Managing Resource Networks with a Generic Open-source Software Platform

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Outline

• Sustainability and resource systems
• Systems modeling software
• HydroPlatform
• Example applications
• Project organisation
• Conclusions
Sustainable City ...
Sustainable Resource Network

Water resources, energy, food, transport, trade, logistics, social networks, ...
Systems modeling in the 21st Century

- Large problems
- Multidisciplinary
- Many spatial and temporal scales
- Computationally complex
- Simulation, optimization, and mixed
- Data intensive
- Require sophisticated user interfaces
Traditional stand-alone software / DSS

Examples
- HEC products
- DHI products
- Riverware
- WEAP
- etc.
Model Platform

- Manages & displays model inputs & outputs
- Export/import functions or add-ins
- Open-source, freeware, or proprietary models

Models:
- Model A
- Model B
- Model C
- Model D
HydroPlatform
an example platform for network models

- Free, open source (GPL license & Python)
- GIS interface (Thubian)
- Customize node and link objects
- Several plug-ins

Phase B: Import & display model results (next step)

Phase A: enter, manage, & export data (completed)
The old way...

[Jacobs et al. 1995]
... in HydroPlatform
Define required data for each network object
Example Applications

London water supply and Thames water resource system

Water Supply Capacity Expansion and Trade in England

Zambezi Basin Hydropower

Traffic Optimisation

Network Analysis
English water management context

• Water supply & waste water utilities privatised since 1989

• Companies must submit environmental and financial water plan to regulators (EA, Ofwat) every 5 years

• Companies have incentive to invest in capital schemes (i.e. prefer a desalination plant to sharing supplies with neighbor)
London and Thames water resource system

**Goal:**
- Predict London water supply system performance under climate change
- Robust, meets environmental targets

IRAS-2010 model uses a weekly time-step over 85-year time horizon with a runtime of 1 sec
Gauged flow at Teddington

IRAS-2010 and AQUATOR show same flows and follow trend for gauged flow
Capacity Expansion and Water Trading

Goal:
- Identify minimum cost portfolio of supply and transfer options to meet future demand
- Uses ‘Economics of Balancing Supply & Demand’ framework
Goal:
Find allocation policies that maximize agricultural, hydropower and ecological benefits
Goal: Model optimises real-time control of traffic light duration
Linear-Quadratic traffic signal control

• Input
  – Traffic inflow
  – Nominal ‘fixed’ timing plans
  – Traffic light cycle time, green durations
  – Max storage and flow of each link

• Output
  – Queue lengths
  – Optimal ‘dynamic’ timing plans
Finding community structures in complex networks using mixed integer optimisation

**Goal:**
reveal the relationships between individual objects and their groupings in networks

Community of 62 bottlenose dolphins living in Doubtful Sound, New Zealand

Each node represents a dolphin and the links in the network are identified based on the significantly frequent communications among them.
Project organization

- www.hydroplatform.org
- Wiki, code, and bug reports
- Pre-release available
- Future app store
  - open-source,
  - proprietary,
  - freeware models
Conclusions

• Model platform = user interface + data manager
• Helps focus on model development rather than software
• Efficient, flexible, scalable, open-source platform
• Goal: catalyze model innovation and use
• Coming soon: ‘App store’ for HydroPlatform add-ins
• Applications: general simulation, capacity expansion optimisation, water trading, traffic control, network analysis, etc.