INTEGRATED CATCHMENT MANAGEMENT FOR SUSTAINABLE WATER USE IN RESPONSE TO CLIMATE CHANGE

PROCEEDINGS OF SYMPOSIUM (MELBOURNE, AUSTRALIA: SEPTEMBER 1 – 2, 2009).

BACKGROUND

Monash University is collaborating with the Institut Pertanian Bogor (IPB), the University of Palangka Raya (UNPAR), the National Council on Climate Change (DNPI), Indonesia; Viet Nam National University (VNU (Hanoi)), the Ministry of Natural Resources and Environment, Viet Nam (MoNRE); the Indian Institute of Technology Bombay (IITB), the National Institute of Technology, Rourkela, India (NIT), and the Indian Institute of Remote Sensing (IIRS) in three linked AusAID projects "*Developing integrated catchment management strategies for sustainable water use in response to climate change*". The aim is to develop an integrated approach to managing catchments, given likely climate change scenarios (sea level rise, increased frequency and severity of floods, storms, increased wild fire risk). Drawing on the disciplines of climate science, engineering, economics, hydrology, geography, environmental science, sociology, biology, and ecosystem modeling, the projects aim to develop capacity and to provide an improved basis for development and application of policy relating to climate change mitigation and adaptation. The following summarises the proceedings of the two-day symposium.

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Program

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DAY 2

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Water sensitive cities: historical co-evolution of technology and society
A/Professor Rebekah Brown (Monash University)

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Flood management
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Hydrological aspects of the Mahanadi river system
Professor K.C. Patra (NIT)

Theme: Socio-economic issues

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Modelling socio-cultural drivers for REDD schemes: Central Kalimantan and beyond
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Alue Dohong (UNPAR)

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Dr Paul McShane (Monash University)




SUMMARY OF PRESENTATIONS

Climate change: an international perspective
Professor Christian Jakob (Monash University)

Downscaling of global circulation models to provide greater regional climate forecasting capacity is problematic in tropical latitudes. Predictions of rainfall and temperature patterns on tropical land masses can be inaccurate. This has implications for the development of biophysical models which include climate change effects. The development of dynamic downscaling techniques offer improved forecasting capability. This is particularly important as tropical nations feature prominently in both climate change adaptation (e.g. response to disasters such as floods, storms and fires) and climate change mitigation (e.g. reducing greenhouse gas emissions through avoided deforestation, reduced fire risk, and improved land use).

Watershed management in Indonesia in the context of climate change
Dr Hendra Yanto (IPB)

Watershed management issues in Indonesia include declining water quality. To date, management approaches have addressed the symptoms rather than the cause. Land management, including the conversion of native forest to oil palm can adversely affect water sheds. There is a strong commitment from the Government of Indonesia to address land use policy. Extant issues include: land tenure, property rights, the judicial system, and human resource capacity. Addressing these issues will require institutional capacity building through appropriately targeted multidisciplinary research.

Downscaling climate change models
Dr Subimal Ghosh (IITB)

Hydrological models, developed to predict climate change impacts, require precipitation forecasts on smaller spatial scales. Dynamic downscaling techniques use nested gridding in the region of interest. Forecasts of rainfall and evapo-transpiration require downscaling at a local/regional scale given the interaction of land use (e.g. cropping, vegetation, forestry) and run-off into catchments. Risk management considers hydrological extremes with projections of hydrological variables (stream flow, run off). These variables are influenced by land use particularly urbanisation which can considerably influence run off rates and increase the risk of flash floods. Models applied to Indian catchments apply dynamic downscaling with PRECIS to link to input to commonly used hydrological models such as SWAT. SWAT models can be trained to include land use patterns and improved regional scale forecasting to present more realistic hydrological scenarios linked to likely climate change. Current AusAID funded studies of the Mahanadi river basin are examining how fine scale land use patterns interact with changes to Monsoonal rainfall.





Climate change: A Vietnamese perspective
Dr Nguyen Ninh (VNU (Hanoi))

Viet Nam is severely exposed to climate change impacts including increased frequency and severity of typhoons and sea level rise. Issues include: land inundation including major cities such as Ho Chi Minh City and community health (increased prevalence of asthma and pneumonia). Regional resilience will be influenced by literacy and access to electricity. However, remote rural communities which lack these will be particularly exposed with food security, social capacity and government capability all underdeveloped in remote regional areas of Viet Nam. Constructive links between policy makers (central and provincial governments), industry, and science are required to increase resilience and decrease vulnerability to climate change.

