

DEVELOPING INTERDISCIPLINARY RESEARCH AGENDAS FOR TOTAL WATER CYCLE MANAGEMENT – SUMMARY PAPER

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EXECUTIVE SUMMARY: Speakers at the workshop *Developing Interdisciplinary Research Agendas for Total Water Cycle Management* addressed a wide range of issues covering technical options, their efficacy and health implications; principles and techniques for integrated management; organisation and governance in the water sector; and appropriate regulatory regimes and their requirements. Participants agreed on the strong need for interdisciplinary cooperation in attempting to understand the current system of water provision and use and its shortcomings, and in setting out an agenda for reform of policy, practice and regulation to enable integrated water cycle management and the wider adoption of particular initiatives such as water reclamation. They identified a variety of gaps in our current understanding and a need for improved techniques and procedures for evaluating and managing water projects and for involving users and the wider public.

1. INTRODUCTION

This paper summarises the issues raised at the workshop *Developing Interdisciplinary Research Agendas for Total Water Cycle Management* held on 9 December 2002 at the University of Wollongong. The workshop was the first in a series organised in support of the Australian contribution to the EU 5th Framework project *AQUAREC: Integrated Concepts for Advancing Sustainable Urban Water Management*.

The aim of the workshop was to identify an interdisciplinary research agenda for addressing critical issues in integrated urban water management. The agenda is intended

to inform and help shape a range of work in Australia directed to developing the sustainable use of water.

The workshop was organised in three sessions which attempted to address different perspectives: technical options and strategies, organisation and governance, and regulatory issues.

2. STRATEGIES FOR CONSERVATION, ENVIRONMENTAL MANAGEMENT AND RECYCLING

The challenge of the effective management of water resources is one of developing and integrating scientific, technological, economic and social knowledge of the water cycle into policies and programmes to create a sustainable use of resources and interaction with the environment and to maximize human welfare.

The dominant current approach to water resource management is based on a traditional linear sequence of activities from collection to discharge – in the case of Sydney and Melbourne, to the sea. Most water management institutions focus on one stage of the sequence: collection, supply, usage, treatment or disposal. Recent reforms to deal with problems emerging in this system have been additions or modifications to address specific problems – for example:

- catchment and resource management authorities to manage the collection of raw water;
- environmental monitoring and standard setting bodies to regulate water use and disposal;
- pricing authorities to manage water market and human and environmental welfare issues;
- state and local government regulation – or deregulation – of urban design and building standards to manage water collection, use and disposal.

The problem with this approach is that it has consisted of *ad hoc* responses to emerging issues rather than a coherent strategy of research, policy development and action. It is inadequate as a basis for sustaining resources and meeting the needs of an increasing population.

Progress is being made on many fronts in developing a knowledge and policy framework for an integrated and effective water management strategy. Contributions to this broad

endeavour were outlined by the speakers in this session: Tony Wong (Monash University), Alan Gregory (Sydney Water), Peter Dillon (CSIRO Land & Water), and Paul Sherman (Queensland EPA).

Tony Wong pointed out that in terms of water-sensitive urban design some progress is being made in wastewater and stormwater management, but effective and efficient management requires further improvements in knowledge, technology, regulation and organisation. Community knowledge and values present obstacles in many places to the introduction and acceptance of new ways of doing things. Developing and implementing more effective water use practices and institutions is not an option, but a necessity. Alan Gregory pointed out that the sustainable yield of existing bulk water stocks is 600GL a year, and consumption exceeds that figure now, while Sydney's population is rising by 50,000 a year. Though between 10% and 30% of existing water use could be reduced by introducing efficiency measures, and the three quarters of raw water used that is deposited in receiving waters could be cut, there are significant obstacles to achieving these goals. Of particular importance to Gregory is the challenge of increasing rainwater harvesting and the reuse of wastewater. These goals cannot be achieved, however, without more R&D, the development of more appropriate and comprehensive water-valuation and price-setting practices, and increased individual, household, community and stakeholder acceptance of new water use practices. Paul Sherman reinforced this point and noted there is a need for more scientific research on water quality and use issues, legal reform to enable greater reuse, and demonstration projects to encourage reduced raw water use and the spread of reuse practices. Relying on water service providers to do this in conditions of fixed or falling bulk water supplies and use presents problems, and raises the question of where funding should come from for these requirements.

There are multiple facets to the institutional barriers facing the adoption of new ways of managing water provision and use and dealing with water-related issues, as Peter Dillon pointed out in his paper – matters of organisation, regulation and social norms. Raw water and discharge costs are not incorporated fully in water bills and users are therefore not given the necessary incentives to change their attitudes and practices. There are no easily 'closed' systems in the water cycle; household, community, industrial and other water users require, even with the most advanced treatment and reuse systems, supplementation on a regular or seasonal basis. Design, installation and maintenance of

appropriate systems require knowledge and skills, and there are deficiencies in these in both trades like plumbers and professions like urban planners.

