



A FUTURE OF EXTREMES



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ABSTRACTS



WATER SECURITY IN THE MIDDLE EAST: AS A CASE STUDY THE EUPHRATES AND TIGRIS RIVERS

ACMA Bulent

Anadolu University

Session – D1F

The first section gives a brief geological and hydrographic background of the Euphrates and Tigris Rivers, illuminating their diverse character and apportioning figures for discharge, drainage area and river length between Turkey, Syria and Iraq. The second section, analyses water security in Turkey with focus given to Turkey's hydro imperative, in particular major water development planned on the Euphrates and Tigris Rivers. Analysis shows that Turkey linked security in Anatolia and water and Syrian and Iraqi water security are discussed in the third section. Agricultural policies from both countries are explored and linked to their respective and wasteful withdrawal of water from both the Euphrates and Tigris rivers. Conflict over water depletions after the construction of dams in Syria and in Turkey are analyzed in detail at the end of this section. Finally, the last section argues that water resource scarcity, increasing interdependence of river resources, expanding security policies and unethical river usage provides a recipe for protracted conflict. It goes on to examine why efforts to cooperate in the Euphrates-Tigris Basin failed and looks into the validity of current international law as a water management tool. The paper concludes by suggesting an ethical framework for environmental management of water in the Euphrates-Tigris Basin.

ECOSYSTEM SERVICES PROVIDED BY RIVERINE AND TIDAL DOMINATED MANGROVES: RETENTION OF DISSOLVED NUTRIENTS.

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Session – B4D

One of the key ecosystem services provided by mangroves is their role as natural biological filters, thereby protecting adjacent coastal ecosystems from negative impacts of nutrient enrichment. In this study we aimed to understand whether mangrove capacity for bio-filtration varied among mangroves within different geomorphological settings and with differing levels of rainfall. We studied six sites across southeast Queensland. These sites comprised a range of geomorphological settings from riverine to tidal dominated settings. Sampling was conducted throughout whole spring tidal cycles (36 in total) for two consecutive years (2007 & 2008) with significantly different levels of precipitation. Concentrations of dissolved ammonia, total nitrogen, phosphorus, and silica were measured from the flooding and ebbing water entering and leaving the mangrove forest from which we calculated a net nutrient flux. We show that mangroves in southeast Queensland act as sinks of dissolved nitrogen and that riverine mangroves are stronger nitrogen sinks and weaker phosphorus sinks than tidal dominated sites. We also show that these patterns are stronger in years with high rainfall than years with low rainfall. These results underscore the need for conservation of mangroves and the ecological services they provide over a range of geomorphological settings.

TOXIC CYANOBACTERIA BLOOMS OF *LYNGBYA* AND LINKS TO NUTRIENTS IN MORETON BAY

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Session – A2D

Proliferation of benthic cyanobacteria, particular members of the genus *Lyngbya*, appear to have increased in many subtropical and tropical embayments and reef environments around the world, with many blooms linked to anthropogenic nutrient loads. Research into the growth dynamics of a benthic, marine cyanobacterium *Lyngbya majuscula* in south-east Queensland coastal embayment's, links seasonal toxic blooms with land-based nutrient influences. Somewhat analogous to the 'canary in the coalmine', this nutrient-driven response is now supported by laboratory experiments and in-situ field experiments. The research, conducted over the 2003–07 period using factorial experiments and statistical analysis, clearly demonstrates that additional supply of organically chelated iron and phosphorus to the water column can trigger massive *Lyngbya* growth. This for the first time provides quantification of nutrient dynamics over the bloom lifecycle and raises questions about nutrient loads in coastal waterways. Indications of the magnitude of the nutrients inputs from the blooms can be inferred from three-dimensional (GIS)

modelling of the 509ha (2005–06) and 797 ha (2006–07) blooms in north-western Moreton Bay. At its peak in 2005–06, the bloom contained 5057t_{ww} (510t_{dw}) of biomass, involving 150000kg C, 18000kg N, 720 kg P and 5200 kg Fe. The results support a new policy 2.4.7 *Algal Blooms* in the *Southeast Queensland Regional Coastal Management Plan* designed to influence planning and development assessment to assist in limiting bioavailable nutrients that can exacerbate algae blooms entering South-east Queensland waterways.

CLIMATE CHANGE IMPACTS ON FISHERIES PRODUCTION IN LAND-WATER INTERFACE

AKEGBEJO-SAMSONS Yemi

University of Agriculture

Session – B3B

It has been considered that the impacts of climate change are likely to be considerable in tropical regions. Developing countries are generally considered more vulnerable to the effects of climate change than more developed countries. This has been attributed to a low capacity to adapt in developing countries. Fisheries and aquaculture are threatened by changes in the earth's atmosphere and oceans, such as increasing global surface temperature, rising sea levels, increases in incident UV radiation, irregular changes in average annual precipitation, and increases in the variability and intensity of extreme weather events. Greater climate variability will surely complicate the task of identifying impact pathways and areas of vulnerability requiring research to devise and promote coping strategies and improve the adaptability of fishers and aquaculturists especially in developing countries. Fish is the main source of animal protein for a billion people worldwide. Many coastal and island communities, where poverty is widespread and livelihood alternatives limited, depend heavily on fish resources for their well-being. Fish also provides an important source of cash income for many poor households, especially in Africa. This paper examines the ways in which climate change and extreme events may directly affect fisheries and aquacultural production in Africa. Specifically the paper looks at the effects on African river fisheries, coastal fisheries, coral reefs and mariculture. It presents the implications for this important sector on the people, resources and the environment. The paper recommends (a) the strengthening of capacity including that of African scientists, governments and civil society; (b) supporting adaptation by rural /urban people particularly the most vulnerable and (c) adding value to existing adaptation initiatives to enable African scientists to apply expertise and carry out research in support of adaptation projects in land-water interphase ecosystem.

AGRICULTURE AND WATER MARKET DYNAMICS

ALEXANDRA Jason, BIESAGA Christopher

Murray-Darling Basin Commission

Session – C2A

Escalating demand for valuable and scarce water resources required governments to limit diversions, through the introduction of the Murray-Darling Basin (MDB) Cap in 1995. Since then, the decade long drought has severely reduced irrigation water supplies. Water markets are a central component of Australian water reform, allowing trade in water rights either through permanent, entitlement transfers, or temporary, allocation transfers. Water markets allow irrigators to decide whether to buy additional water or sell surplus water, as part of their business planning. Growers are making business decisions on the price and availability of water and the relative value of their water and their crop. Within the MDB, water trade is allowing the movement of water between users, helping to optimise irrigation decisions. In the 2007-08 water season, approximately one third of water available to consumptive users has been transferred between irrigators, within and between irrigation regions in New South Wales, Victoria and South Australia. The majority of traded water has moved from annual crops and pasture to permanent horticultural and viticultural plantings. Water markets are achieving more economically efficient use of water by contributing to the production and survival of valuable permanent plantings. This paper outlines the value of water trade to the agricultural economy.

