Report on the 2011 Symposium on Data-driven Approaches to Droughts (DDAD)

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Overview

The driNET project team hosted the 2011 Symposium on Data-driven Approaches to Droughts (DDAD2011) on the Purdue University campus, West Lafayette, Indiana on June 21-22, 2011. Participants from a broad set of scientific domains in academic and national operations centers, government agencies and industry attended the symposium. The symposium featured 16 invited speakers, 24 posters, two panel sessions and full length research papers. The symposium participants - representing a cross-section of the community that studies and utilizes drought related information in research and decision making - focused on the theme of data-driven approaches for characterizing, understanding and modeling droughts. Many recommendations for future directions of drought classification, drought prediction and impact assessment tools, dissemination and education were made during this symposium.

The DDAD symposium information is available at: https://driNET.hubzero.org/symposiuminfo.

The papers, posters, presentation slides, as well as videos of the presentations and panel sessions are available at the Purdue e-Pubs web site (http://docs.lib.purdue.edu/ddad2011/) maintained by the Purdue Libraries.

Agenda

Tuesday, June 21, 2011, Stewart Center 202, 204

8:00 AM	Registration, Breakfast	
8:45 AM	Welcome and opening remarks	Carol Song, Bruce Erickson, Purdue University
	Morning Session (Chair: Dev Niyogi, Purdue University)	
9:00 AM	A look at the 20th century global droughts	Vijay Singh, Texas A&M University
	An update of NOAA's national integrated drought information system	Doug Kluck, NOAA
	Monitoring drought across many scales	Chris Funk, USGS/UCSB
10:30 AM	Break/coffee	
11:00 AM	Data challenges in the DataOne project	John Cobb, Oak Ridge National Laboratory

	Drought monitoring in the Midwest	Steve Hilberg, Midwestern Regional Climate Center
12:00 PM	Lunch (West Faculty Lounge)	
	Afternoon Session (Chair: Rao Govindaraju, Purdue University)	
2:00 PM	On the physics of droughts	Levent Kavvas, UC Davis
	A modified standardized precipitation index for monitoring drought	Brent McRoberts, Texas State Climatologist office
	driNET project overview	The driNET Team (Carol Song, Jake Carlson, DRao Govindaraju, Indrajeet Chaubey, Dev Niyogi), Purdue
3:30 PM	Break/coffee	
4:00 PM	Panel session: "Droughts in the 21th Century and Beyond"	Panelists: Jim Angel, Chris Funk, Vijay Singh, Mark Svoboda
5:30 PM	Poster session	
6:30 PM	Dinner (West Faculty Lounge)	Invited Speaker: Professor Emeritus Jack Delleur
8:00 PM	End of workshop schedule for June 21	

Wednesday, June 22, 2011, Stewart Center 202, 204

8:00 AM	Breakfast	
	Morning Session (Chair: Jake Carlson, Purdue University)	
9:00 AM	Building an enhanced drought early warning system: tool and services for decision support	Mark Svoboda, National Drought Mitigation Center, University of Nebraska, Lincoln
	Designing the workflow for a digital data repository	Cole Whiteman, University of Michigan
	Indiana's water shortage plan drought triggers	Jerry Unterreiner, Indiana Water Shortage Task Force, IN Dept of Natural Resources
10:30 AM	Coffee/break	
11:00 AM	The Microsoft Geospatial Library	Michael Kallay, Microsoft
	The use of large-scale climate data to predict drought, river flows, and vegetation over Central-Southwest Asia	Mathew Barlow, University of Massachusetts Lowell
12:00 PM	Lunch (West Faculty Lounge)	
	Afternoon Session (Chair: Subramania Sritharan, Central State University)	
2:00 PM	Multi-Hazard Mitigation Planning: Overview of the Local Planning Process and Future Enhancements	Laura Danielson, The Polis Center at IUPUI

	Developing a Climate Science Education Professional Development Program	Dan Shepardson, Purdue University
	Information to Action: Providing Management Recommendations to Agricultural Users affected by Drought	Bruce Erickson, Purdue University
3:30 PM	Break/coffee	
4:00 PM	Panel II: Where do we go from here?	
5:00 PM	End of Workshop	

Participants

The background of the attendees of the symposium covers a wide spectrum of interests from researchers and students pursuing studies related to drought and its impacts to data management, cyberinfrastructure development to support such research, and state and government agencies and other stakeholders interested in the broader dissemination of drought related data and information. Participants were from universities, state agency representatives, the National Drought Mitigation Center, NOAA, Oak Ridge National Lab, Microsoft and independent consultants. Among the attendees, 42% are students. The complete list of attendees is included at the end of this report.

The symposium featured presentations by experts in various fields, including hydrology, droughts, modeling, data standards, hazard mitigation, agriculture management, geospatial data processing, geoenvironmental education, and so on, many with years of experience providing drought and other information to end users.

The complete list of speakers, presentation abstract and their bios are available at the end of this report. The full attendee list is available at https://driNET.hubzero.org/resources/280/download/Contact.pdf.

Panel Discussions

Panel I: Droughts Management in the 21st Century and Beyond, June 21, 2011

Moderator: Dr. Rao S. Govindaraju
Panelists:

- Jim Angel (IL State Climatologist)
- Chris Funk (UCSB)
- Vijay Singh (Texas A&M U)
- Mark Svoboda (NDMC)

The first panel was structured with the following description and questions posed to the panel members and all participants to begin the discussion.

"Quantification of drought impacts and a follow up vulnerability assessment is currently done in a reactive manner. A reasonably comprehensive list of drought impacts, broadly divided into economic, social, and environmental categories, is available with some guidelines for how to estimate vulnerabilities. With the use of new models developed as part of the driNET efforts, we are now able to not only predict future drought states, but are able to assess the uncertainties with the classification of the drought states.

