

Western States Water Council

"Water Information and Decision Support - Issues and Solutions"

November 17th, 2008



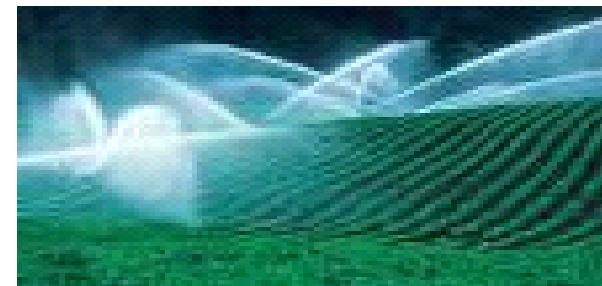
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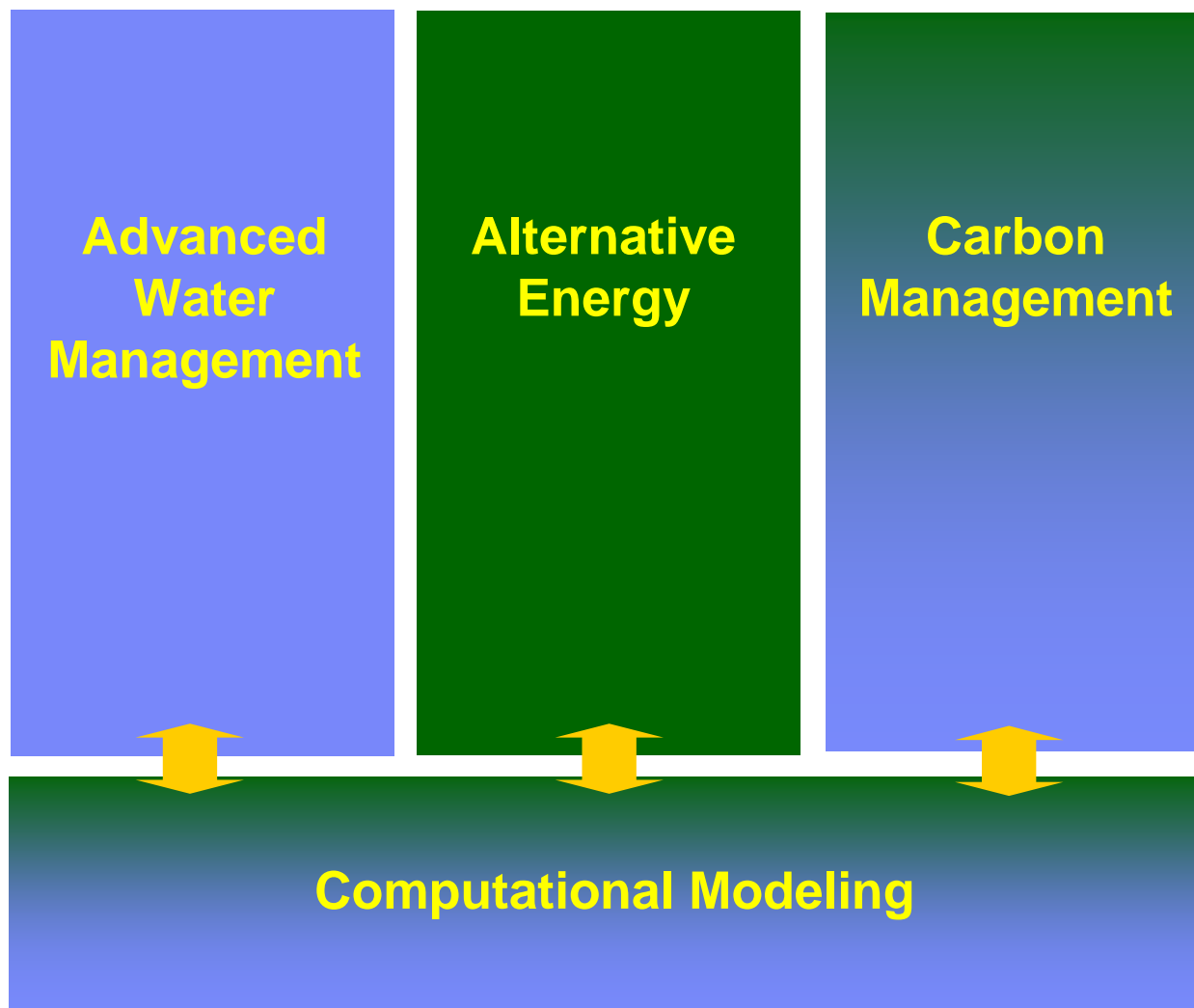




