

INTEGRATED WATER RESOURCES MANAGEMENT IN PERI-URBAN LANDSCAPES: LESSONS FROM ENGAGING STAKEHOLDERS AND COMMUNITY

GESTION INTEGREE DES RESSOURCES EN EAU DANS LES REGIONS PERI-URBAINES: LEÇONS APPRISES DE L'ENGAGEMENT DES PARTIES PRENANTES ET DE LA COMMUNAUTE

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ABSTRACT

The concept of Integrated water resources management (IWRM) is centuries old but it got blurred with the onslaught of the modern technologies. What is new in the current IWRM paradigm is the renewed emphasis on bringing the varied stakeholders together and gaining a greater appreciation of local peculiarities for developing IWRM strategies. Sydney, like all growing cities, is expanding into adjacent rural lands (peri-urban areas). However, IWRM is significantly different in peri-urban landscapes and it is more difficult due to the complexity of issues and range of stakeholders, agencies and interests involved. In this study, we explored a multitude of issues that had to be resolved, the challenges that had to be faced and the opportunities that were created when undertaking IWRM in this peri-urban landscape. The most important issues for IWRM in peri-urban landscapes include maintenance of the water cycle for agriculture, recreation and environment in the face of expanding urban needs. For achieving long-term regional water security in peri-urban landscapes, we need effective engagement of stakeholders, regional water managers and land-use planners for developing common vision and long-term planning. In addition, we need to treat regional water cycle as one unit rather than manage water within local government boundaries.

Key words: *Peri-urban water management, Stake holders' participation, Water cycle, Western Sydney.*

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RESUME ET CONCLUSIONS

L'Australie est le continent le plus sec et bien habité de sa population réside dans quelques centres urbains. La région de Sydney est le plus grand hub du pays de la population et l'activité économique et le commerce. En raison de la pression démographique dans l'agglomération de Sydney, la croissance urbaine se produit dans l'ouest. En conséquence, les changements rapides se produisent dans le paysage de la région de l'Ouest de Sydney. Centrale à la durabilité de cette région, un paysage péri-urbain, est intégrée des ressources en eau. La gestion intégrée des ressources en eau (GIRE) a été examinée pendant près d'un demi-siècle et n'est pas un concept nouveau. Cependant, ce qui est nouveau dans le paradigme de la GIRE est l'accent mis sur la rencontre des acteurs variés (usagers domestiques, agriculteurs, décideurs, planificateurs, gestionnaires et autres) et d'obtenir ainsi une meilleure appréciation des particularités locales. En d'autres termes, il n'y a pas une telle chose comme un modèle unique pour tous GIRE. La GIRE est de plus en plus en train de devenir une alternative acceptée dans le style de gestion du secteur par secteur et de haut en bas en grande partie échoué de la gestion des ressources en eau passé. La GIRE implique la gestion par le biais d'un processus participatif. Fondamentaux de ce processus est la bonne compréhension des ressources en eau d'une région et rassembler les parties intéressées à développer des moyens pour répondre aux besoins de la région en eau à long terme, tout en maintenant des services écologiques essentiels et les avantages économiques.

Dans cette étude, nous avons exploré une multitude de questions qui devaient être résolues, les défis que devait relever et les opportunités qui ont été créés au moment d'entreprendre la GIRE dans ce paysage péri-urbain. Sydney, comme toutes les villes en pleine croissance, est en pleine expansion dans les terres adjacentes rurales (zones péri-urbaines). Gestion intégrée des ressources pourrait être un moyen important d'établir un dialogue entre les parties prenantes pour la planification des ressources en eau efficace et à long terme à l'échelle régionale. Toutefois, la GIRE est significativement différente dans les paysages péri-urbains et il est plus difficile en raison de la complexité des questions et l'éventail des parties prenantes, les organismes et les intérêts en cause. Les questions les plus importantes pour la GIRE dans les paysages péri-urbains comprennent l'entretien du cycle de l'eau pour l'agriculture, les loisirs et l'environnement face aux besoins croissants en milieu urbain. Pour atteindre à long terme la sécurité régionale de l'eau dans les paysages péri-urbains, nous avons besoin d'un engagement efficace des parties prenantes, gestionnaires de l'eau et des planificateurs régionaux d'utilisation des terres pour développer une vision commune et une planification à long terme. En outre, nous avons besoin pour traiter cycle de l'eau comme une unité régionale plutôt que de gérer l'eau dans les limites du gouvernement local.