The panel discussion was aimed at how drought-related websites, including but not limited to driNET, can be made more useful. We would like to use recently added capabilities and leverage 'expert knowledge' to develop methodologies that translate projections of water shortages and drought states into quantifying impacts and vulnerabilities.

1. Are we missing any data sources that can be added to drought monitoring that we are currently either not collecting well or are unable to incorporate into the analysis due to monitoring, mobilizing, calibration or lending issues? What are the modes and approaches to engage these datasets? Are there issues of ground survey to assess calibration, validity etc? Are there any other hindrances?
2. Can drought assessment handle uncertainty, for example, as indicated in driNET? How can it be addressed within drought indices and decision making? What are useful ways for this information to be conveyed to end users?
3. If uncertainty is accepted in drought classification, what is the best mechanism for engaging this information into impact assessment or vulnerability calculations?
4. What are vulnerabilities in the urban areas, and how are they different from ag applications?
    - Can urban areas (i.e., dense locations where people live and use water) be improved/altered so that their water consumption is less?
    - Is this a priority or is it more of a concern for agriculture?
    - When there is drought, there is less water in general, so how much/directly does this affect urban areas?
    - Should we address this as part of same drought monitor, with a special concern section for urban areas?
5. What longer term resilience options are there for droughts?
6. Where is drought in education?"

Each panelist spoke for a few minutes in response to these questions. The audience also participated in this discussion.

Further, questions were actively sought from the participants during the course of the workshop. A list of these questions follows:

1. As much as I know, drought indices reflect anomalies from normal amounts of the variable. So I wonder how to make a consistent sense of an index value?
2. Since different types of droughts are inherently correlated to each other, isn't it best to assess the reasons of inconsistency among indices calculated for a certain period at a particular location?
3. Have you seen any correlation between droughts and other natural disasters?
4. Can a cooperative NWS station "real time" dataset be posted to the driNET site? This information can be gleaned from the IN state climate site, only county by county.
5. Is there a relation between oil resources and drought? Will it make drought more severe?
6. Is sustainability the same as resilience?

7. How can we include mitigation studies?
8. If the uncertainty in drought classification is known, how do you account for this in the existing drought response plans?
9. How frequently should one perform vulnerability assessment?

Only some of these questions could be discussed in the panel session because of time limitations. Subsequently, a discussion board was set up at the DDAD forum on the driNET web site where all the questions were posted and participants were encouraged to respond to these questions.

Panel II: Where do we go from here? June 22, 2011

Moderator: Dr. Dev Niyogi

Panelists:

- Laura Danielson (The Polis Center at IUPUI)
- Bruce Erickson (Purdue University)
- Mark Svoboda (NDMC)
- Jerry Unterreiner (IN Dept of Natural Resources)

This discussion aimed at soliciting recommendations from the panelists and the audience on what the priorities are for next steps. Our panel consisted of experts and stakeholders in disaster management and mitigation, agribusiness and education, state resource management and water policies, etc. The following recommendations were recorded from the panel discussion on the topic of future directions both at the local and regional levels, and in the directions for the broader community and stakeholders.

1. Review and revise the IN water shortage plan -- needs updates and community input
2. Partner with NIDIS portal and, in longer term
3. Research results transfer beyond IN and Midwest
4. Incorporate drought assessment into multi hazards mitigation model
5. Assessment of secondary effects related to droughts
6. drought what-if assessment
7. Integration of multidisciplinary drought mitigation in long term
8. Communicating drought risks for sustainable agriculture (e.g. rice in arid regions) through extension programs, experts, farmers
9. effect of biofuel production related to risk assessment (land use change)
10. How to incorporate uncertainty into drought classification going from discrete to probabilistic; discrete has advantage how to convey/communicate may be useful for forecast; for mitigation, assume worst case DM going global, higher priority for global market needs
11. Outlook presentations can have higher resolutions
12. Need simple text/descriptions, history of droughts in plain language, for driNET/DNR sites
13. Top down approach, need more visibility
14. Develop story lines for different drought types - timing, intensity, types in simple language
15. Ask experts rank impacts from users/experts viewpoints via NIDIS (willing to fund) develop survey and conduct it at DM meetings
16. Current voids in drought related research communicating research to broader audience improve prediction, hybrid approach, ecosystem, environments

Exit Survey

All attendees were given an exit survey to complete before they left the workshop. The survey consisted of eight sections including:

- Which of the following best describes your professional role?
- How did you hear about the DDAD Symposium?
- Please indicate the value you found in each of the DDAD Symposium activities.
- What are the most significant challenges you face in using data to study droughts?
- Please rank the following areas (tools) according to your level of interest.
- How could we further develop the driNET portal to help you address these challenges?
- What could we have done to make the DDAD symposium event better?
- Other Comments

27 attendees responded to the survey including 7 faculty, 11 graduate students, and 9 non-academic professionals. Most heard about the symposium from others rather than from emails or web portals. 110 out of 122 responses for the value of the five sections of the symposium were high to very high. The one recommendation for improvement was for a larger room for the posters

Some themes in the responses from to the question about the most significant challenges being faced to study droughts included lack of data (continuous, long-term, different time-scales, spatial coverage) and lack descriptive information to determine the quality of the data.

The response to the section on ranking the needed tools according to the attendee's level of interest seemed to be highest for research tools as opposed to classroom tools. The important tools are those for sharing/accessing, analysis of and visualization of drought data sets.

There was a broad range of responses to the question on how to further develop the driNET portal to help address the challenges. More than one requested soil moisture data. Another requested the need to learn how to access driNET data programmatically. Another requested a link or integration with NIDIS' vegDRI index. And another requested that more data sets be of regional nature rather than local. The full list is given in Appendix C.

