SWITCH Policy Briefing Note 3

Decision Support Tools for Integrated Urban Water Management Systems

The following policy briefing note presents an overview of the basis for the knowledge management and decision support system (DSS), developed by SWITCH, known as *CITY WATER*. The note is aimed mainly at decision makers on integrated and sustainable urban water management, local government including urban planners, water utilities, and major international agencies working in developing countries.

Headlines

1. *CITY WATER* is a combined knowledge management system and decision support system (DSS) that integrates a suite of models with a graphical user interface and general data base.
2. It has been designed to support collective decision making among the many stakeholders in a City concerned with integrated water management.
3. The embedded models allow a wide range of future scenarios and management alternatives to be scoped rapidly and they provide as output a broad range of current and future potential performance/sustainability indicators (including water requirements, energy demands, water quality, financial costs and cost recovery).
4. It provides a novel framework for an iterative learning environment that should maximise knowledge exploitation and minimise knowledge waste. Maintaining the database is a key requirement for implementing such a framework.
5. *CITY WATER* does NOT replace the need for detailed analysis and engineering design for any future water management plan.

Introduction to the SWITCH City Water DSS

The rate and ease of adaptation of a city's water system to changing conditions will be a factor in the environmental wellbeing of the city and its sustainability.

The SWITCH project advocates a major shift towards integrated urban water management (IUWM) focused on the sustainability of urban water systems and a much greater interaction of the different water sectors and stakeholders. As one aspect of this work, knowledge management and decision support tools for exploring future options are currently being developed.

CITY WATER is a combined knowledge management and decision support system that integrates a suite of models with a graphical user interface and general database. It provides scoping calculation tools for exploring different aspects of water and wastewater accumulation, treatment, transfer, and use across the city. *CITY WATER* builds on past and contemporary work but incorporates features specific to the SWITCH project and the Learning Alliance (LA) environment for participatory planning of Integrated Urban Water Management (IUWM) strategies:

i. Progress in water provision in the city of the future will focus not just on the demand for water to supply basic needs and a clean environment but also on the living conditions and the amenity value of water in the urban landscape. *CITY WATER* gives significant weight to the integrated exploitation of the natural environment as one possible contribution to the development of a sustainable future.
ii. Most models for scoping options for IUWM adopt quantitative frameworks that are largely concerned with minimizing or maximizing either water supplied, water consumed, cost or energy components. *CITY WATER* also includes views of the regulatory environment, the legal frameworks for decision making and the historical data that define past conditions, approaches and outcomes. This provides a totally new paradigm for exploring a city's waterscape and for evaluating options for its development.

iii. *CITY WATER* can explore the long timescale issues of life cycle costing, as well as short timescale risks identified as indicators of sustainability. It can also explore the evolution of a city landscape as opposed to only addressing the end-point(s) of a process of development. By expanding the range of space and timescales examined, it allows scoping by an LA that is more in tune with the nature of change in the city and is more inclusive of the range of experiences of the LA members.

Issues and challenges

Decision support tools have a strong academic record of development and application and are rapidly being taken up and used in practice across a wide range of applications (Denzer, 2005). The usefulness of these tools has evolved as users have provided input to their design. *CITY WATER* is founded on the large body of past work in the area of DSS design.

What makes a good decision support tool?

Rizzoli and Young (1997) identify the attributes of a good environmental DSS:

- The ability to acquire, represent and structure knowledge in the domain under study (stored in the domain base);
- The domain base allows the separation of data from models, by interfacing the domain base with the model base and the data base;
- The ability to deal with spatial data (the GIS component);
- The ability to provide expert knowledge (stored in the knowledge base);
- The ability to be used for diagnosis, planning, management and optimization; and
- The ability to assist in problem formulation and selection of solution methods.

Makropoulis et al. (2008) extend these attributes from the perspective of the decision-maker:

- sustainable practices for UWM cannot be universally applied, they are location specific;
- good communication between stakeholders is essential;
- Decision Support (DS) tools must support rather than replace the judgements of decision-makers and allow them to explore alternative solutions.