Mots clés : *Gestion d'eau péri-urbaine, participation des parties prenantes, cycle d'eau, Sydney occidentale.*

(Traduction française telle que fournie par les auteurs)

1. INTRODUCTION

Although water is a renewable resource, its availability is finite and more importantly it is not always available where and when it is needed. This means that the water available for

consumption is limited in most places and most of the time. Compounding the problem of limited water availability is the degrading water quality. Looking at the global picture, nearly two-thirds of the global population resides in water stressed areas. The scarcity of water is being further exacerbated by growing population, rising standards of living, changing land use, urbanization, increasing economic activity and climate change. Unless water is used efficiently, recycled, reused, treated and managed properly, it is doubtful there will be enough water for everybody in the decades ahead. Fortunately, water is now receiving a lot of attention from all quarters. At the centre of this attention is the concept of integrated water resources management (IWRM).

The key tasks in IWRM may include developing an integrated view of water resources at the regional level; assessing different water supplies for best possible uses and least environmental impacts; managing demand through strategic policies and innovative technologies; providing equitable access to water resources through participatory and transparent governance and management; establishing improved and integrated policy, regulatory and institutional frameworks and water authorities and stakeholders working together in decision-making processes.

The objective of this article is to discuss some key lessons learnt when undertaking IWRM for a peri-urban landscape in the Western Sydney region in New South Wales, Australia.

2. WESTERN SYDNEY REGION

General

Western Sydney is the western region of the metropolitan area of Sydney (Figure 1), Australia, and includes 12 local government areas (LGA). These LGAs are Cities of Auburn, Bankstown, Baulkham Hills, Blacktown, Blue Mountains, Camden, Fairfield, Hawkesbury, Holroyd, Liverpool, Parramatta and Penrith. The region stretches over nearly 9,000 km² of residential, industrial and rural lands. The climate in Western Sydney is warm with wet summers and cool, relatively dry winters. Rainfall in summer is associated with thunderstorm and the region receives less rainfall than the coastal areas of Sydney. Rainfall varies significantly across the Western Sydney area with an annual average of 856 mm, while the annual evapotranspiration is 1373 mm (UPRCT, 2004).

The region is one of the largest economies with a significant manufacturing base in Australia (GWSEDB, 2006). From its origins as the food and manufacturing heartland of Sydney, it is now regarded as a global centre for trade, innovation and learning. The future growth and development of this region depends on how we maintain an adequate supply of clean water and dispose of, or reuse, effluent in environmentally sensitive ways.

The population in Western Sydney is projected to increase significantly over the next 20 years. The proposed North-West and South-West Growth Centres will add about 600,000 people to the 400,000 already living in the South Creek Catchment – a significant area of Western Sydney. It is likely that there will be further population growth in this period, due to the natural increase within existing land use zones, placing additional pressure on water that is available for non-potable uses. This might pose a threat to commerce; industry; and most

importantly agriculture as well as recreational sites, such as playing fields and reserves that require significant amounts of water to sustain their user-friendly quality.

Source of Water Supply

The Hawkesbury-Nepean River System is the major source of water for the Sydney Metropolitan Area (SMA) and one of the important trademarks of the Western Sydney region (Figure 1). The Hawkesbury-Nepean Catchment supplies drinking water, fresh fruit and vegetables, turf and many other farm products to the people of SMA. It also serves as a source for recreational activities, fresh water habitat, tourism and aesthetics. In effect, the river is an integral part of daily life and is inexorably linked with the quality of life and future opportunities for the people of Western Sydney and the SMA at large.