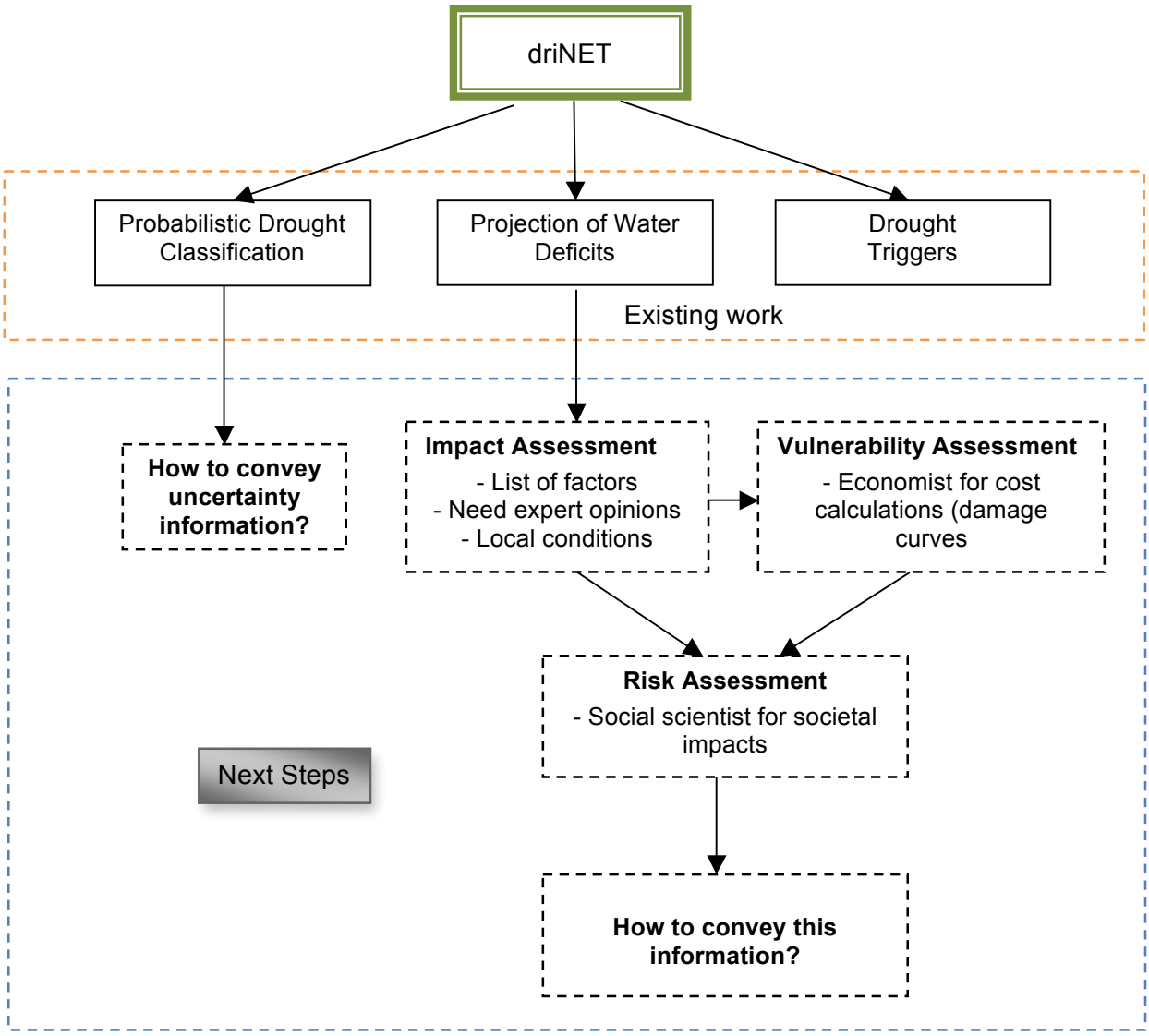
The response to the question concerning what could be done to make the DDAD symposium better included: larger room for posters, separate into description and modeling sessions, encourage more users of the data to attend, allow students to give oral presentations, have activities planned for out of state attendees, expand focus to view drought within the context of change and extremes and some of the database presentations needed more tie ins to the symposium topic.

Overall there were many positive comments on the symposium including but not limited to 'excellent conference', 'extremely well done', and 'love the food'.

The full details of the survey can be found at the end of this report.

Future steps: Drought assessment framework

Based on discussions at the DDAD panels and the feedback from the regional Climate Services Workshop, the following flowchart was created to describe immediate and future steps for drought related projects that could be built on the existing driNET project.



The team plans to integrate driNET findings and results with the national drought mitigation center efforts, further study on how to convey uncertainty in drought characterization to public and stakeholders, leveraging the framework and processes that have been developed for assessment of other natural disasters (e.g., flood) and developing a drought impact assessment framework to aid with decision making by stakeholders.

Some specific tasks we intend to pursue as a result of the feedback we have received include:

a. We will extend the tools dealing with uncertainty of drought characterization to a larger area encompassing the Upper Mississippi and Ohio River Basins. This will include portions of the states of Minnesota, Wisconsin, Iowa, Illinois and Ohio. This was felt desirable given that the spatial extend of droughts can be larger. Under this uncertainty umbrella, we will study the space-time scale relationships of meteorological, hydrologic and agricultural droughts. Such an analysis will require us to work with a larger area.
b. We will include soil moisture fields in drought assessment. Thus far, we have been working with rainfall and streamflow stations with observed data. As we do not have observational records of soil moisture with enough spatial-temporal density to conduct meaningful statistical analysis, we will rely on modeled soil moisture datasets.
c. We will develop a methodology for making drought impacts available to users through driNET. We will combine information from multiple data sources, conduct probabilistic drought assessment analysis, and overlay this spatial information on ground information of land use and populations to determine impacts of water deficits.

We plan to explore potential collaboration with other data-driven cyberinfrastructure projects, such as the DataONE project as many issues faced by the driNET team are common to those projects as well.

List of Speakers, Presentation Abstracts and Biographies

Mathew Barlow. The use of large-scale climate data to predict drought, river flows, and vegetation over Central-Southwest Asia.