3. GOVERNANCE OF WATER USE

As discussed in the previous session, developing TWCM requires interdisciplinary work and debate on appropriate technological options and management strategies. However, this discussion on its own is limited without rigorous reflection on the governance of water provision and use – the social institutions that establish and control their operation and shape change in them. Today, it is generally well accepted that current systems of governance are too fragmented – often with overlapping jurisdictions and with conflicting interests and agendas – and that they typically vest technocratic knowledge and control in the hands of government agencies at the expense of communities and other non-government organisations. This context, entrenched over the past century, can present significant impediments to developing and implementing TWCM, and its overhaul must be a central issue in any research agenda for advancing sustainable water management. The complexity of this issue was explored in different ways by the speakers in this session: Hal Colebatch (University of New South Wales), Rebekah Brown (University of New South Wales), Stewart Russell (University of Wollongong), Richard Dennis (Australia Institute) and Walter Moore (Shoalhaven City Council).

Hal Colebatch focused on the issue of risk and governance in water management and suggested that the theoretical framework of the institutionalisation of social practice is helpful for illuminating the dimensions of the water management problem. He highlighted the distinction between risk as measured by analysts and the risk perceived by those affected, and drew on a number of analogous areas of social change – such as the shift in social norms around smoking – which can provide important insights for considering social action in the field of water management. Rebekah Brown highlighted the importance of understanding how change is institutionalised as a critical precursor to formulating a research agenda. By presenting a case study of the local management of urban stormwater, she highlighted the importance of intra- and inter-organisational capacity in a watershed catchment for developing new forms of governance. In particular she emphasised political capital, intersectoral policies and a general orientation towards

technological adaptability, as important factors conducive to the development of organisational capacity. Stewart Russell explored contributions from the field of Technology Studies which can shed light on current water systems, the prospects for water recycling and the changes needed for its wider uptake. He argued the need to understand water provision as a sociotechnical system, examining the interdependence among technical components and knowledge, and economic, political and cultural structures and processes. He discussed several overlapping foci of work within that general approach that are particularly pertinent: critical perspectives on the assessment and management of risks, the possibilities and requirements of public participation, and strategies for implementing technological systems flexibly and reflexively. Richard Dennis focused on the issue of policy and implementation and argued that we often overstate the power of economics and underestimate the importance of politics. To advance the practice of TWCM there needs to be a political demand for the product of clean and recycled water. As priorities are set among the many issues vying for political attention – like safety and employment – water provision is still all too easily relegated. This neglect is partly because the problem is still not well understood and articulated, and no timeframe or deadline is recognised for its adverse consequences. Walter Moore concluded the session by reporting a positive experience of community involvement in a reclaimed water management scheme for Shoalhaven City Council. He stressed the importance of providing high quality information to the community with the explicit aim of enabling the community to participate meaningfully in decision-making. A number of different strategies were used to inform the community. Walter highlighted how the project reached a successful outcome by meeting adequately a number of – often competing – environmental, economic and social objectives as a direct result of extensive community involvement.

4. GUIDELINES, MONITORING, INDICATORS & PERSUASION

The discussion following the presentations by John Anderson (NSW Department of Public Works and Services), Kaye Power (NSW Department of Health), Peter Dillon (CSIRO Land & Water), and Adrian Langdon (NSW Department of Land and Water Conservation) covered a variety of angles on appropriate regulation and what it requires. That the discussion was so wide-ranging and difficult to channel itself indicates the need for substantial work to support the necessary reform of water regulation – particularly for the wider adoption of reuse.

It was argued that adequate regulation required clarification of the health and quality issues in reuse, identification of the relevant contaminants and suitable indicators to cover these. A systematic review of health and quality issues would highlight possible shortcomings in current regulation – particularly in dealing with potential contaminants such as endocrine disruptors and other trace chemicals that are the subject of growing international concern, and the use of proxy indicators to cover a range of micro-organisms.

Standards or guidelines needed to link more carefully and specifically applications of recycled water and required water quality.

The choice between guidelines and standards was discussed. It was argued on the one hand that guidelines should be seen as an interim measure to get new schemes implemented, providing guidance rather than fixed criteria. On the other hand, there were difficulties from the discretion that gave regulatory bodies. The comment was made that because guidelines to some extent can be treated expediently and flexibly, their success depends on their perceived value and basis. Since water authorities were traditionally government bodies, the absence of appropriate standards may have reflected their unwillingness to be subjected to such strict rules, with the costs of potential compliance a major concern. The implication is that a greater organisational mix in the sector may require clearer and more explicit regulation than was appropriate when centralised government bodies dominated the system.