How can decision support tools support decision making?

Starkl et al (2009) explored the development of a new decision making process that moves away from traditional approaches for allocating funds to new water projects. They were concerned with the problems of financing IUWM developments through local and government actions and rejected complex decision aids. One reason for this might be that preferences must be accounted for in the setting up of the optimisation problem. While this is easy for a single decision maker, it is more difficult as the number of contributors to a decision expands and preferences diverge. A second reason is that it is difficult to quantify the implications of any unknowns in the optimisation; the quality of the decision is not necessarily easily understood. Most importantly, it is essential to avoid the problem of optimal individual or local decisions producing a globally poor decision.

The question remains of how DS tools should support collective decision making. Linking the use of DS tools to changes to organisational interactions might provide better ways of consensus building and could then make better use of the analytical capacity of decision support software. *CITY WATER's* design relates to its use within a Learning Alliance framework for decision analysis.

Highlighting the importance of risk, resilience and adaptive capacity

Sustainability is not just about managing risk but about managing and living with change. Resilience addresses the ease with which a system recovers from a stress. Adaptation assesses the ease with which a system changes to accommodate a stress. DS tools that concentrate only on identifying the risk to a system during operation may not effectively assess sustainability. In an ecological sense, survival is as much about the ability to adapt as it is about circumventing risks. Cities that do not adapt to changes in available water resources may suffer similar problems. Indeed the droughts in Australia have forced the government to consider the problem of evacuating some small towns.

While most cities' water problems are not so problematic, the rate and ease of adaptation of a water system will be a factor in the environmental wellbeing and sustainability of the city. Measuring adaptive capacity for IUWM is not well developed and developing systems that increase adaptive capacity is still relatively new.

What are the attributes of a city's water system and its governance that make it resilient and or adaptive and how can one incorporate these attributes into any strategic planning for IUWM? New decision support tools that can assist in the development of answers to such questions should prove highly useful.

Embedding iterative learning processes

Do we need to get all aspects of a sustainable urban water management strategy right from the outset, or can we learn from our successes and failures and iteratively move towards our goal of a sustainable urban water management system? This is an important question as it has implications for the way in which we use decision support tools. It also has implications for the way in which we gather and organise data and information and the way that we use it when making decisions. Mitchell (2006) presents case studies from Australia's cities to see how well urban water management approaches are succeeding in delivering improvements to the water environment. The results are encouraging and advances are being made, but additional efforts are identified as being needed. Mitchell acknowledges that the real importance of these case studies is the knowledge they can feed into developing future IUWM developments. By sharing knowledge from recent and past work, confidence in IUWM approaches can grow and mistakes will be avoided.

> *"Prevailing approaches of planning and strategy making, which traditionally deal with the states of systems in terms of fixed goals, fail to acknowledge the process nature of sustainable development ….. it is argued that triggering a social learning process with full involvement of all stakeholders and planners in the process would be the most suitable strategy for sustainable development."*
>
> *(Bagheri and Horth, 2007)*