Abstract: Central-Southwest Asia is a semi-arid, economically stressed region where droughts have severe societal impacts in terms of agriculture, farming, access to fresh water for drinking, and sanitation. There are two sources of drought predictability for this area: the influence of predictable modes of large-scale climate variability at both seasonal and intra-seasonal timescales, and the importance of the snow pack to warm season river flows and vegetation. Local data scarcity is a critical problem for the region, both for historical analysis and for real-time monitoring. However, analysis shows that satellite data can be used to provide a considerable amount of high-resolution local information about the region, and that operationally-available large-scale climate data adequately captures the influence of regional-scale variable and, critically, can also be used to infer the snow pack. These different aspects of predictability can be combined to provide information at a range of time-scales from seasonal to daily, but communication of the predictions to the relevant decision-makers in the region has proven difficult.

Bio: Matt Barlow is an assistant professor in the Department of Environmental, Earth, and Atmospheric Sciences at the University of Massachusetts Lowell. His research focuses on understanding how large-scale climate variability and change influence local conditions, especially with regard to societal impacts. A particular research focus is the dynamics and predictability of severe drought, which has been supported by NSF and NOAA. He is an Associate Editor at the Journal of Climate and currently a member of the Phenomena, Observations, and Synthesis (POS) Panel of US CLIVAR.

John Cobb. Data challenges in the DataONE project

Abstract: The DataONE project is a NSF funded datanet project aimed at sustainable digital data preservation for biological, ecological, and environmental datasets. DataONE seeks to enable universal access to data about life on earth and the environment that sustains it. DataONE has created an architecture that enables the integration disparate data archives into an accessible collective that can be searched and used by a larger number of interested scientists, policymakers, educators, and other stakeholders for better research, discovery, and decisions. In addition, DataONE seeks to enhance the ability for workflows to use archived data as well as facilitating data synthesis and re-use. In this presentation, we will discuss goals, challenges, and proposed solutions that the DataONE project team is undertaking in these general areas. We will discuss the proposed architecture, community assessment and engagement efforts. We will also give a progress update and in particular discuss the proposed software V.1.0 functionality. Finally, we will present information about a pilot science case study that help provide information about bird migration patterns and was featured in the 2011 State of the Birds report.

Bio: John Cobb is a researcher at the Oak Ridge National Laboratory (ORNL) specializing in introducing high performance computing and cyberinfrastructure for different areas of science and engineering research, particularly experimental and observational data sciences and areas that have not traditionally used these tools to accelerate and increase the impact of their research. His professional preparation includes a doctorate is in theoretical physics specializing in large scale computational plasma physics modeling and simulation applied to alternative

fusion energy concepts. He has worked in several science areas, all with the unifying theme of applying advanced computation to solve research problems. Such areas have included: advanced fusion concepts; plasma based semiconductor fabrication equipment modeling; neutron scattering science; biological and ecological data synthesis, archive, and curation. Some of his previous positions have included: scientific computer user advisory committee chair for ORNL; CIO, IT-staff, and computer Security officer during the construction period for the Spallation Neutron Source; ORNL TeraGrid resource provider principal investigator; and Co-investigator for the national science Foundation's DataONE Datanet project. He is currently on staff at ORNL's Computer Science and Mathematics division.

Laura Danielson. Multi-Hazard Mitigation Planning: Overview of the Local Planning Process and Future Enhancement

Abstract: Counties in the United States are required by federal mandate to develop a multi-hazard mitigation plan in order to be eligible to receive federal mitigation funding. Laura Danielson will deliver a presentation on the local multi-hazard mitigation plan development process. This presentation will highlight how FEMA's hazard simulation software, Hazus-MH, can improve the quality of a community's hazard risk assessment and will discuss potential future improvements to the planning process to make communities more aware of the unique risks they face from droughts.

Bio: Laura Danielson is the Project Coordinator for The Polis Center at Indiana University Purdue University-Indianapolis. In her work with Polis, she has managed a number of projects for state and federal agencies including the development of more than 50 multi-hazard mitigation plans in Indiana and Illinois. Laura works closely with GIS and non-GIS professionals to achieve community collaboration and understanding of hazard-related mitigation activities.

Bruce Erickson. Information to Action: Providing Management Recommendations to Agricultural Users affected by Drought

Abstract: Mitigating drought's impact on agricultural production is a key part of any food security and economic stabilization plan. While most agricultural producers periodically experience abnormally dry periods that sometimes limit production, extreme or exceptional droughts may occur infrequently enough that management strategies are unfamiliar, outdated, or untested in a particular set of circumstances. While information to spatially delineate and characterize the effects of a drought is important, the real payoff comes from providing drought-affected individuals with recommendations on how to best manage their situation, and for them to actually adopt these practices. In crop production the ramifications are many: decisions related to crop choice, hybrid/variety selection, tillage, pest management, fertilization/crop nutrient strategies, harvest, crop quality and utilization, insurance, and the like. Livestock producers face their own acute concerns. The decision-makers and decision-influencers in agriculture are geographically dispersed and exist within the agribusiness retail channel, academic, consulting, and producer networks. Assembling a set of resources that also includes identifying individuals to deliver through a variety of outreach modes will expedite our preparedness to manage future drought events.

Bio: Bruce Erickson is the Director of Cropping Systems Management and Associate Director of the Center for Commercial Agriculture, Purdue University. He is a Certified Professional Agronomist that uses his expertise and experience in education and agribusiness to provide solutions for crop producers, their advisers, and the industries that depend on them. His areas of expertise include corn and soybean production, remote sensing and its application in precision agricultural practices, instructional design, and competency-based education and

assessment. He has experience in building technical, product-related, sales and marketing programs to fulfill individual proficiency needs and to meet business goals, and then delivering through classroom, in the field, teleconference, and web-based platforms.