Changing rainfall patterns and continuing population growth in the region has put enormous pressures on the natural water cycle resulting in a marked deterioration in the health of the Hawkesbury-Nepean River system and placing at risk irrigated cropping, public open space irrigation and businesses that depend on water. Traditionally, water is captured, used and piped away to be dumped in the river and at sea. More efficient and effective usage of water, along with its reuse and recycling, is necessary to minimize the growing strain on the Hawkesbury-Nepean River system. Innovative management of the total water cycle (groundwater, effluent, stormwater, river and dam water and potable water) and its integration with end users through IWRM is required to meet future growing needs.

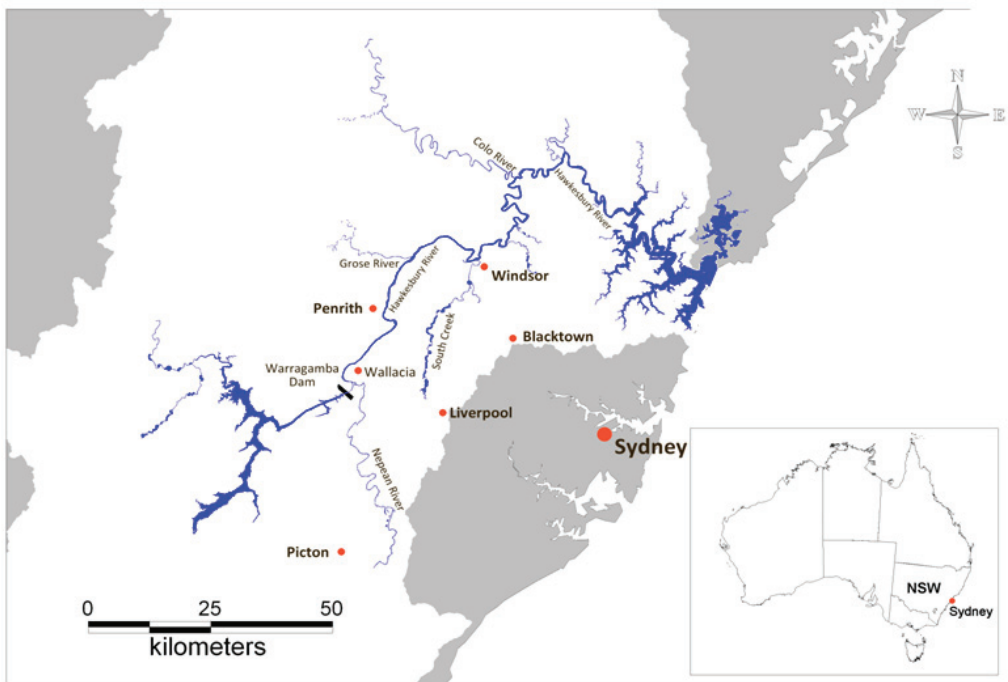


Fig. 1. The Sydney Metropolitan area and the Hawkesbury-Nepean river system. (La zone métropolitaine de Sydney et le système de la rivière Hawkesbury-Nepean).

Regional Problems and Challenges

The Hawkesbury-Nepean River Catchment is currently facing important challenges arising from limitations on water allocation for irrigation, discharge of nutrient laden runoff from market gardens and other areas into the river system, environmental flows, community issues related to use and reuse of water and interactions between water and the landscape. Being close to a large metropolitan area, both effluent use and management and urban irrigation (including, for example, irrigation for golf courses) play important roles in the overall water use and management in the catchment.

Water and waterway quality of the Hawkesbury-Nepean River system is currently considered poor (HMCMA, 2007). The river water quality is compromised by the discharge of sewage effluent and urban and agricultural runoff. In addition, significant volumes are extracted from the river system on a daily basis to meet the demands for domestic, industrial and urban and peri-urban irrigation in the region. These extractions significantly reduce the flow volumes needed for dilution of pollutants discharged into the river. Exotic aquatic plants also thrive because of high nutrient concentrations and in the dampened flow patterns not prevalent in Australia's variable rainfall regime. A study by Hawkesbury-Nepean River Management Forum (2004) concluded that managed environmental flows are required to maintain the health of the river system.

