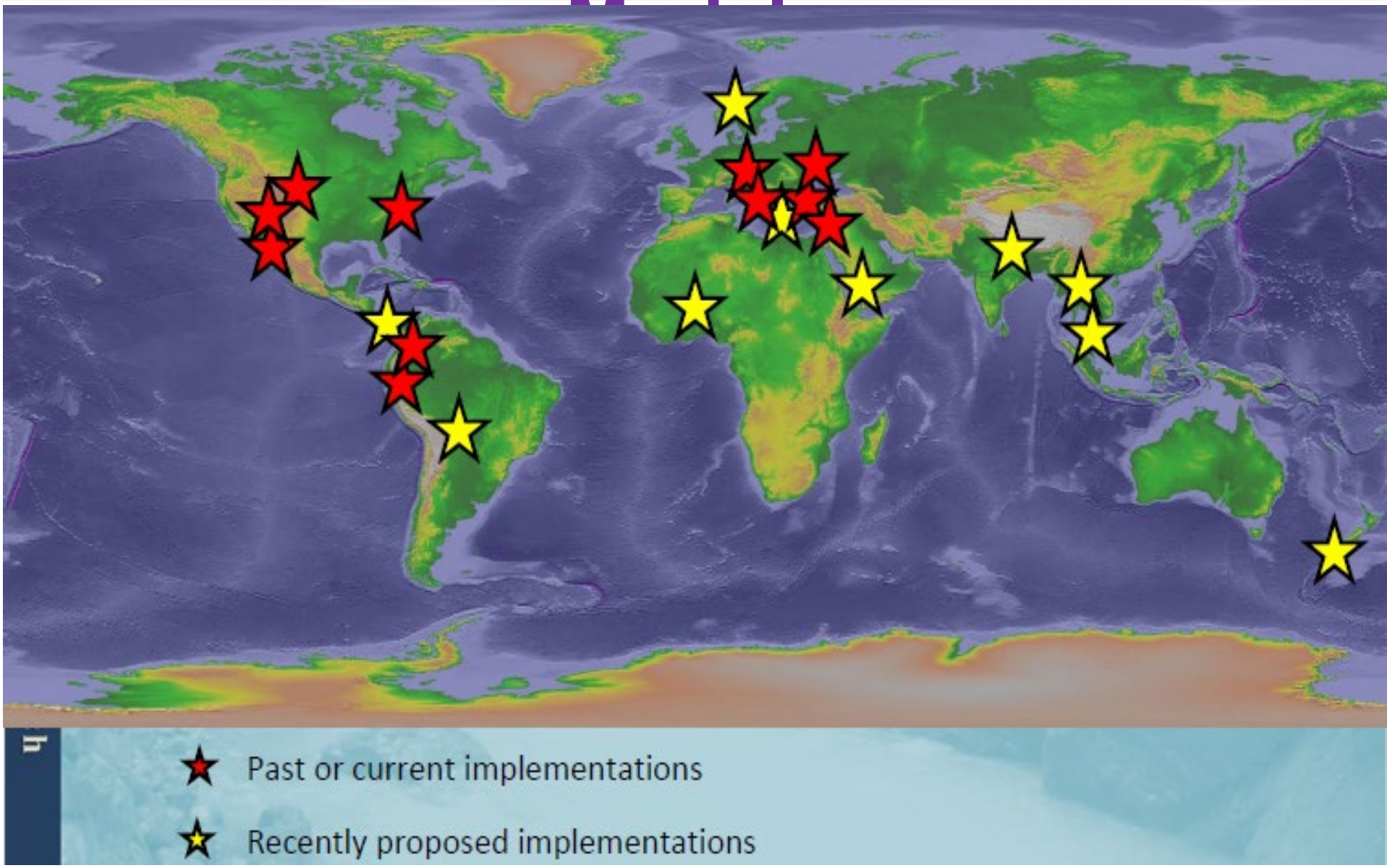
NASA-SERVIR CREST Modeling Workshop Commencement at RCMRD of Kenya