Chris Funk. Monitoring drought across many scales

Abstract: Monitoring drought across many scales Chris Funk As gas and food prices increase while per capita harvested area decreases, drought and disruptions in food availability exert more and more pressure on the political and economic stability of 'frailed' states. Improved drought monitoring across many spatial and temporal time scales has therefore become increasingly important. As this need mounts, so have our capacities to observe and understand the earth's climate. Relatively new satellite systems, such as the Moderate Resolution Imaging Spectrometer, allow us to watch the earth at scales of ~100 meters. Improved rainfall retrievals give us more timely and accurate observations of hydrologic extremes. Web-based mapping and analysis tools help us integrate and utilize this information in 'actionable' ways. Over the past few years, scientists at the US Geological Survey and the University of California, Santa Barbara's Climate Hazard Group have developed new monitoring datasets, tools and methods supporting the monitoring of drought across South America, Africa and Asia. This talk summarizes these new products, and sets out some general principles that will help us to identify agricultural droughts in rainfed environments. Special attention is given to monitoring and understanding low frequency changes in climate over and around the Indian Ocean during boreal spring and summer. This work links 'bottom up' evaluations of terrestrial drying trends with 'top down' diagnostic analyses tracing the associated changes in atmospheric thermodynamics and moisture transports. The resulting framework for 'drought forensics' is helping us to understand and prepare for near-term climate changes. As the south-central Indian Ocean (SIO) has warmed beneath rapid surface winds, SIO evaporation and rainfall have increased dramatically, setting up overturning circulations helping to lower rainfall across east Africa and India. Current collaboration with USAID links this research with climate adaptation and the identification of emergent at-risk populations.

Bio: Chris Funk is a Research Geographer with the US Geological Survey and a founding member of the University of California Santa Barbara's Climate Hazard Group (CHG). Chris' research focuses on three main areas: drought early warning, 'forensic' drought analysis techniques, and evaluations of long term trends in climate and food security. He works primarily in Sub-Saharan Africa in support of the US Agency for International Development's Famine Early Warning System Network (FEWS NET). His drought early warning research has focused on improving satellite rainfall estimates, enhancing historical precipitation archives, providing more accurate and timely climate forecasts, producing NDVI-based yield predictions, and developing improved online decision support tools. Dr. Funk's drought forensics use climate reanalyses to evaluate the fluctuations in energy and moisture transports that lead to rainfall deficits in sub-tropical monsoonal weather regimes. By following the water and energy, we can gain critical insights into emergent and persistent drought patterns, both at seasonal and multi-annual time scales. Chris' work combines these diagnostic climate analyses with careful evaluations of terrestrial rainfall trends. This work has identified a link between anthropogenic warming in the Indian Ocean and more frequent droughts in eastern Africa. Current research is extending this analysis of drought trends into India. Chris directs research activities at the Climate Hazard group (chg2.geog.ucsb.edu), and is a member of the USGS EROS Early Warning and Environmental Monitoring Group. He helps coordinate a large multi-year collaboration between the USGS, UCSB and USAID, focused on improved drought early warning, and serves as the lead FEWS NET climate change scientist. He collaborates with many colleagues in Africa, the USGS, NASA, NOAA, and UCSB, teaches spatial statistics at

UCSB, and advises graduate students and post-doctoral researchers. A few relevant links: New Climate Dynamics article on East African drought and changes in the Warm Pool: http://www.springerlink.com/content/u0352236x6n868n2/ USAID Kenya climate trend analysis: http://pubs.usgs.gov/fs/2010/3074/.

Steven D. Hilberg. Drought Monitoring in the Midwest

Abstract: Climate monitoring is one component of the mission of the Regional Climate Centers, and the Midwestern Regional Climate Center (MRCC) has created web pages to provide near real-time monitoring of the weather and climate of the Midwest. A dedicated drought monitoring page was developed by the MRCC to provide a snapshot of current moisture conditions in the region using a number of specialized maps and products. Users are able to drill down to state and local conditions and impacts through links to the respective state climate offices and water resources agencies.

Bio: Steve Hilberg is director of the NOAA Midwestern Regional Climate Center at the Illinois State Water Survey, Prairie Research Institute, University of Illinois. He is responsible for the day-to-day operations of the MRCC and works closely with the other Regional Climate Centers, State Climatologists, the National Climatic Data Center, the National Weather Service, and other climate services partners. Before coming over to the MRCC he was assistant Illinois State Climatologist for two years, and prior to that he was responsible for extension services at the Water Survey.

Michael Kallay. The Microsoft Geospatial Library

Abstract: In SQL Server 2008, Microsoft introduced support for geospatial data, with a rich set of spatial queries and constructions, in both Cartesian and geodetic coordinates. Most of this functionality is also available as an independent (free download) .NET library. This talk will focus on this library, touching on the differences in functionality between its TSQL and C# interfaces.

Bio: Michael Kallay holds a Ph.D. in mathematics from the Hebrew University in Jerusalem. After a short academic stint, he has been developing computer applications of geometry since 1983. After 10 years of 3D geometric modeling for CAD/CAM (mostly for cars and airplanes), he was demoted by one dimension when he went to work on 2D geometry for desktop graphics, first in Visio and later in Microsoft Windows. His current focus is on geospatial computations.

M. Levent Kavvas. On the physics of droughts

Abstract: By means of a simple general circulation model of the northern hemisphere the interaction of atmospheric and hydrologic processes during droughts will be analyzed at continental scale. It will be shown by numerical solutions of this model that the mechanism leading to droughts is a non-linear positive feedback mechanism in the sense that it feeds on itself. Imposing a temperature wave over western USA for a short period on the order of few months induces geophysical conditions in that region which tend to reduce the hydrologic water storage for a period on the order of years. The mechanisms for returning to the climatological average conditions of water storage (drought recovery period) will be investigated.