THE LOS ANGELES RIVER REVITALIZATION MASTER PLAN

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Session – C3E

The Los Angeles River Revitalization Master Plan is an exciting and inspirational plan to revitalize a 32-mile river corridor within the City of Los Angeles. The Plan represents a blueprint to meet the following objectives:

- Improve water quality, wildlife habitat, and ecological functioning of the river.
- Establish environmentally-sensitive urban design and land use guidelines.
- Provide significant recreation, open space, and new trails.
- Create community amenities and economic development opportunities by providing open space, housing, retail spaces, and educational facilities.
- Preserve and enhance flood control features.

Foster a growth in community awareness and civic pride in the Los Angeles River.

The project has moved into the implementation phase with development of a 3-tiered governance structure: (1) the joint powers *River Authority* for governance of the right-of-way, (2) the entrepreneurial *River Revitalization Corporation* tasked with developing public/private partnerships, and (3) the philanthropic *River Foundation* tasked with raising funds and community promotion. Public outreach was a critical component of this effort which touched thousands of stakeholders and included over 75 public/stakeholder/task force /advisory meetings during the Plan's 18-month development timeframe. The Plan was prepared for the City of Los Angeles. The Tetra Tech team included 11 subconsultants.

COUNTERING CLIMATE CHANGE: MAINTAINING FOOD PRODUCTION IN JAFFNA, SRI LANKA

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Freelance Consulting Engineer¹, Institute of Fundamental Studies²

Session – B3B

Jaffna Peninsula (area 1000 km²) is the northernmost tip of Sri Lanka. The average height above sea level is 3 metres, it has no rivers; water for agriculture is obtained by pumping from wells. There is fissured limestone underground, and as no part of the Peninsula is more than 15 km from the sea, there is saline percolation into the aquifer. Over-pumping of water from wells has resulted in 30% of the 100,000 wells becoming saline. Recently, 4500 hectares of fertile agricultural land has become uncultivable, and yields are decreasing elsewhere, because of saline intrusion from two salt-water lagoons within the Peninsula. This situation is becoming worse with increasing saline intrusion due to climate change causing rising sea levels and drought reducing recharge of the aquifer by rain. The "River for Jaffna" project proposes to counter this loss of food production due to climate change. It converts the seawater Elephant Pass Lagoon (area 77 km²) which is south of the peninsula into a freshwater lagoon. From here a canal will feed the presently saline lagoons within the Peninsula (Vadamarachi and Upparu, surface areas 77 and 25 km² respectively) which will be barraged to become freshwater lagoons.

CLIMATE CHANGE AND WATER RESOURCES: ADAPTIVE RESPONSES ARE NEEDED NOW

ASH Andrew

CSIRO

Session – A4

Climate change is a strong driver of water resources and their management. Observed and projected increases in temperature, rainfall variability and sea level have and will strongly affect water availability, water quality, infrastructure, and society. The effects of anthropogenic climate change will play out in different ways with winners and losers at international, national, regional and local scales. For example, rainfall and run-off are projected to increase in higher latitudes but decrease in mid-latitudes. At the national scale, southern Australia is expected to dry in comparison with northern Australia, and at regional and local scales increased run-off in snow-melt regions might provide more water but with potential changes in runoff seasonality and increased flood risk. Water supply systems around the developed world have been planned and operated under the assumption that the climate system fluctuates within an unchanging envelope of variability. However, there is mounting evidence in Australia and elsewhere that hydroclimatic change is already underway. Adaptation can help to minimise the negative impacts of climate change and in taking advantage of the opportunities that might emerge. There is a need for early

adaptation in water resource management because small changes in climate can lead to large changes in water availability. However, adaptation needs to be well planned and it requires a systems approach that addresses all of the major drivers, not just climate change. The two biggest challenges with adaptation are building adaptive capacity in governments, industries and communities, and knowing when and where incremental adaptation will need to give way to transformational change. At the very least adaptation will require a move away from basing water planning decisions on simple analyses of historical records towards: rigorous assessment of the strength of evidence for inter-annual and multi-decadal trends; incorporation of methods for considering the interaction and impact of multiple socio-economic factors and issues; and the use of scenario planning techniques to manage strategic risks and opportunities. It is time to move beyond the "business-as-usual" approach.

DILEMMA OF MANAGING RIVER NAKIVUBO AS A CLEAN URBAN WATERWAY

ASIO Pressy Polah

Makerere University

Session – C4C

River Nakivubo and its wetland located in Kampala city, Uganda are internationally recognized urban ecosystem. The 9 km stretch of the river traverses the city carrying raw municipal and industrial wastes. The 5 km² patch of the wetland purifies the waste waters before being discharged into Lake Victoria which is the source of water for over 5 million city inhabitants. However, rapid urbanization and industrialization have undermined the capacity of the river and its wetland to manage wastes. The problem has been worsened by the destruction of the wetland for industrial expansion and establishment of slums. In recognition of the critical role of this ecosystem, two projects aimed to rehabilitate it, have been undertaken. In 1996, IUCN funded Economic Valuation of Nakivubo Wetland to provide data for decision making and between 1994 - 1996; World Bank funded a project to rehabilitate the river into a channel and fenced portions of it to protect it from directly being used as a solid waste dump. However, these projects have not been able to adequately address the pollution problem. Pollution of Lake Victoria through the Nakivubo River continues to lower water quality and therefore posing serious risks to the population. This paper presents lessons learnt from the implementation of the two projects, and reforms required to comprehensively manage Nakivubo River as a healthy urban waterway.

THE GREAT ARTESIAN BASIN - A 'RIVER' OF EXTREMES

AUSTIN Jeff

Great Artesian Basin Coordinating Committee

Session – C2D

The Great Artesian Basin (GAB) waters are akin to a hidden maze of underground river systems drawing on and contributing to surface flows as it takes some 2 million years to flow across 1,000 km ... a 'river' of extremes. This paper highlights the current information available for the GAB and work needed to ensure its appropriate recognition as both a contributor to, and protector of, the expected climate change environment. The paper focuses on key areas within the Symposium's special theme referring to a contribution of an estimated 330,000 tonnes of Carbon as CO₂, 200,000 tonnes of salt each year, and a wasted 200,000 Ml each year. The GAB provides artificial access to surface waters by feral fauna and flora, sustains mound springs and their biodiversity, draws on some river flows and contributes to base flows in some rivers onto the surface catchments including the Murray Darling Basin, sustains towns and communities remote from surface flows as the only reliable source of water, and supports livestock, mining and petroleum industries.