Guidelines need to incorporate a risk management approach, rather than simply providing standards to be met, and should set out appropriate risk management procedures for developers and operators to follow. In particular they may need to identify critical control points, and to enforce the use of semi-quantitative and qualitative assessment methods to cover risks for which quantification is impossible or inappropriate.

Paul Sherman pointed out that in Queensland a working group is currently developing water recycling guidelines based on a risk management approach. To date, the group has designated three categories of water quality. Unrestricted Use - 'U' water is of high quality, is suitable for all irrigation methods, and can be used on crops to be eaten raw. Restricted Use 1 - R1 water requires some additional treatment beyond conventional wastewater treatment such as filtration or lagooning to ensure destruction of pathogens. Restrictions

apply to irrigation techniques and produce. Restricted Use 2 - R2 is basically municipal effluent from a conventional biological treatment process with disinfection. The use of this water is restricted. The use of R1 and R2 waters requires special attention for the protection of farm workers. Work on this classification scheme is still in progress.

Many delegates indicated that they did not fully understand the current regulatory system: it is complex and in some respects incoherent; responsibilities are not clear; and it is inconsistent across different jurisdictions. There is a need for uniform and transparent processes. In particular there was wide agreement on the need for consistent guidelines at a national level. These should give clear directions on the issues to be examined, processes to be followed, and the appropriate expertise to draw on. This raised the question of which agency should produce such guidelines – and more generally which agency should be in control of water reuse. There is a need for a clearer demarcation of responsibilities between agencies. It should be noted that similar issues are of concern in Europe and will be addressed under the AQUAREC framework.

The issue of centralised versus decentralised treatment was raised. Kaye Power opened the argument by asking whether people could reasonably be expected to look after their own sewerage system. The issues of responsibility and liability for decentralised systems needed consideration; it is not clear that liability is currently distributed appropriately nor is there an existing ruling on liability. Liability shared between owners/operators and authorities might be appropriate for decentralised systems. Adrian Langdon pointed out the relevance of the conflict between farmers and the state government over responsibility for blue green algae.

The applicability of the precautionary principle to water regulation was discussed. Rebekah Brown pointed out that the burden of proof was a problem – currently the regulating body has to prove the existence of pollution, whereas a system requiring the potential polluter to demonstrate the absence of pollution might be more appropriate.

Issues of assessment and regulation were again linked back to the question of community consultation. There is a need to educate the public with the aim of equipping them to make choices on the basis of information about consequences. However, there are major uncertainties and unknowns in our knowledge of those consequences, and these must be

openly acknowledged, even if to do so generates concern. It was suggested that options need to be presented in context, using comparisons such as that between the quality of polluted surface water supplied with minimal treatment and highly treated recycled water.

The EU AQUAREC project is particularly important for the issue of micropollutants. While micropollutants, and specifically Endocrine Disrupting Chemicals (EDCs), are apparently not regarded as an issue in Australia, evidence from many parts of the world is cause for concern. As Andrea Schäfer pointed out, this area of hazards spans the fragmented water, wastewater and stormwater domains and should be a stimulus to integrated water management. While EDCs are seen only as a threat to humans if present in drinking water, a closed water cycle may turn what is currently a wastewater issue into an issue for the entire water sector if it is not taken seriously. The problem is critical where receiving waters and source waters used for potable purposes are in a closed loop, as with many rivers in Europe, and where contaminants may enter the food chain (via water or solids) and affect ecosystem health. There the risk of reuse needs to be compared with the risks, for example, of exposure to contaminants through the food chain, but there are substantial gaps in our current knowledge and ability to make such comparisons. Further work is required on how to control these contaminants effectively at source and prior to discharge into sewerage systems or receiving waters.

5. WORKSHOP DISCUSSIONS

The issues raised during the workshop turned out to be far less easy to compartmentalise than the organisers had envisaged, and the discussions after each set of papers ranged freely and widely, indicating a wider set of questions and much greater interdependence between issues than had been anticipated.

In a facilitated participatory session partway through the workshop, participants were asked to identify and prioritise key research issues for TWCM. The process generated a long list of potential research questions, and towards the end of the day workshop participants were asked to rank them in terms of importance. The top seven questions were as follows:

- How should we benchmark sustainable water technologies – what works and how? – and provide this information in a useful and coherent framework?
- What are the intangible costs and benefits of TWCM – particularly environmental costs and benefits – and how should they be assessed?
- How might we facilitate collaborative interdisciplinary reflection on a number of possible TWCM scenarios?
- What factors affect attitudes, intentions and behaviours with respect to reuse?
- What are the lead time and drivers for changing social behaviour?
- How can we understand future changes in demography and social characteristics and anticipate social needs and responses?
- What are the structures governing how we use water?