Big Green Innovations' portfolio has four core areas



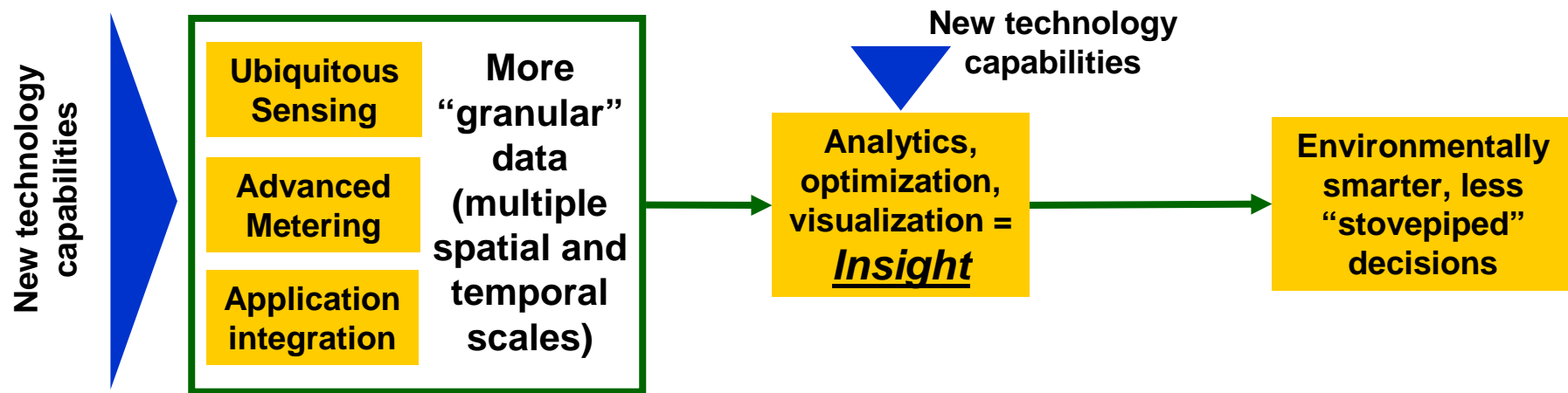
Relevant to this presentation





“Instrumenting the planet”

- Much of Big Green Innovations is based on enhanced understanding of planetary & human systems, and their interactions



- Sensing and metering will be in ever greater detail and ever closer to real time/ continuous.
- Modeling & optimization will be “whole business, real-world, operational”, no longer “function-based, off-line, advisory”
- Decisions can be taken at the scale of the problem - not just subsets of it





Much of water management is information management

*“One barrier to better management of water resources is simply **lack of data** — where the water is, where it's going, how much is being used and for what purposes, how much might be saved by doing things differently. **The water problem is largely an information problem.** The information we can assemble has a huge bearing on how we cope with a world at peak water.”*

Source: Wired Magazine, “Peak Water: Aquifers and Rivers Are Running Dry. How Three Regions Are Coping”, Matthew Power, April 21st, 2008

*“Today’s decisions and policies will shape our water future... The effectiveness of those decisions **depends on the quality of information** ... In addition to improved water data the United States should **develop and expand ... forecasting and predictive models and systems...** to educate and influence water use behavior of individual[s], businesses and resource managers”*

Source: NSTC, “A Strategy For Federal Science And Technology To Support Water Availability And Quality In The United States, - Report Of The National Science And Technology Council Committee On Environment And Natural Resources Subcommittee on Water Availability and Quality”, September 2007



Data “pathologies” - and a prediction

- **No data**
- Data is in the **wrong scale** (spatial or temporal) for the decision
- Data is **fragmented** between different stakeholders:
 - Different formats, scales, frequencies, standards
 - Re-capture of data many times
- **Too much data** to use
- **Incompatible or incomplete models** mean that data is not leveraged
- **Poor visualization** of information impedes effective decision-making
 - “So what’s this telling us?” syndrome

- **Prediction:**
 - *“Unless we solve these problems, some percentage of whatever we invest in water management in the West (let’s say, 30-50%) will be wasted.*
 - *But we won’t know which 30-50% until something major breaks”.*



The “exam question”

- Building on sensing capabilities and data availability today, how to:
 - ... **routinely** capture information required to manage water resources, and rely less on one-off exercises or studies?
 - ... enable scientific research to be executed and new questions to be answered faster and at lower marginal cost?
 - ... create a “single version of the truth” for a given water resource (aquifer, watershed, estuary, etc)?
 - ... serve up data and analyses for rational water management decisions?
 - ... use information to build trust, and serve as the foundation for collaboration, between agencies?