PARTNERSHIPS FOR RIVER RESTORATION: CASE STUDIES FROM AUSTRALIAN AND INTERNATIONAL PERSPECTIVES

BAKER, Natalie

International Riverfoundation

Session – B2A

IRF works in partnership around the world and in Australia to drive the protection and restoration of the world's rivers, lakes and wetlands. As a dynamic international NGO we have a meaningful, measurable and life-changing impact on individuals and communities by helping them restore and sustainably manage their rivers for improved health, ecological, economic, and social outcomes. Case studies of three Thiers Riverprize winners (Mersey River (UK), Torbay Catchment (Aus) and Siuslaw (USA))

will be presented to demonstrate some of the key elements for successfully working in partnership to restore rivers locally and internationally.

THE RISK IN WATER PLANNING

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University of Sunshine Coast¹, Hamstead Consulting²

Session – B2E

Water planning is a key means of achieving the objectives of Australia's National Water Initiative and one of the most important tools for achieving sustainable use of water. It is also a critical vehicle for consideration of climate variability and climate change in planning and managing for future use and environmental protection. This paper draws from our review of water allocation planning in Australia, undertaken for National Water Commission in the latter half of 2007. The review gathered information from documents, planners and stakeholders to identify best practices and lessons learned. Eleven case studies from States and the Northern Territory were used to illustrate the strengths and challenges of planning processes in delivering desired outcomes. The focus in this paper is on how governments in Australia have addressed climate variability and climate change in water planning to date. We review current approaches to managing climate risks and suggest a range of options for responding to this challenge within the water planning framework. In doing so, we explore risk assessment, future scenario development, contingency planning and adaptive management and highlight the role for transparency, public involvement, and assessment of possible impacts through this process.

A FRAMEWORK FOR CONTEMPLATING CLIMATE CHANGE IN THE LAKE SIMCOE BASIN

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Lake Simcoe Region Conservation Authority

Session – A3E

Climate change is being felt globally, nationally and especially within rivers and lakes. Changes in climatic and hydrologic regime are clearly evident in the Lake Simcoe basin with reductions in the traditional spring freshet, increased periods of drought and an increase of episodic storms during the year. These changes create new challenges in managing the Lake Simcoe basin. Challenges range from maintaining or restoring environmental flows, irrigation needs, in-stream thermal changes, significance of natural heritage systems in a changing hydrologic environment and social response. The Lake Simcoe Region Conservation Authority (LSRCA) has developed a framework from which to predict, model and evaluate the impacts of climate change on the rivers, streams, lake and hydrologic cycle of the Lake Simcoe basin. This framework consists of a holistic approach to evaluate the key factors that influence the hydrologic cycle and therefore influence rivers and streams as well as their changing contribution to the Lake Simcoe ecosystem. The core components of this framework address water supply (ground & surface), detailed water budgets, atmospheric modelling, and predictive hydrologic and hydraulic models. The use of this framework allows for informed decision making and increased communication on the influence of climate change at the local level.

STORMWATER MANAGEMENT CONCEPTS TO ENHANCE ENVIRONMENTAL FLOWS

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Lake Simcoe Region Conservation Authority

Session – B2D

The Lake Simcoe basins located in southern Ontario, Canada has experienced significant urban growth as well as experiencing localized effects of climate change. The combined effect of these aspects has been decreased baseflows in several systems within the Lake Simcoe basin predominantly in the summer period including complete loss of flow in certain systems. The Lake Simcoe Region Conservation Authority (LSRCA) has recently been working with both municipalities and the development industry to develop and implement innovative stormwater management techniques to enhance Environmental Flows (E-Flows) in systems currently under stress. Traditional stormwater management has focused on the capture of stormwater to reduce peak flows within systems as well as pollution reduction for parameters such as nutrients and suspended solids. The LSRCA has expanded the role of stormwater management facilities to not only maintain their traditional roles but

to also store and release water during drought or dry conditions to supplement baseflow in systems enhancing E-Flows. This paper will provide insight into selecting techniques and concepts, suitable locations and examples from the Lake Simcoe basin. The paper will also present innovative concepts that are being examined by the LSRCA as well as other agencies for discussion and consideration.

INVIGORATING LOCAL GOVERNANCE TOWARDS EFFECTIVE RIVER SYSTEM MANAGEMENT

BANSUAN Abdula, BANUELOS Anna Lou

Allah Valley Landscape Development Alliance

Session – B4C

The 1991 decentralization of state powers in the Philippines - maintenance of community forestry, regulation on small scale mining, management of rivers and watersheds - has provided expansive opportunity for local authorities to develop and engage in a more relevant, speedy and efficient program. The experience of Allah Valley Landscape Development Alliance (AVLDA) in Southern Philippines suggests positive results of innovative local environmental governance framework against the backdrop of varying political agenda and interests among leaders of separate political boundaries. The Allah Valley along Allah River experienced flashfloods in 1995 and 2002 with a combined damage to properties, infrastructures, and crops of about P 200 million (US\$ 4.76 million) including loss of lives. The ill effects of flashfloods was a horrible experience for communities who are now very vulnerable to another water-related disaster. The challenge has paved the way for renewed commitment of local leaderships whose expected role is to be front liners of public services. They need to establish partnership with stakeholders to build an alternative governance institution that is not another layer of bureaucracy, plan and implement the project without responsibility overlapping, engage in new financial transaction in acceptable government auditing procedures. The bringing of the communities, NGOs, civic groups, private business into the core of management framework of river rehabilitation, restoration and protection program has created more desirable corporate and community responsibility actions. The encouraging result of this initiative is the overwhelming voluntary undertaking of households, farmers and landowners of their own support actions in line with the ongoing program. The planning actions that are going on focus on the addressing challenges and developing strategies of stabilizing the river systems while improving their ecological values and water quality for community access in the midst of changing climatic condition and upstream land uses.

EFFECT OF TRANSBOUNDARY FLOW REGULATION ON WETLAND AND RIPARIAN LIVELIHOOD IN THE SURMA-KUSHIYARA BASIN

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Session – A2F

The Surma-Kushiyara Rivers are the main source of water to a vast wetland system, locally known as haors in Bangladesh. The hoar wetland has been recognised as wetlands of international importance as a Ramsar Site and provides habitat for a wide variety of flora and fauna species. Floodplains are intensively cultivated and fishing is an important livelihood providing income to the rural marginal population and a source of protein. The rivers are still unregulated, but India is planning to build a barrage at Fulertal for Kachar Irrigation Project and a reservoir further upstream on the Barak River for the Tipaimukh Hydroelectric Project. Such upstream storage and diversion will bring significant changes in the discharge regime of these rivers affecting the functioning of the wetlands and floodplain. The objective of this research is two fold: to make an assessment of the instream flow requirements of the Surma river using Physical HABitat SIMulation (PHABSIM) model and to investigate how the changing flow regime due to upstream storage and diversion alters the existing land type, for example a shallow flooded area might change to flood free or deeply flooded area changed to shallow flooded area, etc., creating significant impact on the wetland ecology and agricultural productivity. Analysing available information about the possible downstream release scenarios of the proposed storage and diversion schemes, the discharge hydrographs at the headwaters of the rivers were constructed. A digital elevation model of the study area combined with a hydrodynamic model enables the generation of spatially defined flooding with extent and depth of flood. This model is then used to define the impacts of a changed flow regime. For an average year the pre- and post-regulation flood depths and extents are simulated for the pre-monsoon, monsoon and post-monsoon seasons, and their effects on wetland, agricultural productivity and fish yield are analyzed. Results obtained demonstrate the potential of such analyses in identifying the relationship between the river flow regime and the connected wetland, floodplain productivity and riparian livelihood.