Despite ongoing efforts to protect the river system and its dependant activities, most initiatives have been undertaken in isolation and have failed to take into account the complex interrelationships between the various biophysical, socio-economic, institutional and policy factors that influence the region's water resource management. The lack of a holistic regional water resource management plan and integrated partnerships to maintain the health of the river system as a valuable future asset is putting in jeopardy the prospect of having a sustainable, green, and liveable urban and peri-urban landscape with embedded smart growth.

In order to meet the needs of existing and future populations and ensure that habitats and ecosystems are protected, Western Sydney's water must be used in a sustainable manner. Sound water resource management practices that emphasise careful and efficient use and reuse of water in the landscape are therefore critical. Water is the single most important factor in maintaining future sustainability of catchments, in particular water for irrigation and the river health. There is a need, therefore, to investigate and tap alternative non-potable supplies through a team of multi-disciplinary researchers who can work closely with relevant stakeholders and local and state government agencies. The team particularly needs to focus on providing key information that may assist in securing these additional regional water resources and implementing necessary on-ground actions.

3. WATER MANAGEMENT ISSUES IN PERI-URBAN LANDSCAPES

The term 'peri-urban' refers to the transition zone between urban and rural areas. This zone usually has low population density, high rates of change and heterogeneous land uses. They are areas within the sphere of influence of adjacent urban centres (Buxton et al., 2006; NSWDP, 2008). In Australia, the land use in these landscapes is changing rapidly and presenting

serious water management problems. Water is a key resource and the competition for water has become more intense due to increasing population and associated demand from a range of users including irrigation, industry and the environment. In particular, the migration of people from rural areas and overseas and inner city dwellers moving out to peri-urban landscapes for open space, the pressure on water supplies has continued to build over time. The landscapes are quite important from social, environmental and economical viewpoints and their value and the potential for sustainable development are increasingly being debated. Prevailing drought and prediction of climate change have forced governments, community groups and individuals to rethink the way we use and the value we place on water in peri-urban landscapes.

Peri-urban areas being close to urban centres, means a significant influence on the use and demand for land and water. Therefore, the viability of farming in these areas can be constrained by increased land prices and availability of water and can discourage new or expanding farmers. However, peri-urban areas with their proximity to large population centres can encourage intensive farming of high value crops and provide market opportunities to sell the produce. Devising sustainable water planning in the context of peri-urban issues is one of the greatest challenges for planners. A clearer understanding of the water, economic and housing demands that drive peri-urban development in these areas is critical.

4. PERI-URBAN CHALLENGES AND COMPLEXITY

Investigations of regional water resources from hydrologic, productive, environmental, social, policy and institutional perspectives have showed that the water cycle of peri-urban areas is significantly more complex than rural or urban areas alone. Controlled and natural flows that are part of the rural setting can also be present in peri-urban areas and, similarly, urban water cycles consisting of potable, sewage effluent and stormwater elements can be present in peri-urban areas. This means, the water for irrigation, industries, environment and other uses can be obtained from all these supply sources but with a greater number of management issues and increased complexity overall.

A range of social, economic and environmental benefits can be gained from the use of water for primary production, backyard irrigation, inside homes, industries, recreational activities, maintenance of public open space and environmental flow in rivers. All these uses can apply to peri-urban areas, but they usually do not apply to rural or urban areas. Furthermore, issues relating economic benefits, security of supply, water quality, human health and environmental flows can be common to all regions. Land use changes, development pressures and acceptance of alternative water supplies, however, are more part of the peri-urban scene. The complexity of peri-urban areas also means that there is greater competition for water and greater policy and political issues to deal with than in rural or urban areas alone.

A range of government departments dealing with water, land and environment and their myriad policies and regulations serve to fragment and confuse management of water resources. They also fail to satisfy the large number of stake holder groups that sometime have very different motives and expectations from the region's water and other natural resources. Often, the existing government agencies, policies and governance arrangements are not adequately designed to cope with complex and conflicting scenarios presented by the tasks of peri-

urban water management. For this reason, the existing institutional and other arrangements become overwhelmed and dysfunctional. These make water management in peri-urban regions in Australia so complex and full of conflicts.