The Murray Darling system
Dr Rob Freeman (Murray Darling Basin Authority)

The Murray Darling river basin: Australia's largest, is exposed to climate change with increasing irrigation use causing decreased availability of water for consumptive use. The basin has been managed as separate states with individual planning schemes applicable to state-based catchments. More recently, the system has been managed as a basin. A priority allocation is for water to maintain environmental flows. Objectives are to maintain: biodiversity; connectivity between ecosystems; ecosystem resilience; protection of threatened and protected species; and water quality. Remaining water (surface water and ground water) is then allocated for other uses. The integrated basin management plan is designed as a dynamic plan. Challenges in equitable water allocation remain, particularly given likely climate change impacts, population growth, and increasing demand for water.

Issues and modeling of the Ciliwung catchment
Dr Nana Arifyaya (IPB)

Issues in the Ciliwung catchment include: increasing human population and increased flood frequency and severity. Polarity in water supply promotes flooding in the wet season and droughts in the dry season with concomitant water quality. The catchment has been modeled with distributed parameter models (SWAT) with parameters including: base flow, total Carbon, total Nitrogen). Parameters are calibrated and the model reiterated as new data are available. Social factors including urbanisation, and changed land use pattern can affect model outputs by influencing run off and stream flows. Water quality data are available but for a limited time series. The AusAID funded project developing an integrated plan for the Ciliwung will couple biophysical models with socio-economic factors and likely climate change scenarios.

The Red River Basin
Dr Nguyen Tien Giang (VNU (Hanoi))

There is an inadequate institutional framework in Viet Nam governing its water sheds. Increased industrialisation is affecting water quality and there is a need to incorporate reservoirs and dams into planning and management of catchments. Deforestation increases run off and the risk of flash floods. Dyke management is one approach to control flooding in major cities such as Hanoi.



Project overview
Dr Paul McShane (Monash University)

AusAID has supported three congruent studies of catchments in India, Indonesia and Viet Nam to develop capacity for integrated catchment management for sustainable water use in response to climate change. The case study analyses provide an opportunity to compare and contrast issues in each country. In Indonesia, the Ciliwung catchment presents climate change adaptation issues with increased frequencies and severity of floods exacerbated by urbanisation which increases run off (and the potential for flash floods). Similarly in Viet Nam, major cities are exposed to flooding of the Red River Basin and the Mekong Delta. Rural communities are particularly exposed. In India, issues of transboundary management of catchments is exemplified by the Mahanadi basin which straddles four states. The linking of climate models to hydrological models for improved regional forecasting is an outcome of the project. Similarly, regional impacts on the economy and on communities is an important component of integrated management plans. In country workshops involving major stakeholders can assist in improving government to government communication and in identifying practical and cost effective strategies for managing climate change. Studies of the Sebangau catchment (Central Kalimantan) also involve a strong climate change mitigation component with land use and land use change and forestry presenting an opportunity to reduce carbon emissions.

Integrated catchment management in India
Professor Eldho Iype (IITB)

Developing realistic models of catchments requires an understanding of the interaction of agriculture and rainfall. There is an unequal distribution of water resources. The water potential for the Mahanadi basin is about 67 cukm/yr. Most water is used for food production (including feedstock for agriculture). Improved catchment management is an important tool in poverty alleviation. Villages, institutions and communities can participate in capacity building initiatives linked to integrated management. Mapping of natural resources, and social structures is an important component. The impact of environmental and of anthropological demand creates water resource stress. Other issues such as soil erosion and sediment load in river basins can be incorporated in integrated models. An integration of anthropogenic stress conditions into such models can yield informative insights as to likely climate change impacts (at field scale level).