INTEGRATED WATER CYCLE PLANNING PROCESSES AND SYSTEMS: A LOCAL GOVERNMENT CASE STUDYBARTON Alan¹, Hawkins Emma² Brigden, Amanda³Brisbane City Council¹, MWH Global (formerly of Lloyd Consulting)² Brisbane City Council³**Session – C3F**

Brisbane City Council (BCC) has developed a planning process that reflects the integrated nature of the urban water cycle, and maps out the mid term (5 Year) delivery of *Water for Today and Tomorrow*. BCC's public commitment to integrated water cycle management. Through the process, current and historical information is used to allow BCC to better understand the relationships between each component of the urban water cycle, highlight opportunities, constraints, areas that are meeting targets and those that require more attention. Outcomes of all proposed programs or actions are researched and, where appropriate, modelled before being entered into a comprehensive multi-criteria assessment. Through an improved understanding of the urban water cycle and assessment of potential solutions with regard to whole of water cycle outcomes, BCC is better able to plan and manage Brisbane's water resources and better serve both internal and external stakeholders. The paper outlines the IWC Planning Process and its supporting systems, and provides a case study of the development of the first Local IWC Plan for BCC.

WATER AND HEALTH - PREVENTABLE DISEASE AND WATER MANAGEMENT

BARTRAM Jamie

World Health Organisation

Session – A1

The presentation will summarize the state of knowledge on water and health from two new/forthcoming publications from the World Health Organization. 'Safer Water Better Health' provides for the first time country-by-country estimates of the burden of water-, sanitation- and hygiene-related disease. The WHO/UNICEF Joint Monitoring programme for Drinking-water and Sanitation is now providing more disaggregated data on access to different levels of drinking-water and sanitation services. Access to basic water supply is progressing in the developing world with less than 1 billion people lacking access to a simple protected well or spring, and more than half of the world's population now receiving water from piped supplies to their home. However much of this water is unsafe and the associated burden of outbreaks and endemic disease is significant. Based on these insights, WHO has recently revised its strategy towards Water, sanitation, hygiene and health, which is summarized. The implications of the findings of the reports and strategy for water management are summarized.

IMPACTS OF DROUGHT AND CLIMATE CHANGE ON NATIVE FISH COMMUNITIES IN THE MDBBARWICK Matthew¹, LINTERMANS Mark², BARRETT Jim¹Murray-Darling Basin Commission¹, University of Canberra²**Session – C2A**

The overarching aim of the Murray-Darling Basin Commission's (MDBC's) Native Fish Strategy (NFS) is to return native fish population in the Murray-Darling Basin (MDB) to 60% of pre-European levels by 2050. Drought can impact detrimentally on native fish populations through exacerbating a number of threats, such as flow regulation, habitat degradation, lowered water quality and translocation and stocking of fish. Mitigating the impacts of drought and climate change on native fish in the MDB is therefore critical to achieving the aim of the NFS. This paper describes a number of research projects and initiatives catalysed by the MDBC to better understand, and more effectively mitigate the impacts of drought climate change on native fish. These include: convening an expert panel; initiating projects on drought refugia and ecosystem resilience; development of a fish rescue protocol; implementation of an emergency response fund; and a study on the impacts of climate change on native fish. Together this program of research and initiatives will help us to better understand and alleviate the likely impacts of drought and climate change on native fish in the MDB.

ENVIRONMENTAL FLOW REQUIREMENTS VIS-A-VIS HABITAT USE PATTERN OF FRESHWATER DOLPHINS

BEHERA Sandeep, SAGAR Viveksheel, NAWAB Asghar

WWF-INDIA

Session – B4D

The freshwater Ganges river dolphin (*Platanista gangetica*) is protected under national and international conservation laws as an endangered species. In India, the species is endemic to the Ganges and the Brahmaputra river systems and the populations are purported to have declined drastically due to infrastructural activities causing habitat loss. We studied the habitat use pattern of these dolphins in relation to environmental flow requirements between February 2007 and February 2008. The study was carried out in the Upper Ganga River covering a stretch of 40 km i.e. between Narora to Anupshahr, in the state of Uttar Pradesh. Sampling strategy consisted of boat transects followed by direct sighting method and data was collected at every 5 km. Relative abundance of dolphins is expressed in terms of sightings per km. Habitat preference of dolphins is attributed to perennial deep pools and shallow water for feeding. Conservation implications have been discussed in the light of the results indicating the minimum environmental flow requirement for the species in the particular river stretch.

INTO HOT WATER: ADAPTING TO A CHANGING CLIMATE

BERGKAMP Ger

World Water Council

Session – A1

Water utilities, food and fibre production, hydropower, and protection of our rivers and lakes all face significant challenges in the wake of climate change. Understanding and unravelling these challenges is key to coping with and adapting to the impacts of climate change. Around the world, a number of examples of ongoing climate change adaptation work exist that paint a picture of 'a future that is already here'. The examples show how the interlink ages between evolving technologies, new management approaches and emerging governance arrangements are key to adapting to climate change. Taking a 'hot-spot' approach, a number of geographic areas will be examined in terms of their issues and capacities to address water and climate change adaptation. Areas such as low lying delta areas and their major cities, snow and glacial depending economies in the Himalayas and the Andes, arid and semi-arid areas and small island states all have their specific issues that need tailored approaches. As a number of examples will show, for most of these, adaptation to climate change is not a thought for the far future but much more a key issues for realities that are well within planning and management horizons. But, what are the latest insights in how climate change and adaptation are more fundamentally accelerating a paradigm shift in water planning and management? Water management today is largely based on stationarity and uses hydro-meteorological records. In the future we will need to incorporate higher degrees of uncertainty and unpredictability. On the management side, this will require us to move to portfolio approaches with sector based, single purpose, shorter time frame optimization is replaced with more flexible arrangements and optimizations over longer time scales. The presented work draw from and be closely linked to the work carried out in preparation for the 5th World Water Forum.