Bio: M. Levent Kavvas is a Gerald and Lillian Orlob Endowed Chair Professor at Department of Civil and Environmental Engineering, University of California, Davis. Kavvas' specialty is in mathematical modeling of hydrological and hydro-meteorological processes. Together with his students, he developed the Watershed Environmental Hydrology (WEHY) model. Starting in 1990, he was instrumental in the development of coupled regional hydro-climate models for

Japan, Korea, Mekong River Basin, Tigris-Euphrates River Basin, and Malaysia. As a product of this work, he developed the first physically-based regional land surface hydrology model that is based on areally-averaged conservation equations to account for subgrid-scale variability in hydrologic processes (Kavvas et al. 1998). Recently, he developed a general methodology for the probabilistic description of nonlinear stochastic hydrologic processes. He is an ASCE Fellow, is the founding Editor-in-Chief of ASCE Journal of Hydrologic Engineering, and is the winner of ASCE 2009 Ven Te Chow Award in Water Resources Engineering. He has been member of numerous journal editorial boards, of UNESCO Expert Panel on Climate Change, and of Asia Pacific Water Forum Steering Group in Climate Change and Water.

Doug Kluck. An Update on NOAA's Drought Programs

Abstract: NOAA through the National Integrated Drought Information System (NIDIS) supports planning and early warning preparedness amongst communities and states. Since the inception of NIDIS in 2006 there have been a series of regional drought projects across the United States that have begun to help different groups renew or begin to plan for drought. This presentation will briefly touch upon some of the successes those pilot projects have achieved and where they are headed. In addition and overview of NIDIS and the drought portal will be included.

Bio: Doug Kluck worked for the National Weather Service for the last 18 years and served as a research meteorologist, forecast meteorologist, forecast hydrologist and regional hydrologist. For the past eight years he was the Climate Service Program Manager for the Central Region. In this capacity he focused on building key networks and relationships with core partners and groups with climate interests in the Central Region. He works closely with the Regional Climate Centers, state climatologists, tribal colleges and universities, land grant universities and extension services, federal and state governments and non-governmental organizations on a number of issues including informing adaptation, climate data stewardship, building climate change capacity and assessment of climate services needs by sector and community. Kluck serves on the implementation committee for the National Integrated Drought Information System as the lead on education and outreach. In addition, he serves as the climate representative for the Central Region NOAA Regional Collaboration Team. He holds a bachelor's degree in geology and a master's degree in geography from the University of Nebraska.

Brent McRoberts. A modified Standardized Precipitation Index for monitoring drought

Abstract: The SPI Blend is a modified Standardized Precipitation Index (SPI) created for use in a newly developed, high-resolution drought monitoring tool, assessing drought using precipitation data on multiple time scales. Unlike the traditional SPI, the SPI Blend uses a linear weighting system that places a higher importance on recent precipitation within a time period. At each time scale, the MPE precipitation data are divided into several periods and the precipitation total from the most recent period is given the highest weight, with a linear decrease in the weights for succeeding periods. The high-resolution (4 km) precipitation data are obtained daily from the Advanced Hydrologic Prediction Service multi-sensor precipitation estimates (MPE) and are aggregated on several time scales. Cooperative Observer Program (COOP) daily station precipitation data provide the historical context for the MPE precipitation data. Pearson Type III distribution parameters were interpolated to the 4 km grid based on a regional frequency analysis of the COOP stations and L-moment ratios of the precipitation data. For a given time scale and grid point, the SPI Blend is a summation of the MPE weighted precipitation values placed on a historical cumulative distribution function derived from COOP precipitation data. The SPI Blend can be used as guidance for the United States Drought Monitor and provides an improvement over the traditional SPI because it places a greater importance on

more recent precipitation.

Bio: Brent McRoberts received a BS in Synoptic Meteorology at Purdue University, 2004. He is currently working on his Ph.D. at Texas A&M University. He has worked for Dr. Phil Smith Masters in Atmospheric Science at Texas A&M University, and Dr. John Nielsen-Gammon.

Dan Shepardson. Developing a Climate Science Education Professional Development Program

Abstract: This presentation overviews the process and challenges of developing a climate science professional development program for teachers. Implications to drought education will be explored.

Bio: Dan Shepardson is Professor of Geoenvironmental and Science Education with a joint appointment in the Departments of Curriculum and Instruction and Earth and Atmospheric Sciences at Purdue University. His research focus is on students' conceptions and ways of reasoning about science phenomena; the role social interaction plays in students' meaning making. This research looks at students' conceptual frameworks or mental models and how they are challenged and restructured by encounters with science phenomena and data derived from science investigations.

Vijay Singh. A look at the 20th century global droughts

Abstract: Droughts exercise a profound effect on the social and economic fabric of nations. Many nations of the world experienced droughts encompassing the full spectrum of severity, areal extent and duration. The result has been that the economic development was hampered and many countries have not yet recouped fully from the ravages of droughts. The first decade of the 21st century has also witnessed varying degrees of droughts across the globe. Therefore, we ask the following questions: (a) Do droughts affect every part of the world? (b) Are there similarities in major droughts around the world? (c) Are climate change and global warming impacting drought occurrences? (d) How much impact do droughts have on water resources? (e) What can be said about food security, energy security and water security? (f) What do different Global Climate Models (GCMs) and the IPCC report say about future drought scenarios? (g) How can our understanding of past drought episodes help with planning and managing future water resources?

Bio: Professor V. P. Singh holds the Caroline and William N. Lehrer Distinguished Chair in Water Engineering and is a Professor of Biological and Agricultural Engineering and a Professor Civil and Environmental Engineering at Texas A & M University. He received his B. S., M. S., Ph. D. and D.Sc. degrees in engineering; and has widely published in the areas of hydrology, hydraulics, irrigation engineering, environmental engineering, and water resources. He currently serves as editor-in-chief of ASCE journal of Hydrologic Engineering, editor-in-Chief of Water Science and Engineering, and editor-in-Chief of Water Science and Technology bookseries of Springer, and associate editor or member of 22 journal editorial boards. He has received 60 national and international awards for his contributions and professional service. Professor Singh has served as President and Senior Vice President of the American Institute of Hydrology (AIH), and has served on numerous committees of the American Society of Civil Engineers, Hydrology Section of the American Geophysical Union, and American Water Resources Association, as well as on government panels.