Integrated watershed management, economic policy, and natural resource management
Dr Sudarsono Soedomo (IPB)

Human behaviour is influential in catchment management. Forests connect global issues such as climate change to local issues such as watershed management. Existing regulations require government (Indonesia) to maintain forests in watersheds. Conflicting management such as small scale coal mining can frustrate aims to maintain forest cover in water sheds. Illegal logging remains a major threat to forest cover in Indonesia. However, some forests on private land in Java are increasing in cover. Application of avoided deforestation in Indonesia might restrict supply and, with increasing demand for timber products, increase the price of timber. This will provide further incentive for illegal logging frustrating the aim of forest conservation (for reduced carbon emissions).




Integrated catchment management: a systems approach
Professor Ray Ison (Monash University)

Systemic and adaptive governance of natural resources includes an integration of elements, particularly social elements which influence decision making. Interdependencies among systemic elements introduce uncertainty and complexity. Effective governance (of natural systems such as a river basin) must include, and allow for, dynamic interactions. Thus, as systems change (e.g. climate change), actions must allow for modified situations (and interactions among elements). Regulations and legal instruments must provide for dynamic systems and incorporate social learning and changed system states.

Bayesian networks to inform policy makers
Dr Terry Chan (Monash University)

A Bayesian network approach to catchment management is a way of integrating risk assessment social, economic, and environmental issues in a holistic approach to management. Using the example of the Kongulai catchment in the Solomon Islands, water availability can be expressed in terms of quantity and quality both of which are influenced by management intervention including social (e.g. demography, population, education), economic (land use, industry, forestry), and environmental (climate, weather, run off, evaporation, evapotranspiration). This framework can integrate socio-economic models (e.g. CGE economic models) and bio-physical models (e.g. SWAT hydrological models) consistent with the aims of integrated catchment management. The Bayesian approach is particularly useful for visualising alternative management or policy actions presenting technical issues in a simple format to policy makers.

Rainfall variability in arid and semi-arid climates
Dr Edoardo Daly (Monash University)

Hydrological systems involve a complex interaction of soil porosity, evapotranspiration, and run-off linked to regional rainfall. Thus, the interaction between land use (e.g. agriculture, forestry) and climate is important. Climate (weather) will influence rainfall which will influence vegetation (species/density). This will influence evapotranspiration (if any) and run off which, in turn, can affect regional microclimates. Soil carbon and nutrient fluxes are also important considerations in developing integrated hydrological models as these factors also influence vegetation type. Thus, these bio-physical models can also be used as input to economic models (e.g. crop yields influenced by climate change).

Water quality issues
Dr David McCarthy (Monash University)

Issues in water quality models involve calibration of model outputs with empirical data then adjusting parameter estimates. The link between rainfall and flow data can include uncertainties (e.g. run off, absorption) and reducing uncertainties is an important component of improved regional forecasting (e.g. of river flow rates). Examples of calibration algorithms, reduction of systematic errors and reduced uncertainty were used to illustrate improved water quality forecasting systems.




REDD policy issues: Central Kalimantan
Dr Sehat Jaya (UNPAR)

Socio-cultural issues, particularly those relating to land tenure, are an important component of land-use policy in Indonesia. Policy development is also influenced by human resource capability in the region and technical issues (including institutional capacity). This is particularly relevant when considering potential changes in forest policy (e.g. avoided deforestation schemes (REDD)). Potential benefits from REDD must include transparent regional (and local) benefits). Other benefits include reduction of greenhouse gas emissions (by carbon sequestration and by reduced risk of forest (and peat) fires) and improved forest governance. REDD application will also be influenced by international policies (particularly those emerging from the post 2012 UNFCCC). Forest carbon development in Central Kalimantan requires carbon accounting and monitoring, market mechanisms (for carbon trading) and governance at the district and community level. Land tenure and community access to forest and non-forest resources are also important elements of changes to existing forestry management. Potential areas in Central Kalimantan suitable for REDD include the highlands (northern part of the province including the Muller-Shwannon mountains) and the peat land areas in the southern part of the province. The Kalimantan Forest Climate Partnership (KFCP) is an important driver of changes to forest management including REDD scheme trials.