TRADING FOR A BETTER FUTURE: IMPROVING THE HEALTH OF MORETON BAY THROUGH A NUTRIENT TRADING SCHEMEBELING Ed¹, CUGLEY John², CLOUSTON Beth³Arup¹, John Cugley Environmental Pty Ltd², Queensland Environmental Protection Agency³**Session - Poster**

With the water quality and marine life of South East Queensland continually under pressure from a variety of anthropogenic sources, the Environmental Protection Agency (EPA), with funding assistance from the Australian Government's Coastal Catchments Initiative, has been investigating the feasibility of using nutrient trading to reduce discharges of harmful levels of nutrients to waterways in order to improve the water quality in Moreton Bay. Nutrient trading is a relatively new concept in Australia. It is based on the idea that different industries may face different costs and have different abilities in meeting regulatory standards. It takes advantage of the differences in the costs of control by allowing those who can reduce emissions more cheaply to offset the emissions of others that face higher costs to do so. One key aspect of nutrient trading is the concept of environmental equivalence. This concept focuses on whether trades are equivalent in terms of the ultimate environmental effect of a tonne of pollution

reduced from one source compared to a tonne from another, perhaps distant source. In 2007, the EPA commissioned Arup to develop and apply a mechanism to establish environmental equivalency ratios that could be used in the proposed Nutrient Trading scheme.

A CASE STUDY ON PARTICIPATORY MANAGEMENT OF FISHPASS IN BANGLADESH

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Session – B4C

The paper evaluates factors affecting hydraulics, environmental flow requirements and impacts of Sariakandi Fishpass on fish production, fish-diversity and socio-economic conditions of the region. This is the largest Fishpass in Bangladesh connecting embanked Jamuna and Bangali Rivers to their floodplains. This structure initiates movement of adult fishes, juveniles, fingerlings, fish-eggs and other aquatics to floodplains at the beginning of monsoon. It has three-vents with sixteen-pools (4.2m×4.8m having 0.7m opening) in each vent. To characterize turbulent pattern inside the structure, three-dimensional Acoustic-Doppler Velocimeter is being used to obtain velocity components. The flow-jet travels through centre of the pools with two large recirculation and several small poised zones on either sides of the jet. While head differences in rivers are greater than 0.5m, the velocities at pool openings are much higher than tolerable limits (e.g., reaction, cruising and darting speeds) of juveniles of all local and migratory fishes. It lacks enough poised-spaces there where fish can take rest. Contrarily sedimentation immediately after monsoon restricts enough flows to Fishpass. A questionnaire-survey was conducted on stakeholders to collect information on institutional, socio-economic, legal and environmental issues. While impacts are found positive, it shows participatory management is crucial for maintaining required flows and equitable distribution of benefits.

LIVING RIVERS POLICY TO CONSERVE FLOODPLAIN RIVERS IN THE NORTHERN TERRITORY

BLANCH Stuart

WWF-Australia

Session – A3B

You'll never hear someone say they would like to see the amazing, globally significant floodplain rivers of Australia's Northern Territory end up like the degraded Murray River. But nevertheless, the pressure to clear more land, extract more water for irrigation and dam more of these rivers continues, particularly the Daly, Roper, Victoria, and Adelaide Rivers. With the ever-growing pressure to develop the north into the 'foodbowl of Asia' as drought and climate change drain the Murray Darling Basin's rivers, and establishment of the Federal Government's Northern Australia Taskforce, the Territory needs a strong policy and programs to protect floodplain rivers from over-development. WWF welcomed the election commitment in June 2005 to develop a strong Living Rivers policy and program in the Territory. The Territory Government's proposal for a Living Rivers program will be canvassed and audience members will have the opportunity to participate in commenting on these proposals to help inform WWF's ongoing campaign for a strong, legislative Living Rivers policy to protect the Territory's iconic floodplain rivers. Expect the unexpected.

DELIVERING AND EVALUATING NEW ENVIRONMENTAL FLOWS FROM AVON DAM, AUSTRALIA.

BLOCKWELL Stephen, BERRYMAN Tim, PAULL Tony, KNIGHTS Penny, KOTLASH Amanda, CHURCH Tony

Sydney Catchment Authority

Session – A3D

Avon Dam, located in the Southern Highlands to the south-west of Sydney was completed in 1928 and supplies water to Wollongong and the Illawarra region. Sydney Catchment Authority has completed new works at the dam to make transparent & translucent environmental flow releases from Avon Dam as detailed in the NSW Government's Metropolitan Water Plan 2006. Accompanying the introduction of environmental flows is a comprehensive monitoring program specifically designed to test a series of hypotheses relating to geomorphology, riparian vegetation, water quality, macro invertebrate, diatom and iron bacteria responses to the new flows. The purpose of this paper is to assess the underlying

philosophies in the formulation and design of environmental flows, the generation of hypotheses and subsequent design of the monitoring program. The outcomes of the project will be used to inform a broader environmental flow monitoring and assessment program, and contribute to managing environmental flows, for the remainder of the Hawkesbury-Nepean River system.

EXPERIENCE OF STUDIES ON HYDROLOGICAL AND HYDROCHEMICAL REGIMES OF THE TRANSBOUNDARY RIVERS IN RUSSIA

BOBROVITSKAYA Nelly, YANCHENKO Taras, BESTSENNAYA Margarita, RUMYANTSEVA Elvira, SEMENOVA Olga

The State Hydrological Institute

Session - Poster

The national boundary of Russia is the longest in the world. Its length is 28,000 km. Observations of water; sediments and pollutant transport across the Russian boundary have been performed at 120 hydrological stations for more than 40 to 100 years. To quantitatively estimate changes in water and pollutant runoff, special techniques and computer programs have been developed. As a result of climate global warming, water runoff has increased in a number of regions. This has intensified the erosion processes, which has led to increased sediment amount and microelement outcropping from the mountainous rocks into natural waters. These microelements are mainly iron, manganese, copper, lead, etc. The content of microelements in major systems of a human body has been studied based on the advanced bio-resonance technique. Taking into account the present considerably elevated concentrations of microelements (iron, manganese, copper, nickel, etc.) in natural waters, as compared to admissible concentration limit, measures have to be taken to lower their contents in drinking water.