Mark Svoboda. Building an Enhanced Drought Early Warning System: Tool and Services for Decision Support

Abstract: Perhaps no other hazard lends itself as well to the need for a diligent early warning system (DEWS) than drought. Droughts typically evolve slowly, but have the potential to cover very large areas compared to hazards like hurricanes, tornadoes and floods, which have a much smaller geographic footprint. The U.S. took first steps in 2006 toward developing coordinated and integrated DEWS through the creation of the National Integrated Drought Information System, or NIDIS. More recently, the National Drought Mitigation Center (http://drought.unl.edu) has been working with NIDIS and other international parties (WMO, GEO, United Nations, etc.) with a goal of developing a virtual and comprehensive global drought early warning system (GEWS).

The NDMC's mission is to work to reduce societal vulnerability to drought by helping decision makers at all levels to: implement drought early warning systems, understand and prevent drought impacts and increase long-term resilience to drought through proactive planning. The NDMC is a national center founded in 1995 at the University of Nebraska-Lincoln. The NDMC conducts basic and applied research along with the maintaining of a number of operational drought-related and outreach activities, including the U.S. Drought Monitor (USDM), Drought Impact Reporter (DIR) and the Vegetation Drought Response Index (VegDRI).

This paper will describe in more detail the various drought resources, tools, research efforts, services and collaborations already being provided by the NDMC and its partners along with a look at what is coming down the road in helping others toward developing drought early warning systems in the U.S. and around the world.

Bio: Mark Svoboda has been with the NDMC since it was formed in 1995. As the NDMC's Monitoring Program Area Leader, his duties include overseeing the center's operational national drought monitoring activities. Mark's responsibilities include providing expertise on climate and water management issues by working closely with states, federal agencies and international governments as well as the media and private sector. Mark helped develop and establish the U.S. Drought Monitor in 1999 and serves as one of the principal authors of both the weekly USDM and monthly North American Drought Monitor products. Mark is heavily involved with drought monitoring, assessment and prediction committees at state, regional and national levels. He currently sits on the American Meteorological Society's Applied Climate Committee and as well as NOAA's National Integrated Drought Information System (NIDIS) Program Office's Implementation Team and was appointed as the co-chair for NIDIS Portal development. Mark earned both his Bachelor's Degree in Geography specializing in Climatology and a Masters Degree in Geography with a specialization in Remote Sensing, Climatology and GIS from the University of Nebraska-Lincoln.

The following paper was not presented because of travel conflicts.

Shivam Tripathi. The continuing mystery of Indian droughts: Scientific challenges and societal implications

Abstract: India receives most of its rainfall during four months of the summer monsoon season. Though the Indian summer monsoon is considered to be a relatively stable monsoon system, it has large inter- and intra- seasonal variability that can result in widespread droughts over the region. Various strategies have been developed over the years to predict and mitigate the effects of droughts, but the mysterious droughts continue to elude scientists. This talk will explore some possible reasons for the continuing mystery, discuss its implications for the society, and present new clues and evidences that may help solve it.

Bio: Shivam Tripathi is an assistant professor of civil engineering at Indian Institute of

Technology, Kanpur. He received his Ph.D. in civil engineering from Purdue University. His research interest lies in understanding hydrological processes and their interactions with climate, vegetation and soil. Over the past few years, he has been exploring linkages between global climate and regional hydrology, and developing algorithms to engage measurement uncertainties in hydroclimatic modeling.

Jerry Unterreiner. Indiana's Water Shortage Plan Drought Triggers

Abstract: Indiana's Water Shortage Plan was recently updated (2009) and established criteria to identify drought conditions and associated "Water Shortage Stages" designated as Normal, Watch, Warning, and Emergency. The three drought triggers are the 1-month Standardized Precipitation Index (SPI), U.S. Drought Monitor (USDM), and Percentage of Average Streamflow (28 streamflow gaging sites). The Water Shortage Stage is defined as Normal if no more than one indicator is outside of the normal range. The Water Shortage Identification Regions are the nine climate divisions determined by the National Weather Service. The drought triggers were tested during the dry conditions that occurred in Indiana late summer-fall of 2010. In general, the 1-month SPI and the USDM reflected fairly accurate conditions of surface dryness with groundwater-fed streamflow temporally lagging behind these indicators.

Bio: Jerry Unterreiner is Head of the Resource Assessment Section within the Division of Water of the Indiana Department of Natural Resources (DNR). He holds a doctorate in Hydrogeology from Western Michigan University, a master's degree in Geology from Indiana State University, a bachelor's degree in Geology from Ball State University, and is a State of Indiana Licensed Professional Geologist. Jerry served as the DNR Agency Coordinator for the Indiana Water Shortage Task Force drought triggers work group.

Cole Whiteman. Designing the Workflow for a Digital Data Repository

Abstract: driNET's prototype research environment provides, as a core function, a digital repository for contributed materials. Already, the driNET web portal is enabling contributors to upload materials and enabling other researchers to access them. How shall driNET further develop its repository to ensure that researchers will be able to access these materials in the future, even as current data formats and storage technologies become obsolete? We'll talk about how an organization can build an active curation function to provide long-term access, and see an example of how one research data repository organization (ICPSR) makes it work.

Bio: Cole Whiteman is the Information Technology Process Architect at ICPSR, the Inter-university Consortium for Political and Social Research at the University of Michigan. He specializes in organizational process discovery, visualization, analysis, and redesign. Recently he has spent a lot of time elucidating and mapping ICPSR's core technical functions, notably its data processing pipeline. He also devises automated web tools for managing projects, data processing operations, and other recurring structured communications among people working together, in order to make the organization's operations more effective, efficient, reliable, open, and responsive.

