Routine Crop Water Requirements for Irrigated Crops

One step estimation theory to better represent growing and senescing crops.

Theory: Adopt the Penman-Monteith (P-M) equation to calculate the water requirement for irrigated crops for all crops with full canopy cover, regardless of crop height, using measured 2m climate variables or variables derived using LDAS (Shuttleworth, 2006).

Approaches:
(a) make calculations (based on an assumed crop phase, see below) for all possible/likely crops in each irrigated area and then make all these calculations available to farmers, perhaps via drop-down menus that allow farmers to select the estimate for a particular crop;
(b) develop remote sensing mapping methods to identify the crops in each irrigated area and then make calculations for this more selective set of crops, perhaps even provide estimates for individual fields of crops.

Overview: LDAS/LIS Science and Data Flow

**Inputs**
- Topography, Soils
- Land Cover and Vegetation (MODIS, AMSR, TRMM, SRTM)
- Meteorology Modeled & Observed (TRMM, GOES, Station)
- Observed Land States (Snow, ET, Soil Moisture, Groundwater, Carbon, etc.)

**Physics**
- Land Surface Models (LSM)
  - Physical Process Models
    - Noah, CLM, VIC, SiB2, Mosaic, Catchment, etc.
- Data Assimilation Modules
  - (EnKF, EKF)
  - Physical Space Analysis System (PSAS) 3-D VAR
  - Rule-based

**Outputs**
- Energy Fluxes: Le & H
- Biogeochemistry: Carbon, Nirtogen, etc.
- Water Fluxes: Runoff
- Surface States: Moisture, Carbon, Ts

**Applications**
- Water Supply & Demand,
- Agriculture, Hydro-Electric Power, Endangered Species, Water Quality
- Improved Short Term & Long Term Predictions

(Peter-Lidard, Houser, Kumar, Tian, Geiger)

Paul R. Houser, 12 January 2007, Page 3
The Shenandoah Critical Zone Observatory

Problem statement: The Shenandoah Valley flora & fauna are among the most diverse anywhere, however due to increasing population and agricultural land use, over one hundred species are threatened or endangered. There have been a significant number of insect and disease outbreaks, severe flood and drought, wildfires, mountain harvesting activities, and growing use conflicts at the urban/wildland interface, fish kills, and increasing agricultural demands.

Hypothesis: We hypothesize that contaminant transport in the Shenandoah Valley is controlled by dynamic thresholds of water flux and the epikarst critical zones. The Valley encompasses a gradient of critical zones developed in 3 distinct lithologies: 1) the siliciclastic rocks flanking the valley, 2) the epikarst within the carbonate bedrock, and 3) the non-carbonate flysch sediments of the Martinsburg formation (siltstones, sandstones, and shales) in the valley floor. These zones route through the weathering horizon into the deep groundwater, and 3) the non-carbonate flysch sediments (siltstones, sandstones, and shales) in the valley floor. These zones result in a complexity of flowpaths, including (a) recharge through the weathering horizon into the deep groundwater, and (b) rapid, direct routing through the shallow sub-surface into surface drainages.

Observatory Approach: Our approach for testing the Shenandoah Valley critical zone hypothesis is to follow a water drop as it flows and is partitioned through the Valley, its watersheds, and its various critical zones. We will follow the drop using a set of nested observation and modeling studies that will operate at the critical zone, watershed (Opequon Watershed), and regional basin (Shenandoah Valley) scales. Most of the observation resources will be focused on the 3 geologically-defined critical zones. In this way we will identify the nature of the controlling dynamic thresholds, various pathways and residence times, watershed fluxes and balances, and their implications on water quality and ecology.

Figure 1: The Shenandoah-Opequon Critical Zone Observatory.
**NASA Applied Science Approach**

Solutions Networks harvest and explore research capabilities and support needs to identify candidate solutions. Thus, the role of WaterNet is to

1. Harvest water-cycle *research results* and water-cycle relevant *decision support needs*.
2. Analyze this information to *identify candidate solutions*, and *determine the configuration required to build the solution* (pre-evaluation report)
3. **Optimize the network** to improve the fidelity of the candidate solutions.

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<th>Applied Sciences Systems Integration Engineering Environment</th>
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The pre-evaluation report formally documents the candidate ISS configuration and identifies its components, contributors, and connections.
**WaterNet: Concept**

**WaterNet GOAL:** improve and optimize the sustained ability of water cycle researchers, stakeholders, organizations and networks to interact, identify, harness, and extend NASA research results to augment decision support tools and meet national needs.
1. **Evolve a network of water cycle partners**: identify and analyze water cycle community-of-practice organizations, DSTs and their requirements and develop well-constructed teams and partnerships to define collaboration pathways.

2. ** Routinely identify, prioritize, mine and communicate relevant NASA water cycle results** that address NPAs, and develop operational information system pathways to provide timely user-community access.

3. **Optimize water cycle partner access** to NASA water cycle research, through developing prototypes, evaluation methods, verification procedures, and benchmarking standards to create an evolving and self-sustaining network.
   - **Network Optimization**
   - **OSSEs**: MIT Integrated Global System Model (IGSM)
   - **PROTOTYPES**: SAHRA/USBR Western Rivers Water Management; Coral Reef Early Warning System (CREWS); CUAHSI-Hydrologic Information System (HIS); State-of-the-Water-Cycle Demonstration; CNRFC-Water and Emergency Management Demonstration; NCAR’s Research Applications Lab (RAL)

4. **Analyze and document** the WaterNet effectiveness by developing metrics, standards, resource estimates, documentation procedures, guidelines, and pre-evaluation reports to describe the steps to access and utilize NWRs

5. **Engage in education and outreach** to help society understand the water cycle and its potential application benefits.
Network demonstration projects

We plan several demonstrations to illustrate the development of the network and the identification of NWRs through network optimization.

**SAHRA/USBR Western Rivers Water Management**: SAHRA will participate by developing strategies to assimilate WaterNet database and linkage tools into its multi-resolution integrated modeling, process study and stakeholder interaction activities for the Rio Grande, San Pedro & Northern Mexico regions.

**Coral Reef Early Warning System (CREWS)**: A DST operated by NOAA’s Office of Oceanic and Atmospheric Research as part of its Coral Reef Watch program in response to the deteriorating global state of coral reef and related benthic ecosystems.

**CUAHSI-Hydrologic Information System (HIS)**: We will link the CUAHSI-HIS tools to the WaterNet, and analyze the performance with respect to generating input required for BASINS/HSPF, the existing DST for the Chesapeake Bay watershed.

**State-of-the-Water-Cycle Demonstration**: The emergence of a State-of-the-Water-Cycle (SWC) initiative coordinated through the NEWS Integration Team provides a tangible focal point to exercise NASA investments in water cycle information provision in a fully global context.

**CNRFC-Water and Emergency Management Demonstration**: The NWS California-Nevada River Forecast Center provides an ideal demonstration of state-of-the-technology networking in human and technology dimensions.

**NCAR’s Research Applications Lab (RAL)**: The RAL has extensive knowledge of the aviation industry’s needs from aircraft icing microphysical studies to microburst safety procedures at airports during landings and take-offs.
Water Mgmt: Preliminary Demonstration Scenarios

http://crew.iges.org/climatedata

http://wxmaps.org