5. THE WISER PROJECT

While water scarcity and climate change are considered a driving force for demand management strategies in Western Sydney, the use of water from different sources in peri-urban landscapes is highly fragmented and uncoordinated. As such, this has limited the use of water for irrigation and environmental purposes and made the scarcity of water much worse than it should be. The Water and Irrigation Strategy Enhancement through Regional Partnership - WISER Project was developed to address these vital issues. It is one of the four multidisciplinary projects established by the Cooperative Research Centre for Irrigation Futures (CRCIF) under the System Harmonisation Program. This program was focussed on developing a strategy to improve cross-organisational communication and system-wide management to improve production and environmental outcomes in the context of a whole catchment (Khan et al., 2008). The objective of this strategy is to achieve such co-ordination by establishing a regional business plan with the various stakeholders of the region. Although set in the broad categories of 'hydrology', 'production and environmental outcomes' and 'mechanisms and process for change', the work through system harmonisation requires understanding the needs of, and close collaboration with, stakeholders associated with irrigation and other water uses of the region.

The main aim of the WISER project was to assist irrigation and water dependent businesses by establishing an integrated water resource management and planning framework, development of business partnerships and implementation process for infrastructure development for Western Sydney. As illustrated in Figure 2, IWRM in this project involved the analyses of the region's water cycle components, water productivity and environmental, social, cultural, institutional and policy issues and challenges. The analyses helped, in consultation with key stakeholders and government agencies, in identifying and evaluating scenarios, strategies and opportunities for sustainable use of the region's water resources in the longer-term. The project was also designed to facilitate the formation of a regional partnership that continues beyond the life of this project. The partnership thus formed will provide key input into the implementation of actions identified through this project.

The WISER was a four year project that commenced in 2006, and designed to help stakeholders and agencies work from a common platform with a shared water vision matched to regional sustainability, jobs and prosperity. The project was also about helping the agencies and stakeholders to develop long-term solutions and strategies for total water cycle management. In particular, the project helped to identify the opportunities for improved river health and to understand the rapidly changing hydrology of Western Sydney as influenced by the growing population, the Sydney Metro Water strategy and water use by irrigators and other businesses.

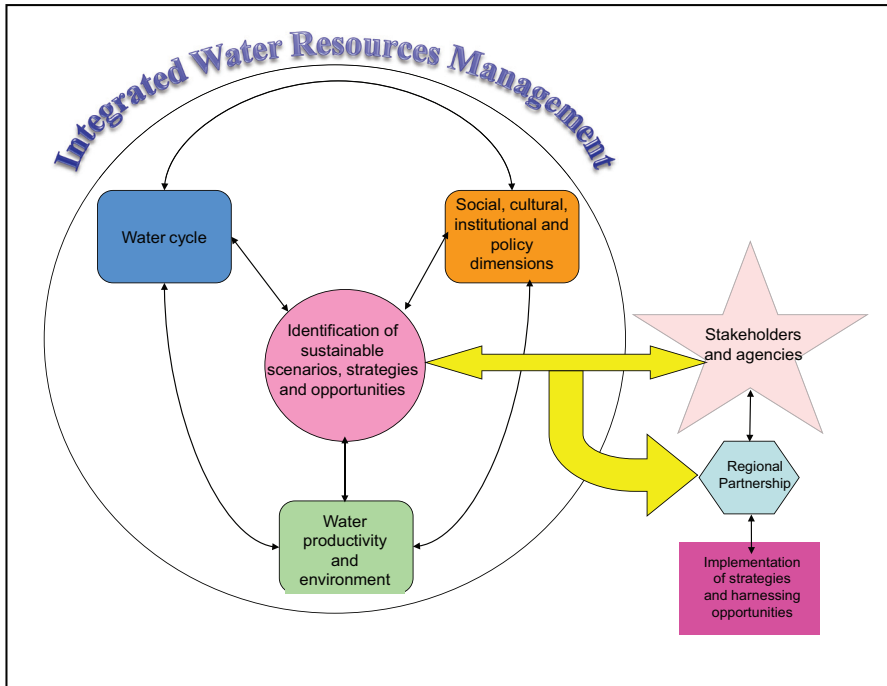


Fig. 2. IWRM approach in the WISER project (Approche de la IWRM dans le projet WISER).