Water sensitive cities: historical co-evolution of technology and society
A/Professor Rebekah Brown (Monash University)

Urbanisation has a major influence on water utilisation and water management. Buildings increase temperatures and urban density presents issues with water infrastructure management. There are several sources of water which can be used to meet societal demands: seawater; gray water; black water, storm water and ground water. Less than 2% of water is used for potable purposes. Institutional and political barriers to improved water management are further problematic given likely consequences of increased urbanisation and climate change. Networked governance linking land water and the environment is more likely to lead to improved utilisation of available water (from the sources listed above). Energy intensive sources such as desalination of seawater are potentially less cost effective than storm water utilisation (given appropriate infrastructure).

Future urban water technologies: the role of distributed systems
Professor Ana Deletic (Monash University)

A range of water generating technologies exists including energy-intensive options (e.g. desalination). Storm water is mostly wasted in large cities. For example, Brisbane generates more storm water than is used for domestic and industrial use. Watershed structure influences run off: urbanised areas typically have high run off rates compared with rural areas in which soil porosity influences groundwater capture. Biofiltration incorporated into stormwater capture infrastructure can yield cost-effective quantities of usable water. Such innovative solutions to stormwater utilisation compare favourably with more energy-intensive systems in addressing water needs in water stressed cities.




Flood management
Dr Subhankar Kamakar (IITB)

There is an interaction between natural hazards including hydro-meteorological (e.g. floods) and geophysical (e.g. earthquakes). High resolution remote sensing can link to census data (e.g. demography/population) to assess vulnerability. Examples of Indian catchments were used to illustrate this interaction.

Hydrological aspects of the Mahanadi river system
Professor K. C. Patra (NIT)

The Mahanadi river basin is both drought prone (one sixth of the catchment) and flood prone (one eighth of the catchment). The basin incorporates the Hirakud dam which is 25 km long. Monsoonal rains influence flood frequency and the effect of the dam on river flows. Data are presented on the Mahanadi catchment to illustrate hydrological interactions.

CGE models and their application in evaluating climate change impacts
Professor Philip Adams (Monash University)

Climate change has an obvious economic impact. For example, changes to rainfall patterns will influence crop yields (types and quantities of crops) and therefore regional economic returns. Inputs to other regional economic activities (e.g. raw materials) will influence output of industrial activities in other regions. Furthermore, increased rates of natural disasters (e.g. storms, floods) impose an increased fiscal burden on governments and communities. This has a social consequence as there will be fewer resources for health, education and other important social activities. Computable general equilibrium (CGE) models can capture such economic interactions in forecasting whole of economy impacts from climate change. CGE models are widely used by governments in forecasting. They can capture short run restrictions on supply (e.g. labour, energy).

Economic issues in Indonesia
Dr Rina Oktaviani (IPB)

Manufacturing is the highest contribution to the gross domestic product (GDP) of Indonesia. Economic data are presented on provinces important to the Ciliwung catchment. These data are important components of economic modeling which can be used to evaluate potential or actual climate change impacts.





Community engagement in climate policy
Dr Craig Thorburn (Monash University)

Field schools are an effective vehicle for community engagement in natural resource management. Examples of improved agriculture practices (rice farming) were used to illustrate implementation of improved pest management and yields of rice. Such an approach is useful in examining changes to agro-forestry management given the need to reduce carbon emissions from deforestation in Indonesia. Similarly, improved catchment management will evolve from integrating environmental services into community-based approaches to management. Community engagement can also utilise ancestral lore in adding to knowledge of catchment systems and their effective management.

Modelling socio-cultural drivers for REDD schemes: Central Kalimantan and beyond
Dr Thomas Reuter (Monash University)

Socio-cultural drivers of natural resource management include culture, religion, and ethnicity. The informal economy is also an important component of forestry policy in Indonesia given current rates of deforestation and palm oil plantations. Benefits of reduced deforestation (REDD) must be weighed up against costs and traded off against other social, economic, and environmental benefits. An understanding of the socio-cultural context of alternative forestry management policy includes the ethnographic mapping of indigenous ethnic groups, identification of traditional networks, cultural and religious attitudes especially in relation to nature and use of natural resources. Kinship structures and regional networks are important in consideration of land tenure/land rights and in considering alternative livelihoods (to deforestation). Relationships between key stakeholders in government will be influenced by these factors.

Community engagement in Forestry
Dr Mukunds Srivastava (IIRS)

A case study exemplifying community engagement in forestry management (Orissa, India) was presented. Forests present livelihoods to the community, including the poor. Forest protection committees provide stewardship of forest resources. This community forest management provides a model for potential application to other regions (e.g. Indonesia).