PURIFICATION OF WASTEWATERS FROM MINING AND POSSIBILITY OF REGULATING HEAVY METAL CONCENTRATIONS IN ENVIRONMENTAL FLOWS

BOCHARNIKOVA Elena

Physical Chemical and Biological Problems of Soil Science Russian Academy of Sciences

Session – B2C

Commonly wastewaters from mining operation contain significant amounts of HM, so they are a potential source of the emission of metals into water system. Use of various forms of active Si seems to be prospective for reducing HM in natural waters. Our preliminary study has demonstrated that active Si allows managing HM mobility. Ability of monosilicic acid as a source of active Si to impact the mobility of Cd, Cr, Ni, Cu, and Pb was studied. Obtained results have shown that active Si can significantly reduce HM input into aquatic ecosystems. The concentrations of all tested HM in the percolated solutions became 2- to 10-fold smaller depending on the type of HM. The HM concentrations in the plant issue were reduced 2- to 5-fold. The concentrations of mobile HM in the soil were reduced 2- to 4-fold. Demonstration test has shown that active Si substances can be successfully used for purification of wastewaters and reducing heavy metal mobility in industrial wastes. Elaborated technology allows reducing HM in soil, water, and living organisms. This technology in the combination with bioremediation could possibly 1) localize polluted area; 2) protect natural waters against HM pollution; 3) accelerate the bioremediation processes.

FUTURE VISIONS FOR THE TULLY CATCHMENT - A PARTICIPATORY PLANNING APPROACH

BOHNET Iris

CSIRO Sustainable Ecosystems

Session – D1B

The Tully catchment is located in the Wet Tropics of Australia adjacent to the Great Barrier Reef (GBR) lagoon. Sixty-four percent of the catchment is occupied by World Heritage listed rainforest. On the remaining 36% of the catchment economic pressures on primary industries coupled with the need to improve water quality provide a challenge for farmers, industry, and natural resource managers who have a responsibility to implement the Tully Water Quality Improvement Plan (WQIP). In response to this challenge, a participatory planning approach was chosen to develop community visions for the Tully catchment which aim to achieve improved water quality as well as multiple environmental, social and economic benefits. Interviews and workshops with a wide range of community members, including farmers, land managers, school students and indigenous and non-indigenous residents provided

Information on the social, cultural and economic values of water in the catchment and adjacent reef for inclusion in the Tully WQIP. In addition, the information was used to create a series of spatially explicit land use and management change scenarios, which were assessed and compared with the current situation using a range of agricultural, hydrological, ecological and economic models. Continued participatory planning and evaluation of land use and management change will be critical over the coming years to track progress towards halting and reversing the decline in water quality entering the GBR and to identify and implement further actions if required.

MULTIFUNCTIONAL ROLE FOR URBAN WATERWAYS: A CASE-STUDY OF KOLKATA

BONNERJEE Sobhanlal

S. Bonnerjee and Associates

Session – C4C

The canals in a metropolitan area can contribute to the urban environment in diverse ways. The direct contributions may comprise (a) creating linear green corridors, (b) improving the micro-climatic conditions, (c) taking a big load from the drainage system and supplying water for various uses, (d) being the storage in large scale rain water harvesting, (e) reducing considerably the freight movement by trucks. The possibility of developing a canal network as part of a river system has however remained largely unexplored. To develop an efficient canal system as a commercially attractive and functionally effective alternative to road system, a definite role has to be assigned to it. It is necessary to identify the freight that can be attracted to this system. Apart from the cheap and bulky goods, agricultural products and construction materials, containerization of the waterways can bring in various industrial products and help achieving the desired modal split. Transfer of the containers to canal-worthy tug-boats directly from the ports, rail-heads and truck terminals can indeed form the dominant traffic in urban waterways. The paper examines the existing canal network and the river system in the metropolitan region of Kolkata and also addresses the issues of the urban form, and the land-use pattern in this context.

MARKET BASED INSTRUMENTS FOR ENVIRONMENTAL WATER RECOVERY

BUCHAN Arlene

Australian Conservation Foundation

Session – D1D

Market based instruments (MBIs) that could be used for environmental water recovery are many and varied. Several MBIs have been used successfully in natural resource management and a suite of novel mechanisms are in development. Commonly considered MBIs relate to the outright purchase of rights in terms of entitlements or annual allocations but opportunities also exist to develop markets in partial rights that could provide water for the environment in some years, whilst leaving legal title and some water with the irrigation industry. The various MBIs have different advantages and disadvantages for stakeholders. The best outcomes may result from using a mixed package of different MBIs and non-market mechanisms for water recovery. There is also a range of administrative methods that can be used to implement the mechanisms which themselves affect some of these outcomes and impacts. As a result, careful consideration should be given to the choice of both the administrative method and MBIs used for water recovery. Also, some non-market factors have a significant effect on the capacity to achieve outcomes with a particular environmental water allocation, such as the ability to carry-over environmental water allocations in dams. These factors must also be considered as part of any environmental water recovery package.

WWF AND GREEN CROSS SEEK URGENT RATIFICATION OF UN WATERCOURSES CONVENTION

BUN Mara¹, PITTOCK Jamie²

Green Cross Australia¹, WWF²

Session – Speaker

WWF and Green Cross are promoting ratification of the UN Convention on the Law of the Non-Navigational Uses of International Watercourses to improve governance for the 263 RIVER BASINS around the globe that cross the territories of two or more countries. The convention requires due consideration of the interests of other riparian countries and protects them from excessive pollution and withdrawal of water. It enables peaceful resolution of water conflicts. This Convention was initiated in the early 70s at a time when UN General Assembly member States anticipated emerging

water conflicts. These conflicts are now emerging and ratification in time for the Istanbul 2009 World Water Forum is vital. WWF brings its extensive conservation expertise to this advocacy partnership, while Green Cross brings expertise in environmental conflict resolution based on active engagement in three major river basin dialogues. The watersheds affected by the Convention cover half the earth's surface, are present in 145 countries, are home to 40% of the world's population and generate around 60% of global freshwater flow. They include key conservation priorities and major river basins such as the Amazon, Brahmaputra, Congo, Danube, Fly, Ganges, Nile, Plata, Rio Grande, San Pedro, Senegal, Sepik, Tigris & Euphrates, and Zambezi rivers.

ADAPTATIONS TO CLIMATE VARIABILITY FOR REDUCING VULNERABILITIES OF ADVERSE CLIMATIC CONDITIONS ON RIVERS

BUSIINGE Ronald

Earthsavers Movement Uganda Chapter

Session - Poster

This paper highlights the fact that water, rivers and climate change are inextricably linked, and are ringing warning bells across the world. The paper will draw on reviews observed (1900–2000) and possible future (2000–2100) changes in temperature and rainfall for Africa in general and East Africa in particular using current modelling. Drawing examples from Uganda and East Africa, the paper will show that extreme events such as drought, floods and sharp temperature changes characterize climate change and variability. The recurrent drought resulting from climate change and variability accelerates desertification. The paper shall also identify some fundamental limitations to knowledge with regard to future African climate in general and East Africa in particular. The paper will conclude by calling for a regional strategy to strengthen the regions capacity to tackle the impacts of climate variability and climate change on water resources in general and rivers in particular through improving and sharing basic scientific knowledge and decision support information, promoting Integrated Water Resource Management Principles and the ecosystem approach in managing water resources, identifying, promoting and disseminating appropriate adaptation technologies, techniques and measures and setting up a regional consultative framework.

