2011 Symposium on Data-Driven Approaches to Droughts

6-21-2011

DRINET Project Overview

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DRINET Project Overview

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Chris Hoffmann
Dev Niyogi
Lan Zhao

Purdue University
Developing Community-based Drought Information Network Protocols and Tools for Multidisciplinary Regional Scale Applications (DRIinet)

- NSF funded Data Interoperability project
- Started in Jan. 2009
- Multidisciplinary team
  - Carol Song (Rosen Center for Advanced Computing)
  - Daniel Aliaga (Computer Science)
  - Jake Carlson (Library)
  - Indrajeet Chaubey (Agricultural and Biological Engineering)
  - Rao Govindaraju (Civil Engineering)
  - Chris Hoffmann (Computer Science)
  - Dev Niyogi (Agronomy & Earth and Atmospheric Sciences)
  - Lan Zhao (Rosen Center for Advanced Computing)
Existing Tools & Systems

Indiana: Policy for drought declaration based on Palmer index

Groups of crops and weather people we were already working with
Implement and explore *computational infrastructure* to create a science base for drought information collection, fusion of heterogeneous data relevant to droughts, and for facilitating the broadest possible participation of the community.

Science questions to be addressed include:
- Do drought conditions currently exist, or are they imminent in my area of interest?
- What kind of a drought is this likely to be (is it analogous to a previous period)?
- What are the potential impacts?
- What are my options for coping with this condition?
- What additional data beyond the traditional hydroclimatic datasets can provide information on drought onset and impacts?

These questions will be addressed both from the collection point of view as well as from the view of the multiplicity of consumer interest in the information.
Cyberinfrastructure

- DRINET CI based on HUBzero for
  - Online interactive tools
  - Sharing and user participation
  - One stop shop for researchers, students and end users

- Expanded capabilities
  - Distributed data access
  - Self data and metadata publishing
  - Map-based navigation
  - Geospatial data enabled
  - Connecting data with tools, models, visualization
Interactive Tools

HMM-based Probabilistic Drought Classification

Water deficit viewer
Data

Water quality data

Upper Mississippi River Basin and Ohio River Basin Data

Historical Averages of Precipitation and Temperature Data

This dataset include plots of historical time series of average precipitation and temperature data, courtesy of the Oklahoma 2009

File Name: trace IL-CD06 prcp April.png

View graph in full size File size (22759 Byte)
Data Publishing

Tabular Data Import Wizard:
- Schema Definition
- Input File
- Delimiter
- Verification
- Execution

Define a database schema:

<table>
<thead>
<tr>
<th>Name</th>
<th>Data Type</th>
<th>UG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Datetime</td>
<td>Date/time</td>
<td></td>
</tr>
<tr>
<td>Avg Level (m)</td>
<td>Real number</td>
<td></td>
</tr>
</tbody>
</table>

Importing data:
- Creating a database table...
- The database table was successfully created.
- Uploading the file...
- Upload completed.
- Importing data into database...
- Importing completed.
Welcome to the U2U Collaboration Site!

Across this site you will find full group and subgroup collaboration space, data and models under development, meeting notes and documentation, discussions, and other relevant information for the Useful to Usable (U2U) research team. This site is only visible to approved, internal collaborators at this time.

Most static documents that are applicable to the full group (proposal, meeting notes, contact lists, press releases, publications, etc.) can be found under Resources. Objective 1 and 2 collaboration spaces are located in the Wiki along with tips for using this site and links to other project information. Feel free to start a Discussion at any time, announce news and current events in the Blog, and share your ideas by making a Wish. For more tips on where to find information across this site, click here.

Please contact Melissa Widhalm (mwidhalm@purdue.edu) if you need any help or have any questions. And keep checking back regularly for updates and new information!
Metadata for DRINET

Jake Carlson
• Functionality:
  – Discovery
  – Description
  – Defining Relationships
  – Dissemination

• Challenges:
  – Diversity of Data
  – Diversity of Audience & Needs
  – Need for a Balance – depth & breadth; standards & local needs
Drought Classification

Rao Govindaraju
Sources and Study Areas

- Precipitation: NCDC daily precipitation dataset; 73 stations with record length greater than 80 years
- Streamflow: USGS unregulated daily mean flow; 37 stations with record length greater than 50 years
• Major drought events in Indiana

1930 ~ 1931

1933 ~ 1935

1962 ~ 1964
Required 1-month precipitation for normalcy, i.e. projected water deficit

Probability of recovering from drought in one month
Probabilistic Drought Classification

1 month HMM-DI vs. SPI at Alpine 2NE, Indiana
Drought implications on river water quality

Indrajeet Chaubey
Correlation of nutrients with drought index

**Phosphorus**

\[ y = 0.009x + 0.1752 \]

**Ammonia**

\[ y = 0.006x + 0.1615 \]

**Phosphorus**

\[ y = 17008x + 40635 \]

**Ammonia**

\[ y = 14656x + 37397 \]
Results indicate that droughts exert an important control on water quality both in terms of concentrations and loads.

Limited data availability: 11 years of weekly data may be insufficient for hydrological extremes such as droughts.