Example 1: Overview of REON



RIVER AND ESTUARY OBSERVATORY NETWORK

Visualizing the Unseen River

DISTRIBUTED SENSOR NETWORK

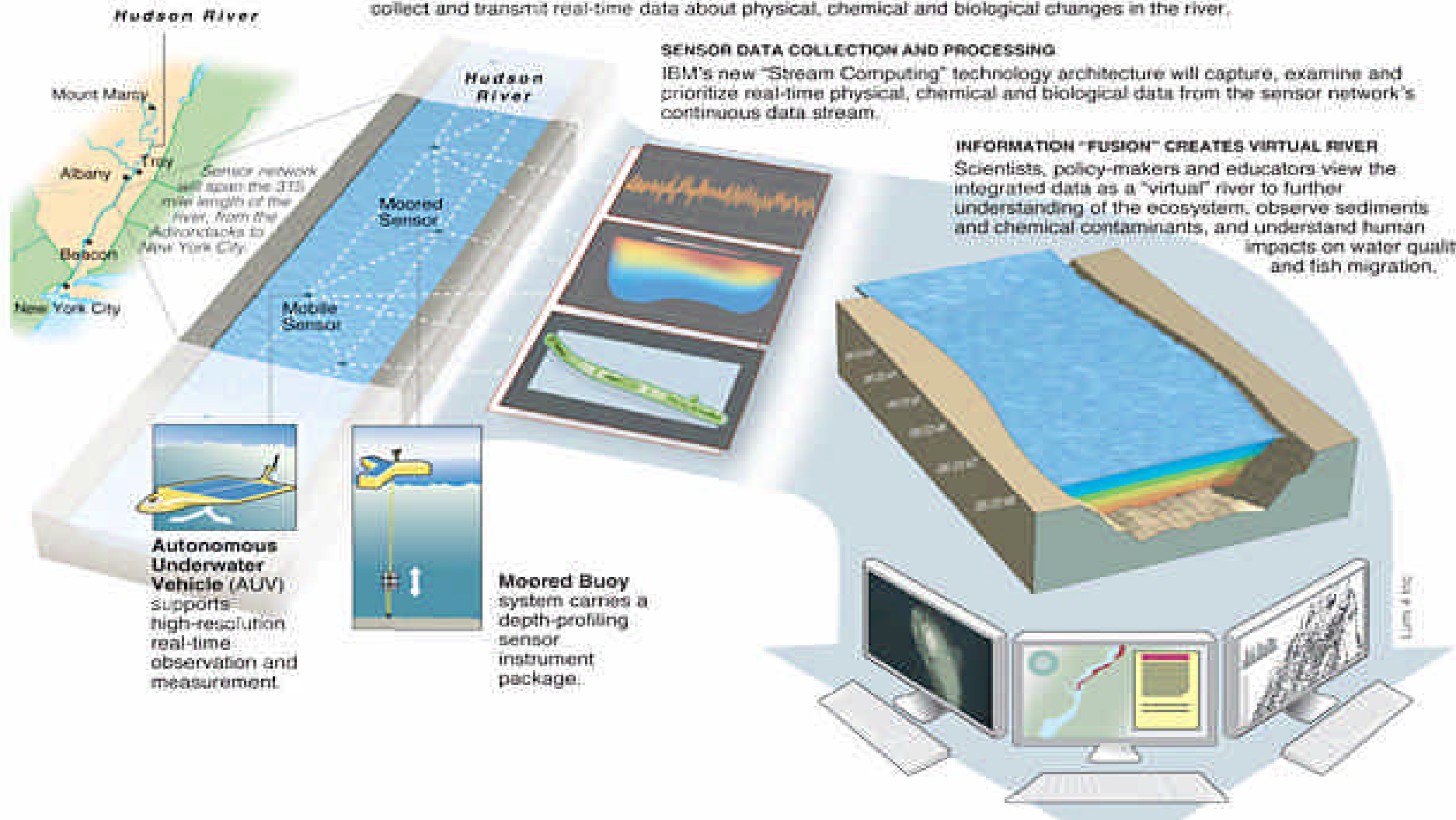
A network of mobile and moored wireless sensors (each sensor with its own computer chip), will collect and transmit real-time data about physical, chemical and biological changes in the river.

SENSOR DATA COLLECTION AND PROCESSING

IBM's new "Stream Computing" technology architecture will capture, examine and prioritize real-time physical, chemical and biological data from the sensor network's continuous data stream.