FREE PRIOR AND INFORMED CONSENT (FPIC) CONCEPT TO RESPONSIBLE MINING IN SUSTAINING RIVERS AND COMMUNITIES

BUSIINGE Ronald

Earthsavers Movement Uganda Chapter

Session – A3F

The paper highlights the fact that Free, Prior, and Informed Consent (FPIC) arises out of the fact that community-based natural resource management offers local people the chance to participate directly in decisions about local ecosystems. In this case emphasis is placed on rivers. The practice FPIC is designed as an antidote to this state of affairs. FPIC consists of giving local people a formal role – and some form of veto power – in the consultations and ultimate decisions about local development projects. To date, however, FPIC has been most relevant and critical in cases involving mining projects in countries as diverse as Australia, Canada, Peru, and the Philippines. The inclusion of FPIC as a legal condition for financing, investment, or regulatory decisions could become a critical means to make poverty alleviation programs more sustainable. The paper will conclude by drawing examples from countries like the Philippines and Australia that have enacted laws requiring that FPIC be obtained by the government for projects within the ancestral domains of indigenous peoples. Internationally, the World Commission on Dams and the Extractive Industries Review of the World Bank have recommended the adoption of FPIC in making decisions about dams and oil, gas, and mining projects.

SAVING WATER IN SYDNEY, CASE STUDIES AND LESSONS LEARNED

BUTLER Reid

BMT WBM Pty Ltd

Session – C3E

This paper will outline the practical application of water efficiency improvements and water supply substitution in Sydney. The sites include Sydney Opera House - updating fixtures to achieve significant savings; NSW Parliament House - rainwater and groundwater re-use for cooling towers; and Sydney Olympic Park - treated wastewater re-use for toilet flushing. Each case study will illustrate how to achieve best practice and some will show where mistakes can be made when the right assessment method is not

used. To achieve maximum water efficiency, there are several key steps to follow – 1. Conduct a thorough water audit of the premises using accurate water use data logging equipment on correctly positioned water meters; 2. Prepare a site water balance showing where and how much water is used; 3. Implement water efficiency improvement measures, from repairing leaking fixtures to replacing older fittings with efficient ones; 4. Assess water substitution options based on best practice usage rate, considering all aspects including energy and chemical demands; and 5. Use accurate monitoring data in the design of the alternate water supply system. These steps can assist in reaching a cost effective solution to reduce potable water use and will result in a much lower water demand.

DROUGHT CONTINGENCY PLAN**CAMPBELL Bruce, ANSELL Dean**

Murray-Darling Basin Commission

Session – C3A

During 2006/07 annual inflows in the Murray River system set a new record low of 1040 GL, 60% below the previous recorded minimum. This new minimum inflow sequence was so low that, should it be repeated in 2007/08, critical urban and stock and domestic water supplies, for over two million people, would not be assured. In response to this unprecedented scenario, a range of measures to reduce evaporation and other losses, to maximise water availability and increase the certainty of meeting critical water requirements was developed and implemented. These include wetland disconnection and changed river operating protocols. In addition, special water sharing arrangements between NSW, Victoria and South Australia, were developed, agreed and implemented, consistent with the provisions of the Murray-Darling Basin Agreement. These measures ensured that critical urban and stock and domestic requirements had the highest priority, followed by access to water carried over for irrigation and the environment. This paper will describe the implementation of an innovative and integrated response by the Murray-Darling Basin Commission to these challenges which may be faced more regularly in a future of extremes.

OK TEDI MINE – LEAVING TIME BOMBS ON THE FLY RIVER FLOODPLAIN**CAMPBELL Ian**

Rhithroecology Ltd

Session – B3D

The Ok Tedi mine in Papua New Guinea is controversial because of its environmental impact. The environmental impacts of the mine have far exceeded predictions in the initial EIS. A mine waste tailings treatment project is being implemented to reduce sulphur content, and thus potential for acidification, in the tailings discharged to the river. However, potentially acid forming sediment from the mine has already been deposited over large areas of the middle Fly River floodplain. While under water these sediments pose a low environmental risk, but if they are exposed to air they will oxidise and release water low in pH and high in metals potentially killing wetland plants and animals. The mine waste treatment project will dump the sulphide materials from the tailings in pits a few hundred metres from the river upstream of the Ok Tedi Fly-River junction. This material will be safe until river erosion cuts through to the pit releasing a pulse of the material into the river. The government and the company hope that some third party will intervene and re-mine the material before a catastrophe occurs.

MURRAY MOUTH SAND PUMPING: KEEPING THE TIDES FLOWING**CAMPBELL Tom¹, ERDMAN Brenton¹, BROWN Richard²**SA Water¹, Department of Water, Land Biodiversity and Conservation²**Session – C3D**

As a result of the drought conditions being experienced throughout the Murray-Darling catchment, there has been no significant release of water through the Murray Mouth Barrages since December 2001. By June 2002, with the removal of freshwater flows and with no foreseeable future flows, it became apparent that without mechanical intervention the Murray Mouth would close over; resulting in potentially catastrophic environmental impacts within the internationally recognised and Ramsar listed wetlands of the Lower Lakes and Coorong. In October 2002, a six month dredging program commenced to create two channels into the Coorong, one from the Murray Mouth into the Goolwa side, and the other from the Mouth to the Tauwitercherie

side of the Coorong. Five years on and the program continues, moving in excess of 5,000,000 m³ of sand at a cost of \$33m. It has successfully drawn together the traditional owners of the area, seven state and federal government departments and agencies, and several private sector contractors and suppliers. The project has been and continues to be successful in achieving the primary objectives of keeping the Murray Mouth open to maintaining a tidal variation, and to deliver cool oxygenated water into the Coorong, thus mitigating the drought impact on this internationally significant site.

SCIENCE AND REGULATION IN A TIME OF STRESS – YOU WANT IT TILL YOU GET IT A REGIONAL ASSESSMENT OF THE SCIENCE AND REGULATION UNDERPINNING THE ONE PLAN**CARLYON Greg, ROYARD Jon**

Horizons Regional Council

Session – A3D

New Zealand shares the same issues around water use and impacts of diffuse pollution from the agricultural sector that many of our global counterparts have. New Zealand's second ever State of the Environment Report affirmed the obvious. Our water resource is polluted and in decline largely as a consequence of diffuse agricultural discharges. Sitting alongside this is a massive growth and demand for the water resource for intensified agriculture. Horizons Regional Council has developed a monitoring framework for the active management of water for the purposes of allocation and discharge of contaminants. It's highlighted a number of issues that would be far easier left undiscovered. At the same time Horizons, one of New Zealand's largest regional council's, has made a commitment to a regulatory framework to bring these matters under control. This is not without its challenges to both traditional thinking and behaviours out in the community. The Council has spent the past four years out in the rural community with science providers and politicians testing that thinking. Greg Carlyon and Jon Roygard will take you the audience through the underpinning science, regulatory framework, and community reaction and response to the One Plan. Sitting above this will be an analysis of the critical national and political context.