Sustainability of new agricultural initiatives, such as biofeedstock production may be constrained by drought events.
DRInet – working with interoperability

Dev Niyogi
• *iClimate* and NWS Indianapolis have created a Community Collaborative Rain, Hail and Snow (CoCoRaHS) network for Indiana.
• Currently over 1500 community observers are provided with a rain gauge and training by *iClimate* and National Weather Service staff.
• Observers monitor and report rainfall values daily.
• Data have wide use in drought monitoring, runoff and water quality studies, flooding, and agronomic decisions on a day-to-day basis.
Regional Evapotranspiration Estimation across PACs

- The largest water loss in the state of Indiana comes from evapotranspiration (ET).
- Currently, there is no information available as to how much water is being lost.
- Obtaining values for ET in the state is crucial to understanding the water budget.

Can models be used where ET measurements are not available to extend an ET climatology statewide?
ETgage water loss data are monitored by automated weather stations and relayed hourly to campus.

A comparison between ETgage measurements and ET models at NEPAC in July 2008 shows early results that ET models do well in comparison to ET measurements and may be useful to extend an ET climatology from PACs to all of Indiana.

Next: use crop coefficients to apply grass-reference ET to targeted major Indiana crops, such as corn and soybean.
Indiana drought atlas (mapping drought in Indiana and investigating the appropriate drought indices for Indiana) – Recommendations now adopted by Governor’s Water Shortage Task Force for declaring drought in Indiana (Indiana now adopts Standardized precipitation index in place of Palmer drought index)

These results show that the SPI efficiently detects drought emergency and warning and identification of drought severity in its early stages.
Using Data Assimilation and Photosynthesis based Energy balance models for developing 4km gridded products – assessing water budgets, moisture transport, air quality and meteorological feedback.
Relating Droughts to Cloud Height Changes

- Soil moisture is slower to change than atmospheric moisture.
- Relating it to cloud potential may give a longer range predictability of cloud & precipitation potential.
- Preliminary results show
  - Wetter soil tends to produce lower cloud base heights.
  - In a wet year, cloud base height not as much a function of soil moisture.
  - Very dry soil can have low and high cloud base heights.
• Tornado Reports, Convective Wind Reports, Hail Reports (3/4 inch and 1 inch diameter), and Extreme Rainfall Events.

• Distribution analysis on yearly, monthly, and hourly storm report data. Distribution analysis on yearly, monthly, and seasonal storm “day” data.

• Density analysis of storm report data using ArcGIS with comparison of report distribution to elevation and landcover.

• 30-year climatology.
How Indianapolis is affecting regional rainfall and thunderstorms?


<table>
<thead>
<tr>
<th>Examined thunderstorm numbers</th>
<th>81</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obvious urban effect event numbers</td>
<td>50</td>
</tr>
<tr>
<td>No obvious change when passing urban</td>
<td>31</td>
</tr>
<tr>
<td>Break up numbers</td>
<td>25</td>
</tr>
<tr>
<td>Intensification after breaking up</td>
<td>8</td>
</tr>
<tr>
<td>Intensification (No breaking up)</td>
<td>14</td>
</tr>
<tr>
<td>Initiation</td>
<td>5</td>
</tr>
<tr>
<td>Distribution changes and dissipation</td>
<td>6</td>
</tr>
</tbody>
</table>

Thunderstorms are intensified and lead to heavier rains after passing over Indianapolis region.

Important from city planning and green zone/ agricultural planning
Visualization-based Decision Tools

Daniel Aliaga
• The local weather in a city is significantly affected by materials and geometry
• Use our behavioral-geometrical modeling system to generate the urban morphology
• Visualize effect of adopting different urban policies and urban geometries
Urban Weather Modeling

Modify land use (e.g., application of greening policy)

New fully instantiated city model is produced
Example Changes in Local Weather

Temperature
-1°C  0°C  +1°C

Rainfall
-20mm  0  +20mm

Humidity
-5%  0  +5%
Future Directions

- Drought characterization
  - Uncertainty
  - Quantification
- Environmental impacts
  - Air and water quality
- Decision tools
  - Focus on urban resilience
  - Agricultural resilience
- Communication
Integrate into urban and social planning: how can we change city's and how can be change people's activities in the face of drought?

Provide economic assessment tools, for instance, of $$$ impact of short-term drought and thus identify the benefit of a technology upgrade to deal with less water and benefit of altering crop/land-use based on drought.

Implementing DIF metadata records for all data sets in DRINET; collaborate with other data-driven projects to investigate interoperability and repurposing of data.

Analyze drought implications using water quality attributes simulated by a watershed model (e.g. SWAT).

Detailed study of water quality data to understand drought indicators using probabilistic approaches.

Sustainability of biofuel production impacted by climate variability and change.
Panel Questions

- 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?
- Can drought assessment handle uncertainty, for example, as indicated in DRI.net? How can it be addressed within drought indices and decision making? What are useful ways for this information to be conveyed to end users?
- If uncertainty is accepted in drought classification, what is the best mechanism for engaging this information into impact assessment or vulnerability calculations?
- 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?
- What longer term resilience options are there for droughts?
- Where is drought in education?