INFORMATION "FUSION" CREATES VIRTUAL RIVER

Scientists, policy-makers and educators view the integrated data as a "virtual" river to further understanding of the ecosystem, observe sediments and chemical contaminants, and understand human impacts on water quality and fish migration.



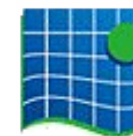


Possible learning points from example 1

- Value of real time data - daily or monthly readings won't suffice
 - Value of single information platform for the river, supporting:
 - Multiple sensing types, data scales, frequencies
 - High numbers ('000s) of sensors =>granularity of data
 - Integrated set of data capture, processing and analytic tools
 - Self re-configuration in response to events
 - Value of infrastructure for projects and needs as yet unthought-of - saves recreation from scratch
- Suppose we gave each major water resource in the West its own **sensing data platform**?
 - Supporting all stakeholders
 - Integrate existing sensing, models, datasets - expand (and/or fill in gaps)
 - Supporting multiple scales of data and analysis
 - Analytic/visualization suite
 - One “version of the truth”
 - Would enable rational debate and managed tradeoffs

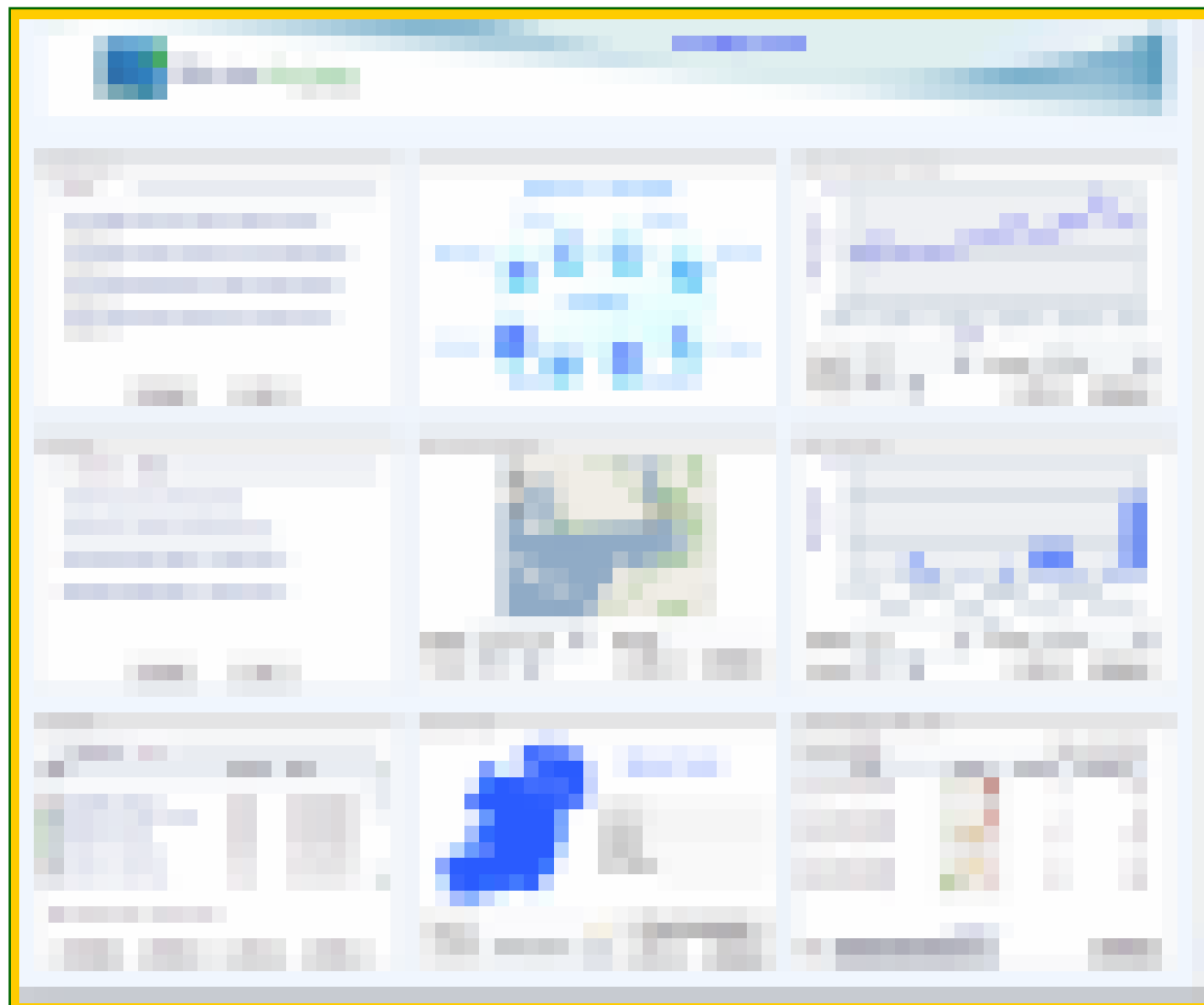


Example 2: Smart Bay (Galway Bay, Ireland)