Water resource management in Vietnam
Dr Tran Hong Thai (Vietnam Institute of Meteorology, Hydrology and Environment)

Water quality and water quantity are both issues in Viet Nam. Large floods can occur in the rainy seasons and severe droughts can occur in the dry season. Conflicts occur over water allocation including use for hydro-electric power (dams), irrigation (agriculture) and flood control (levies). There is an incomplete legal and regulatory framework to deal with water allocation issues and a lack of coordination among government agencies. A model for organisation and content of an integrated catchment management system has not been established. Committees have been established for planning, water management and water resource management. Climate change impacts include increased evapotranspiration and increased climatic extremes. Raising public awareness of water use efficiency is important and part of a master plan for water resource planning (2015-2020). Downscaling of climate models will assist in regional water resource planning.



Forestry management and REDD policy development
Dr Andrew Cock (Monash University)

External policy makers are important actors in forest carbon initiatives. However, institutional relationships are difficult to change given underlying social forces. The reductionist nature of international carbon markets tend to be insensitive to biodiversity and community benefits potentially creating tension at community level. Issues to resolve in forestry management and REDD policy development include establishing benchmarks and dividends from government to government (regional/provincial/district). Public institutions have been mandated with forest conservation including a rights-based approach to management. Resolution of just outcomes for participating communities is an important component of REDD in involving developing nations (e.g. Indonesia, Cambodia) in greenhouse gas reduction strategies. Important actors (often ignored in formal policy positions) include local NGOs, indigenous communities and women and children. There has been little progress in halting rates of deforestation and REDD schemes must resolve the potential or actual conflict between commercialisation (of carbon) and forest dwelling communities.

Land Use and Land Use Change Forestry
Dr Doddy Sukadri (DNPI)

Indonesia has set itself the challenge of dealing with climate change issues. It has established the National Council on Climate Change (DNPI), chaired by the President, as the primary body to develop and apply climate change policy in Indonesia. There are a large number of ministries responsive to DNPI including the Ministries of Forestry, Environment, Finance, Home Affairs, Energy and Mining, Agriculture, Industry, Public Works, Fisheries and Marine Affairs, Trade, Transport, Health, and Bappenas. Carbon trade mechanisms need to be developed and this is being progressed by the Ministry of Environment. The government of Indonesia is developing a low carbon growth strategy utilising a McKinsey cost curve approach to identify cost-effective strategies. Forestry and peat land management is an important component in reducing carbon emissions. Rates of deforestation are increasing with pulp wood plantations (6-8 million ha), oil palm (5-7 million ha) and crop lands (10-13 million ha). 75% of current emissions from forestry come from peat lands (fire and peat draining) and 25% comes from deforestation. Opportunities include utilisation of peat lands for sustainable development; institutional strengthening (including government to government interactions and improving the legal and regulatory frameworks). There is a need to integrate, economic, environmental and social policies in developing a response to land use, land use change, forestry in Indonesia.

Optimising the development and use of persuasive communication to influence behaviour in the Swan-Canning River System
Dr Jim Curtis (Monash University)

Changes in consumer behaviour are influential in reducing nutrient loads in the Swan Canning River system. Positive consumer selection for low impact fertilizers (to reduce nutrient loads through run off) has been influenced by targeted market campaigns. This demonstrates potency in the modification of consumer behaviour to improve water quality in rivers.




Climate, fire and landscape management in Indonesia

Professor Nigel Tapper (Monash University)

Fire resistance (in Indonesian forests) interacts with ENSO-driven climate variation. Savannas and degraded woodland and grasslands are fire prone but have differential vulnerability. Interannual drought is the greatest source of fire danger. The link between ENSO and seasonal rainfall can substantially influence fire risk. Rainfall in the savanna lands is highly correlated with fire in the dry season. The link between climate change, vegetation, and fire risk is an important area for future research.