These most popular questions reflected recurrent points of discussion throughout the day. They highlighted a need for a better understanding in several key areas: the operation of the existing system of water provision and use and the interconnection of its elements – in physical, organisational and governance terms; community responses and their social and cultural basis; and the range of technical options, their characteristics and relative merits – including current unknowns and uncertainties. The corollary is that we need to develop or adopt appropriate and consistent frameworks and techniques for assessing options – for example, for comparing technical characteristics of treatment technologies, or for assessing the costs and benefits of water systems across the range of quantifiables and intangibles. It is evident that arriving at suitable and agreed frameworks still requires considerable work and debate.

Beyond research on the day the following comments were made by which did not fit neatly into the organisers' format but indicated other important areas of contention and necessary work.

Given the effect of water prices on the attraction and viability of water reuse – in both residential and industrial settings – it became evident that much further work is needed on the framework for costing water, and in particular the treatment of externalities.

In the industrial context, as well, further research is needed on the applicability and effects of effluent of different qualities – with secondary treatment or tertiary treatment of different sorts – in specific applications, and on issues such as the safety of workers exposed to aerosols.

Several points in the discussions indicated that a future workshop should address legal issues, as some of the ideas being put forward would open up a legal minefield. Greywater sharing might lead to complex problems of liability if, for example, someone in an apartment block which discharges greywater to a sports field inappropriately disposes of turps or bleach and causes a loss of grass cover or bad publicity.

One notable issue missing from the discussion was the effect of trends in housing: reducing the size of land blocks and increasing the size of houses on those blocks. Already householders on new developments are unable to dispose of household greywater individually on their small lawns and gardens. Research relating number of householders, lawn and garden size, and greywater output would be useful for working out where greywater systems are sensible and cost-effective. A similar analysis of roof catchment space by generic location or rainfall average would also help targeted promotion of rainwater tanks. The experience of rainwater tanks or greywater systems which turn out not to reduce water consumption, or which produce frequent overflowing, not only disappoints the individual householder but probably contributes to poor general publicity for these practices.

Wendy Hirt (BHP Steel, Pt Kembla) commented on the residential use of greywater: that while many commentators included kitchen sinks as a potential source of greywater, the contaminants, food scraps and oil it contained, and the problems they cause with blocked sprays and pipes, meant that the relatively small volume of water obtained was not worth the trouble, and wastewater from this source should be considered as sewage.

6. CONCLUSIONS

The papers highlighted the point that consideration of the total water cycle must have as its most basic aim the provision of reliable water sources, and ask the question: do we understand hydrological systems and ways of matching them to appropriate demands? Research should cover all sources, all forms of use and all possible impacts of these uses on the urban and wider environments. Implicit is the need to deliver safe water through effective treatment and monitoring practices and appropriate regulations, to avoid the detrimental short and potentially long term health effects, for example, of viruses and persistent chemicals. This aim in turn raises questions about what is deemed 'safe' and who should make such decisions, in particular with regards to uncertainties involved.

A number of further requirements emerge for knowledge and policy development for integrated water management.

First, decisions on technological options, evaluations of the efficacy of the technologies, and our understanding of the associated risks, must all be geared to providing flexibility – scope to accommodate the lessons of future performance data and unforeseen events. Strategies for building such learning processes into the implementation and operation of schemes are still not well developed.

Second, we need to understand better the relation between on the one hand experts' framing of health and environmental risks issues and their technical assessments of risk, and on the other hand public responses to the technologies and their risks. This understanding must inform improved programmes for consulting and educating users and the wider public.

Third is the need for a better understanding of socio-economic institutions in the sector and their relationship with the physical systems. In particular, which technologies or configurations of systems are best suited to which types of settlement – in terms of densities, demographic characteristics, etc.? which technologies actually work? how should we link water technologies with other forms of infrastructure, particularly in considering the overall environmental impact of settlements?

Finally, a number of questions remain to be examined and argued about the roles of government. Government at local, state, and federal levels plays a key role in managing and regulating the economy, the environment and the water cycle. As is recognised elsewhere in the world, it is likely that these roles and the division of responsibilities in relation to water provision require a through overhaul and rationalisation if the goals of sustainable water supply and use are to be achieved.

7. FUTURE WORKSHOPS

A series of further workshops at Wollongong through 2003 and 2004 will address

- Technical Limitations in Water Recycling Applications, 21 May 2003
- Community Participation: Methodologies & Best Practice, TBA
- Decentralised versus Centralised Wastewater Treatment – Opportunities & Concerns, TBA
- Legal Issues in Water Recycling, TBA

8. OZ-AQUAREC

Following the discussions during and after this workshop an agenda was developed for the OZ-AQUAREC initiative which resulted in the submission of a major grant proposal with a number of participants. Expressions of interests are welcomed for further partners and case studies in water recycling.

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