Zac Flamig Hosted CREST Hydrologic Model Training Workshop in Kigali, Rwanda

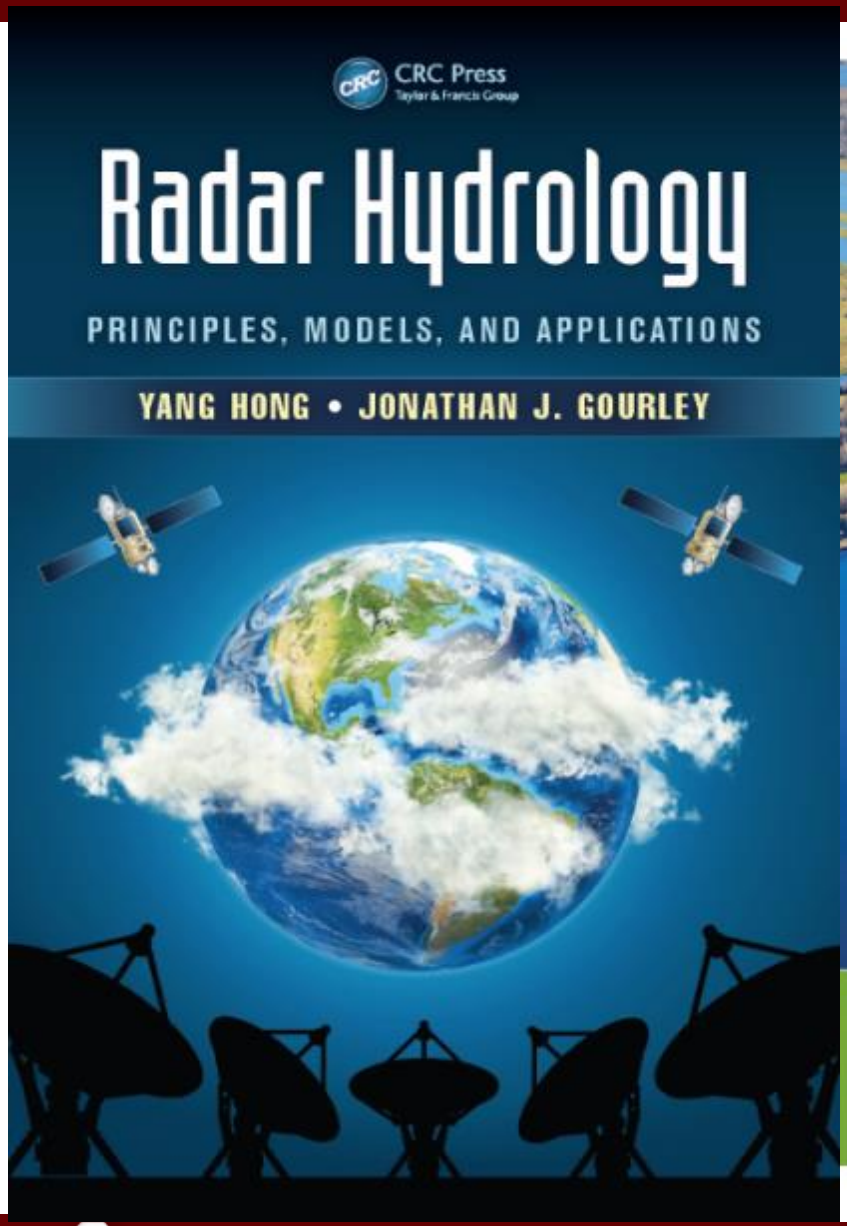
NASA

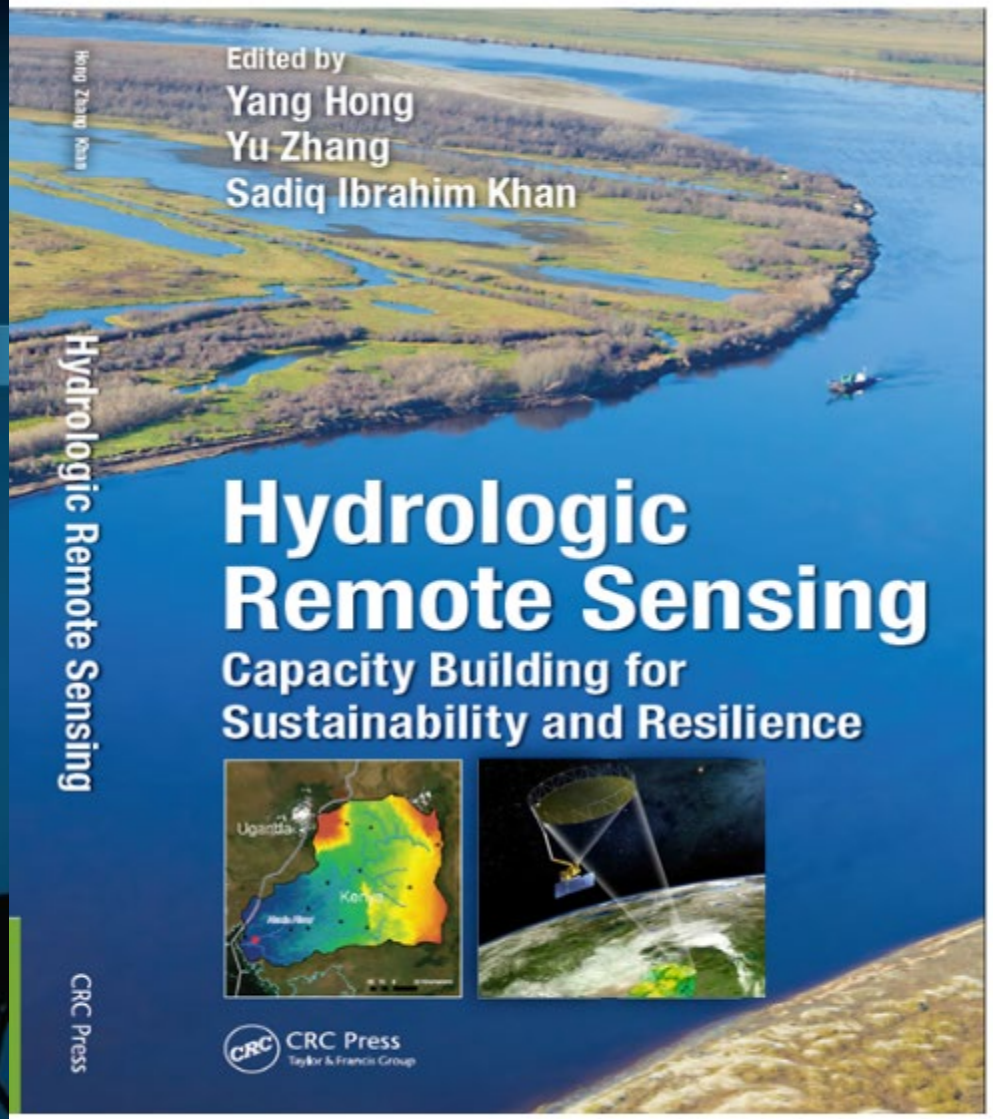
USAID
FROM THE AMERICAN PEOPLE

Worldwide Applications of CREST



Radar Hydrology and Hydrological Remote Sensing Books





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WATER SCIENCE AND RESOURCES CHALLENGES

Emerging and Innovative Technologies

- Over the next 25 years, new opportunities will emerge that will allow for observations that come from an array of sources, are more affordable, offer data from previously inaccessible locations, provide “fit-for-purpose” temporal and spatial resolution, and deliver measurements of new parameters.

- New space- and ground-based sensors, from satellite, aircrafts, drones to “lab-on-a-chip” sensors, will advance observations and analyses of water resources, but many technical challenges exist with respect to measuring and monitoring water quality.

- Microsensors remain an area of research and development that shows great promise, and the technology in this realm will continue to develop, improve, and become more affordable. Environmental DNA (eDNA) methods can already detect invasive species from a single sample of water; new insights into environmental health and resilience will follow.

- Developments in managing “big data” and integrating data from multiple sources and of different types will support improved scientific understanding, development of improved models, and interdisciplinary model integration.

- An area of great interest is improved coupled modeling of the natural-human water system. Projections of future human impacts and water-related risks, however, are inevitably associated with large uncertainties; therefore, a need exists to develop improved models to support decision-making under uncertainty.

- Improvements in water-resources data access and presentation will continue to be needed, as will the expansion of opportunities for citizen scientists to fill data gaps and supplement existing data networks through collection of basic water-quality measurements or water sampling for later analysis.

Collaboration: Working Together in Remote Sensing, Water, Weather and Climate

HWS builds collaborative research and education between OU and state/federal partners at the National Weather Center: **HWS, WaTER, OWS, CREW, ARRC, CAPS, CSA, CIMMS, OCS, OWRB, NOAA/NSSL, NASA(JPL, GSFC, MSFC), Japan, China, Colombia, Africa,**

Thank you for your attention!

Welcome to Visit OU HWS Program at OU/National Weather Center

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