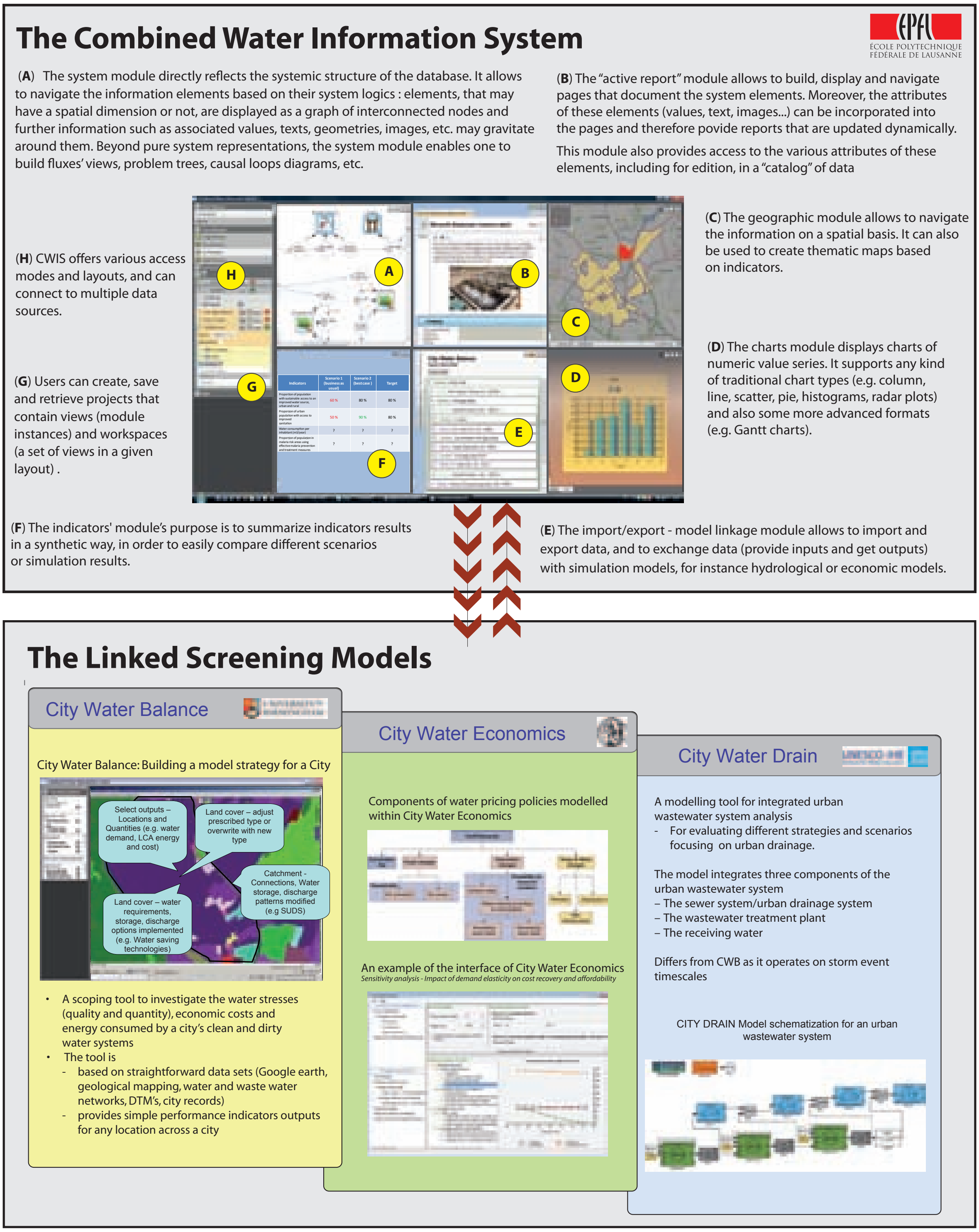

Figure 1. City Water - A knowledge and information sharing platform to support global and integrated urban water planning

This iterative learning environment can usefully be embedded into the application of a decision support tool. Using such a tool as a repository of knowledge about past and current UWM activities should improve future progress towards a sustainable city.

Summary and Conclusions

Decision support tools can be useful for decision making if they are designed appropriately and implemented constructively. The best tools will take account of the way decisions are made; the roles of the community of stakeholders involved in decision making; the value of different analytical methods to the assessment of options; and, the appropriate forms of information that should be accessible. The best use of these tools will involve progressive, sustained application over extended time periods to meet the needs of reflective learning and adaptation.

Key references

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The SWITCH project aims to achieve more sustainable urban water management in the "City of the Future". A consortium of 33 partner organizations from 15 countries are working together on innovative scientific, technological and socio-economic solutions, which can then be more speedily replicated around the world.

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