The project team worked with state agencies, water cycle managers, community and business users to help them collectively optimise water management, investment decisions and risks within a triple-bottom-line framework. Working within the CRC IF, the core research organisations in this four year project were the University of Western Sydney, University of New England, University of Melbourne, the NSW Department of Primary Industries and CSIRO Land & Water. Stakeholders and agencies involved in this project are the Blacktown, Hawkesbury, Liverpool and Penrith City Councils and relevant NSW Government agencies.

The project encompassed three major activities: stakeholder engagement; modelling and analysis of hydrologic, environmental, economic, social, institutional and policy aspects and visualization; leading to the facilitation of regional business and environmental partnerships. These activities helped to understand the current water policies and institutional barriers and identify changes that may improve water use and governance. Importantly, the project assisted the stakeholders and agencies to initiate the development of a Regional Water Resources Planning and Management Framework integrating options for water use, future infrastructure development and cost-benefit analysis.

The tasks that were pursued to develop collaboration with stakeholders have included undertaking workshops to determine values and needs of irrigation in the area. They have also involved developing committees to progress and guide the development of regional irrigation business partnerships. Stakeholders considered for such workshops were water users and agencies associated with water management.

6. STAKEHOLDERS AND AGENCIES

In any region, there are a large number of players involved in water use and water cycle management and none more so than in a peri-urban area. Users (stakeholders) of potable water that is supplied by Sydney Water (a local water supply utility) include households (indoor and outdoor), market gardens and nurseries, parks, public and private playing fields (including golf courses) and industries. The users of water from other sources (river, farm dams and ground water) include agriculture and horticulture and outdoor uses listed above for potable water supplies. The users need to comply with a myriad of regulations from a large number of agencies for the use of water. On a regional planning and supply basis, these include water supply agencies (urban water supply utilities and irrigation licensing departments) and regulatory authorities (e.g., environmental protection and catchment management agencies). Locally, the requirements are further adapted and enforced by municipal councils (who also are users of water) with support from industry and recreational associations (e.g., the Lower Hawkesbury Water Users Association). Until recently the agencies involved in Western Sydney have collaborated only in a limited way on water cycle management often due to their separate and competing objectives for water use (e.g., environmental flow, urban water supply and agricultural irrigation) of the same river system. The yet to be released water-sharing plan of the Hawkesbury - Nepean River system is an attempt to overcome conflicting uses over the region.

To guide the research being undertaken by the WISER project team the steering committee of the four largest local councils (as users) and the Metropolitan Water Authority, (the body responsible for water supply to the Sydney region) determined the research needs for successful IWRM for the region. The committee was being supported by a 'technical advisory committee' consisting of the other stakeholders and relevant government and non-government agencies and industry bodies. The role of this latter committee is to review the technical and scientific quality of the research considered necessary by the steering committee for water cycle policy development and decision making. To date, the collaboration has greatly facilitated the data transfer from agencies to the research team and has allowed a forum for joint project development such as a proposal for a stormwater harvest and reuse grid for Western Sydney.