Exit Survey Details

Which of the following best describes your professional role?

a. University faculty or post-doc	7
b. Graduate student	11
c. Information Technologist	2
d. Climatologist	1
e. Hydrologist	0
f. Other	6
Environmental Engineer	
Research Scientist	
Visiting Scholar	
Economist	
Regulator	
Hydrogeologist	
Total	27

How did you hear about the DDAD Symposium?

a. From a colleague	16
b. Email/Listserve announcement	5
c. driNET portal announcement	4
d. Newsletter (Purdue Today, etc.)	0
e. Other	2
From my Advisor	
Dr. Niyogi personal email notice	
Total	27

Please indicate the value you found in each of the DDAD Symposium Activities. (1 being very low to 5 being very high)

	1	2	3	4	5	N/A
a. Presentations	0	0	2	10	15	0
b. Panel Discussions/Q&A	0	0	2	10	13	2
c. Hallway Conversations	0	1	3	11	11	1
d. Poster Session	0	1	1	9	13	3
e. Reception	0	1	1	7	11	7
Comments						
Fantastic						
Maybe could have a larger room for posters						
Love the food						
Great Symposium						
Excellent						
It can be used for making society saved from drought disasters						
Better than national meetings						

Good activity
It was very friendly and I myself enjoyed being among "drought' people

What are the most significant challenges you face in using data to study droughts?

Droughts are related to some topics such as population, rainfall, expiration and so : The data of rainfall is available but other data is not enough which is a limitation for society.

Data QA/QC of gaps temporarily specified, availability of secondary data on impacts.

Lack of long and continuous research.

The drought event numbers extracted from the streamflow data is limited. Not enough information above drought can be extracted from the streamflow data.

As a comment it would be useful to drought researchers having access to streamflow-related indicator values at different stations (like other indices have been already provided by NIDRS or driNET).

Availability.

Historical drought severity duration data could hardly be found. There are some documentations describing the post drought events but no quantitative descriptions could be found.

Climate/drought prediction at all timescales.

Sharing information between academia, academia & policy decision makers, and disseminating the information down to local communities of people.

Most of the challenge come from biases in survey.

There are a lot of missing values in order to overcome the problem remote sensing data can be validated at local scale.

Availability of data in usable format.

Lack of data, especially in spatial domain – Data streaming – lack of data.

Access to hydro-meteorlogical data in developing countries.

metadata quality, proper context and general knowledge in order to frame intelligent questions and investigations.

Real time precipitation data sets with specific locations of individual stations with the data set available at beginning of the following month.

The data is often not in the most user friendly way – a lot of time is wasted in putting the data in the right format – If this can be done online taking advantage of the back of the computer functions prior to downloading will be very helpful.

Please rank the following areas according to your level of interest.
(1 being very low to 5 being very high)

	1	2	3	4	5	N/A
a. Tools for sharing/accessing drought data sets	0	3	5	7	10	2
b. Analysis tools for drought datat sets	0	1	5	4	15	2
c. Visualization tools for drought data sets	0	1	2	8	13	3
d. Collaboration tools	0	2	4	9	9	3

e. Classroom/Teaching tools	1	2	5	11	4	4

Comments

(None given)

How could we further develop the driNET portal to help you address these challenges?

It would be nice to learn how to access driNET data programmatically.

Historical drought refined to local scale with intensities and longevity – perhaps some simplistic representations that the general public might find interesting and understand the first time through the viewing.

Soil moisture, land use – connection between water, carbon, nitrogen and other cycles.

veg DRI – integrating with NIDIS.

Data to be collected by local user – soil moisture data is challenging to deal with.

Data on drought effects on public health and water quality and air quality.

Famine and drought relationships.

Soil moisture stream flow data or related indices – providing different data sources to develop data assimilation studies in drought field would be quite helpful – driNET is rather locally focused than regionally. I would like to see extended areas being supported by drought data with driNET.

Is it possible to include the stream flow data reconstructed from the tree ring – stream flow/precipitation data – drought analysis (return period)/joint description of drought with different variables.

local weather data generated by individual units – placement of fertilizers in agricultural water sheds – preliminary stat areas.

Temperature evaporation and gis data.

What could we have done to make the DDAD symposium event better?

It was extremely well done -- better than I expected.

Some of the database presentations could have used more tie ins to relevancy with symposium topic.

Excellent conference.

Posters in bigger room.

It was the first time I attended DDAD symposium and I liked the way it was arranged. It was informative and the time was well-scheduled.

Can the symposium be separated into the description and modeling session --If the basic overview of drought concepts and method can be provided as the note to each one, people from different areas can be benefitted from the notes.

This was an excellent conference - perhaps we should encourage more users of this data to participate.

It's better enough -- but in my opinion it's better to give a chance to students for oral presentations.

Drought influence on stream ecology.

The room where poster session was held was s little cluttered -- perhaps next time it would be better to conduct it in a bigger room.

Excellent, informative, diverse, experience about drought data monitoring.

Have some activities planned for people out of state.

I would consider looking at drought holistically within the context of change and extremes. Expand beyond focusing only on drought as many users are interested in many aspects of the entire system.

Other Comments

The amenities were nice and appreciated, veggies and fruit at the break was nice. Reception catering was delicious. Hospitality was appreciated. I was impressed by the breadth of attendees.

Excellent conference -- well-planned and informative.

Great presentations.

Better than I thought this would turn out -- good set of presentations.

The outcome of the discussion can be posted on the web.

Very nicely organized -- perhaps we should expand it to a larger scale.

Very nice symposium -- there is a lot out there about the impact of "disturbances" (floods and drought) on aquatic life.

I really enjoyed the symposium -- great speakers from various aspects of studies.

Very well-organized--all the talks were very useful.

Thanks for inviting me.