Catchment management for multiple use

A/Professor Jason Beringer (Monash University)

Knowledge of land/atmosphere interactions, including boundary layer climatology, micrometeorology, urban climatology is necessary to understand climate change impacts at regional scales. Building on targeted research in tropical ecosystems the school of Geography and Environmental Science is well placed to examine catchment management given plausible climate change scenarios. Examples from Northern Australia ((including carbon flux measurements) are instructive in potential extension to other regions (particularly Indonesia) currently exposed to climate change challenges (adaptation and mitigation).

REDD value chain and financial distribution mechanism

Alue Dohong (UNPAR)

Forest degradation is a substantial source of greenhouse gas emissions (GHG) in Indonesia. Recent attention on reduced deforestation and forest degradation (REDD) as climate change mitigation mechanisms has exposed several unresolved issues. Although REDD is perceived to be a relatively inexpensive means of reducing GHG emissions, financial mechanisms (for carbon accounting and trading), land tenure arrangements, community access, legal and regulatory frameworks, taxation arrangements, and links to international carbon protocols require development. Planned REDD scheme trials in Indonesia under the Kalimantan Forest Climate Partnership and the Indonesia Australia Forest Carbon Partnership will address these issues particularly in identifying and implementing alternative livelihoods for forest dependent communities. Proposed research (in collaboration with Monash University) will examine payment distribution mechanisms linked to REDD schemes with the aim of yielding improved carbon trading systems compatible with the needs and aspirations of forest dependent communities in Indonesia.




Synthesis and next steps

Dr Paul McShane (Monash University)

A gap analysis of case study catchments in parallel AusAID funded projects in India, Indonesia and Viet Nam has revealed the following (with reference to presentations):

- A need for dynamic downscaling of global circulation models for improved regional forecasting of climate in catchments. This is particularly relevant to hydrological models which require reliable parameter estimation of rainfall and run off (among other parameters) (e.g. Ghosh, Jakob, Eldho, Thai, Giang).
- Hydrological model development is well advanced but forecasting capacity is limited by available tropical climate science (e.g. Patra, McCarthy).
- Coupling of atmospheric and hydrological models will proceed from ongoing research but there is also a need to link bio-physical models (e.g. SWAT hydrological models) to socio-economic models in an integrated approach to catchment management. Bayesian network provide a systemic framework for examining the consequences of various management actions including social (e.g. demographic, health); economic (e.g. agriculture yields given climate variation), and environmental (e.g. climate, hydrology) inputs (e.g. Chan, Beringer, Arifyaya, Kamakar).
- Microclimatic variation links to vegetation type. Land clearing and forestry can thus influence microclimate through changes to evapotranspiration and to run off. However, climatic variation influencing rainfall patterns will also influence vegetation and therefore microclimate. There is a need to develop understanding of tropical climate models to provide for such variation at appropriate regional scales (e.g. Daly).
- Computable general equilibrium (CGE) models are useful in evaluating whole of economy impacts of climate change (e.g. Adams, Oktaviani). However, their utility in evaluating regional (e.g. catchment level) impacts is limited (generally because input and output data are aggregated at a coarser scale than desired regional scales). Agent-based models may offer a means of measuring economic impacts of alternative policies (e.g. land use, land use change, forestry).
- Climate change mitigation through reduced or avoided deforestation (REDD) offers a relatively inexpensive means of greenhouse gas emissions in developing countries such as Indonesia. However, resolution of issues such as alternative livelihoods for forest dependent communities remains a challenge (e.g. Cock, Reuter). In addition to this, financial mechanisms, legal and regulatory arrangements and land tenure arrangements are unresolved (e.g. Sukadri, Dohong, Jaya).

- Community based management programs offer promise in resolving actual or potential conflicts in implementation of alternative land use or forest management policies (e.g. Thorburn, Srivastava).

- A systems approach to catchment management in which social, economic, and environmental issues are integrated requires improved government to government cooperation (and interagency cooperation) (e.g. Ison, Thai, Soedomo, Yanto). Such an approach is being progressed in the Murray Darling basin which is prioritising environmental flow and tackling water allocation (e.g. Freeman).

- As populations grow and demand for water and energy increases there will be increasing tension between the need to reduce GHG emissions (to reduce climate change impacts) and to maintain social and economic well being. Improved mechanisms to harvest and distribute water (through cost effective utilisation of storm water) are available to large cities (e.g. Brown, Deletic).