7. STAKEHOLDER ENGAGEMENT PROCESS

The aim of stakeholder engagement processes in the WISER project was to form new alliances or partnerships involving government agencies, stakeholders, community and non-governmental organisations to seek solutions that will last longer and meet the water needs of the region, including those of the environment. Useful alliances or partnerships do not form easily – they need time, trust, patience and goodwill. Their formation often requires appreciation of each other's legitimate water needs or interests, understanding of an agreed picture of how much water there is in the region, how much different users require and why the activity of one user influences the needs and interests of other users. In general, a truly effective engagement process should help stakeholders become aware of the fact that the solutions to the region's water problems are linked with interdependencies in understanding problems and seeking solutions. Only when stakeholders recognise a shared nature of the regional water problem and their commitment to facilitate solutions will a constructive,

solution-oriented dialogue emerge (Butterworth et al., 2007). As part of the stakeholder engagement process in the WISER project, over 20 consultation meetings were held with industry, government and community organisations during an 18 month period to: (i) determine priorities for water use in the South Creek Catchment; (ii) identify opportunities for stakeholder investment in productive water activities including environmental services; and (iii) identify potential stakeholders for ongoing irrigation business and environmental partnerships.

8. STAKEHOLDER VALUES AND PRIORITIES FOR REGION'S WATER RESOURCES

A number of meetings and workshops were conducted over the first two years of the WISER project in which, amongst other things, values and needs of water in Western Sydney were canvassed with stakeholders. This culminated in a workshop where representatives of the Project Steering Committee, the Technical Advisory Group and researchers of the WISER project met to discuss the desired outcomes for the Western Sydney's water needs. Initial brainstorming sessions at the workshop produced a list of key water management outcomes desired for Western Sydney. These outcomes were then ranked in order of priority to be achieved through future actions.

The top five desired water management outcomes with their priority ranking were: improved land and water planning, enhanced river health, sustainable community, food security and equitable water sharing. Overall, the workshop helped to produce a mix of broader outcome statements for a fully functioning, healthy river system. Other desired statements included a balanced city and rural life with maintenance of river fisheries and security of local fresh food. There were major concerns, however, that without equitable water sharing the river and agriculture would suffer and human health and well-being in the region would decline.

From this information, it can be surmised that the participants wanted to see a balanced approach to land use, with equitable water sharing to enable agriculture and food production and river productivity for a sustainable future. Due to future development and water shortages, there was a concern that a potable water supply will not be available for industry, playing fields and urban open space and backyards and alternative water supplies (mainly treated effluent and harvested rainwater) will be competing directly with agricultural and river health needs. This workshop emphasised maintaining agricultural production and river health as priorities for the future assisting formation of the hierarchy of research areas for the WISER project to address.

9. IWRM IN WESTERN SYDNEY - LESSONS LEARNT

There are a number of key lessons for IWRM from the WISER project, and these lessons may have relevance to other peri-urban regions in Australia and overseas. At the commencement of WISER project, we realised that an irrigation-only focus of IWRM was too narrow, especially for peri-urban regions such as Western Sydney where there are so many stakeholders, agencies and users and interest groups that drive the region's water planning and future.

Different stakeholders were invited in a series of meetings and workshops to participate in the water management dialogue. Due to the complexity and conflicting nature of the

peri-urban scenario, a facilitator was involved to steer the process. In spite of some level of professionalism and commitment of the various stakeholders and agencies, on many occasions, it was difficult to have a constructive dialogue among the various parties involved. Governmental agencies sometimes cannot see beyond technical details and ministerial directives and may not adequately appreciate the bigger picture of the water cycle and the needs of the very people they are hoping to serve, thus creating mutual distrust among stakeholders, agencies and community. With persistent effort and personal approach, we have found that it was possible to succeed in motivating stakeholders, agencies and community to talk with each other about pressing water issues and solutions.

We found that it is impractical to expect all stakeholders to come to the table at the beginning of the project. The reasons for this are probably related to the lack of a clear understanding of the issues and differences in power and authority. Due to the complexity of the peri-urban water management, conflicts among the various parties involved is part and parcel of stakeholder engagement processes and in fact it can even be helpful in stating openly the perceptions and interests that need to be considered in arriving at practical and acceptable solutions (Leeuwis, 2000). Stakeholder engagement processes therefore become a mix of 'learning and fighting' (Butterworth et al., 2007).

In the past, when agencies are the initiator of the process, there was the possibility of confusion, as stakeholders do not usually see authorities as neutral facilitators. On the other hand, the researchers in WISER project were able to play the role of facilitator between government agencies and stakeholder effectively and eventually were able to bring all the parties together to the table. The engagement in the WISER project has given stakeholders a broader perspective of the region's problems and enabling them to be more integrative in their approach to seeking solutions.