Marine Institute
Foras na Mara

- Shared information/ collaboration platform for all stakeholders (coastguard, fishing, leisure, shipping etc)
- Will allow conclusions to be drawn from real time, streaming data:
 - Weather
 - Pollution alerts
 - Algal bloom prediction
 - Rogue waves, etc





Possible learning points from example 2

- Value of a “collaboration infrastructure” for the resource
- Collaboration built on shared information platform that:
 - Integrates existing and new, sensed & manual data sources
 - Serves stakeholders (leisure coastguard, shipping, fishing) with “one version of the truth”
 - Configured “portlets” for each
 - Data accumulates to enable research on changes, trends etc
- Value of real time data
- Standards are vital

- How could we **aggregate data** in this way for each of the West’s major water resources?
 - Water quality, quantity (usage and consumption, discharges and run-off)?
 - Planning data?
 - Ecosystem health?
 - Climate change impacts?
- What data, models would be needed? What standards?
- What are the collaboration needs to bring this about?



Example 3: Ijkdijk (“Calibration Levee”)

Ijkdijk

smart levee solutions,
from design to construction
to long-term maintenance

- Netherlands project to understand what this instrumented levee will “look and feel like” as it breaks
- Multiple sensor types create a reference real-time “signature” from inside the levee, as hydraulic pressure builds up. Also tests:
 - Effectiveness of different sensor types
 - Applicability of numerical models
- IBM is undertaking integration task, working with TNO (NL Government scientific research organization)



“A more accurate and more continuous insight into the functional quality of water management infrastructures will become increasingly important...occasional measurement and manual data processing procedures will no longer be sufficient...” Source: “The Ijkdijk” (Ijkdijk brochure)



Possible learning points from example 3

- Value of real time data (even from a pile of dirt!!)
 - Bake the information infrastructure into the physical infrastructure
 - Value of a “reference architecture” for levee management: will be incorporated in levees when rebuilt
 - Sensing, models, visualization
 - Idea is to enable a “levee control room” for the whole country
 - Will also enable IT and engineering industries to create products and services
 - Business case is based on risk mitigation
- What would a “**reference architecture**” look like for a collaboration platform for major natural water systems in the West?
 - Stakeholder information needs to be met,
 - Data sources (local, national)
 - Sensor types, frequencies
 - Models, integration points
 - Standards for data granularity, formats, models
 - How would it be propagated?



Example 4: Great Rivers project



- Science-driven conservation with I/T expertise and computing power
- Modeling framework and decision support system to simulate behavior of river basins around the world
- Inform policy and management decisions regarding land use and management tradeoffs
- Data: climate, rainfall, land cover, soil moisture, land use, etc.
- Software:
 - Scenario forecasting tools
 - Integrative modeling framework
 - 3-D visualization





Possible learning points from example 4

- Value of integrated modeling suite for entire water resource
 - Paraguay-Parana, Yangtze and Mississippi
 - Need for metadata and semantic harmonization - standards vital
 - Ultimate goal is to create semantic framework that allows models to be chained together - while avoiding “frankenmodels”!
 - Visualization techniques are vital for effective decision making
 - (Evaluating interactive 3D, “Second Life”-style)
- Could we create a **“reference set” of model components** for policy formulation for the West?
 - Components chained and processed sequentially, in parallel, or both
 - Rules define inputs and execution sequence
 - Output of one component forms input to others (e.g., net radiation into canopy evaporation)
 - Auto-calibration will be key



Proposal for “WaterITOrg” - to educate the water industry on value, and effective use of, advanced IT

- **Articulate a vision** of how advanced IT will benefit water management
- **Create supporting collateral** - reference architectures, ROI tools, data and modeling standards, etc and work for adoption
- **Sponsor & stimulate pilots** for:
 - Wide-scale sensing, advanced analytics and visualization
 - Data and model integration on the scale of the water resource being managed
 - Multi-agency collaboration
 - (Supported with Federal funding)
- Educational focus



- Federal, state and local agencies
- Water industry associations
- Universities
- Water users
- Water industry vendors - engineering, IT, equipment, other

Interested? Contact
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Thank you!

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Illustration of major elements of a reference architecture