We have learnt that effective stakeholder engagement requires us to trust the views of stakeholders and provide sympathetic facilitation while avoiding any manipulation in the process. The people who represent agencies and stakeholders are only human and on many occasions they may propose seemingly unsustainable or impracticable decisions. However, water issues in peri-urban regions are so complex that we cannot expect everyone to think the same and agree at the beginning of the dialogue. The role of an effective stakeholder engagement process is then to work in a spirit of co-operation and mutual respect and lead vision building and solutions that are jointly owned by agencies, stakeholders, researchers and community at large.

We have also learnt that the engagement needs to be ongoing by the partners involved to allow development of formal relationship among themselves, e.g., by forming an entity through a Memorandum of Understanding. Our experience suggests that such relationships greatly benefit the region in building social capital emanating from regular sharing of ideas, debunking engrained prejudices and urban myths about each other and providing confidence and positive interactions.

10. CONCLUSIONS

Sydney like all growing cities is expanding into adjacent rural lands (peri-urban areas). Integrated water resources management could be an important vehicle to establish dialogue

among stakeholders for an effective and long-term water resource planning at a regional scale. However, IWRM is significantly different in peri-urban landscapes and it is more difficult due to complexity of issues and range of stakeholders, agencies and interests involved. The most important issues for IWRM in peri-urban landscapes include maintenance of the water cycle for agriculture, recreation and environment in the face of expanding urban needs. For achieving long-term regional water security in peri-urban landscapes, we need effective engagement of stakeholders, regional water managers and land-use use planners for developing common vision and long-term planning. In addition, we need to treat regional water cycle as one unit rather than manage water within local government boundaries.

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REFERENCES

- Butterworth, J., Ducrot, R., Fayse, N. and Janakarajan, S. (Editors), 2007. *Peri-Urban Water Conflicts: Supporting dialogue and negotiation*. Delft, the Netherlands, IRC International Water and Sanitation Centre (Technical Paper Series; no 50), 128 p.
- Buxton M., Tieman G., Bekessy S., Budge T., Butt A., Coote M., Mercer D., Coote, M. and Morcombe J., 2006. *Change and Continuity in Peri-Urban Australia, State of the Peri-Urban Regions: A Review of the Literature*. Monograph 1 of 4, RMIT University, Melbourne, 320p.
- GWSEDB, 2006. '2006 Regional Economic Profile'. Greater Western Sydney Economic Development Board. Accessed 23 June 2009. [http://www.gws.org.au/imagesDB/webPages/\(1\)GWSSummarydoc2006-FINAL.pdf](http://www.gws.org.au/imagesDB/webPages/(1)GWSSummarydoc2006-FINAL.pdf)
- Hawkesbury Nepean River Management Forum, 2004. 'Water and Sydney's Future – Balancing the values of our rivers and economy', report to the NSW Minister of Natural Resources. Department of Infrastructure, Planning and Natural Resources, ISBN 0 7347 5456 6.
- HMCMA, 2007. 'Hawkesbury Nepean River Health Strategy Volume 1'. Hawkesbury Nepean Catchment Management Authority. Goulburn NSW ISBN 0 7347 5710 7
- Khan, S., Malano, H. M., and Davidson, B. M., 2008. System Harmonisation: A framework for applied regional irrigation business planning. *Irrigation and Drainage*, 57(5), 493-506.
- Leeuwis, C., 2000, Reconceptualising Participation for Sustainable Rural Development: Towards a Negotiation Approach. *Development and Change*, 31: 931–959.
- NSWDP, 2008. *Sydney–Canberra Corridor Regional Strategy*. New South Wales Department of Planning, Sydney, 56p.
- UPRCT, 2004. *Water Sensitive Urban Design - Technical Guidelines for Western Sydney*. Upper Parramatta River Catchment Trust, Parramatta, NSW, 183p.