DEVELOPMENT OF A RAPID MICROBIAL-BASED TOXICITY ASSAY FOR WATERS & WASTEWATERS**CATTERALL Kylie**

Gold Coast Water/Griffith University

Session – B4B

An innovative rapid toxicity assay has been developed for use in the water and wastewater industries. This assay, known as FMTOX, employs ferricyanide in place of oxygen during microbial respiration. While other microbial respiration toxicity assays exist (e.g. the ISO and OECD activated sludge respiratory assays and the Microtox® assay) they each have their own serious drawbacks. For example, the ISO and OECD methods are only applicable for characterising activated sludge and cannot be adapted for sensitive determination of hazardous compounds (or classes of compounds). In addition, they are time consuming (3 - 4 hours), making real time process control of WWTP's difficult. The Microtox® method, while being a rapid assay, relies on a single species of microorganism (*Vibrio fischeri*) and cannot be applied to activated sludge characterisation or be tuned to be sensitive (or resistant) to different classes of toxic compounds. The FMTOX assay, on the other hand, is rapid (45m – 135 minutes) enough for effective process control of WWTP's, can be tailor-made to suit activated sludge applications, and can be tuned for specific sensitivities owing to the fact that literally thousands of species of microorganisms can undergo ferricyanide mediated respiration. Consequently, the developed and optimised FMTOX assay reported in this study was shown to be very promising for the rapid characterisation and assessment of raw and treated potable water, wastewater, recycled water and natural waters. Furthermore, the innovative nature of the technology developed in this study is demonstrated by the success of an ARC Linkage Grant application (2007) with industry partner Gold Coast Water, together with it currently being commercialised by a New Zealand company in collaboration with the author and Griffith University.

APPLICATION OF RIVER CLASSIFICATION TO DEFINE ENVIRONMENTAL FLOW IN THE LIAO RIVER

CHEN He, YANG Zhifeng

State Key Laboratory of Water Environment Simulation - Beijing Normal University

Session – C3B

Water is essential for biology survival and activities, yet the water availability for ecosystems is a big problem. Environmental flow assessment is useful to solve the problem with the constraints of limited water resources. Environmental flow assessment methods widely used in developed countries are not appropriate for developing countries due to the lack of ecological data. Ecological data shortage is a great challenge for water resources managers and scientists in developing countries. The key of environmental flow assessment in developing countries is to make full use of limited ecological data. In order to solve this problem we classify rivers by ecological characters of rivers. The six-step processes include: (1) river networks generation from digital elevation model; (2) map overlay related to river ecosystems; (3) multi-agent based clustering analysis of river network; (4) hydrological and ecological data series analysis; (5) scenario analysis of water resources development plan; (6) environmental flow monitor and regulation plan. This approach can solve the problems of ecological data shortage. These processes were applied to the Liao River in China.

EXPLORING SCENARIOS FOR A TROPICAL RIVER CATCHMENT USING SYSTEM DYNAMICS MODELLINGCOLLIER Neil¹, GARNETT Stephen T.¹, CAMPBELL Bruce M.², HUNTER-XENIE Hmalan¹School for Environmental Research - Charles Darwin University¹, Forests and Livelihoods Programme - Center for International Forestry Research²**Session – A2D**

Australia's tropical northern region is home to numerous large rivers with significant, but highly seasonal, water resources. This region of Australia has become the focus of calls to develop new agricultural enterprises most of which include a strong emphasis on irrigated agriculture. Protracted drought and water restrictions in southern Australia have increased this focus in recent years. However, there is widespread concern and apprehension that there is insufficient information to proceed with such developments in the north. Furthermore, northern communities are well aware of the mistakes of the past that have resulted in widespread ecological and social problems in the southern states of Australia. We are using a systems modelling approach to explore potential scenarios for the Daly River region in the Northern Territory of Australia. Similar approaches have been used internationally to explore trade-offs between improved livelihoods and the conservation of natural resources and biodiversity. The project used participatory modelling techniques to engage multiple stakeholders, including Indigenous representatives from the Daly River region, to develop realistic scenarios for future management of the catchment. Scenarios included broad-scale clearing for pastoral activities, irrigated agricultural development and the associated issues of water allocation, biodiversity conservation, and ecosystem function. We discuss the results of the modelling with particular reference to sustainable management of water resources, economic trajectories, and the aspirations of indigenous people.

ON-FARM WATER QUALITY MONITORING FOR IRRIGATORS IN THE LOWER BURDEKIN

CONNELL Adam

Burdekin Bowen Integrated Floodplain Management Advisory Committee Inc. (BBIFMAC)

Session – B2F

With drought and climate change threatening much of Australia's freshwater resources, there is increasing pressure to expand farming in the Burdekin River floodplain. The Burdekin River is Queensland's largest river system, supplying irrigation water for sugar, horticulture and beef production. The river discharges into the Great Barrier Reef Lagoon (GBR). Run-off from production land has been identified as a major source of pollutants for the GBR and pressure is increasing to monitor and reduce nutrient losses from farmlands. BBIFMAC with funding from Burdekin Dry Tropics NRM is undertaking an innovative project that works with the local farming community to monitor and improve the quality of water leaving farms. Irrigators are supplied with free, easy to use, water quality monitoring kits to measure

nitrate, phosphate and conductivity levels 'on-the-spot'. Samples are collected and analysed in the laboratory to verify farm results. A secure, password protected website will allow farmers to access results. The project collects fortnightly data from over 150 sites in the Lower Burdekin. When this data is entered into a GIS an impressive picture of the region unfolds. The project's collaborative approach supports irrigators to manage their own farming practices, improving efficiency and reducing impacts on the local environment, floodplain ecology and GBR.

AN INTERNATIONAL COMPARATIVE STUDY OF MANAGEMENT RESPONSES TO EXTREME DROUGHT

CONNELL Daniel

Australian National University

Session – A3C

Water management decisions made under the pressure of extreme droughts reveal political priorities, cultural assumptions, institutional strengths and weaknesses which are often hidden during times of less stress. This paper will present a preliminary report on a comparative study of drought management and planning for the impacts of climate change in southern Australia, southern Africa, south-west United States, the Mediterranean rim and northern China, regions in the southern and northern temperate zones that have long been subject to high climatic variability. Their water managers have considerable experience managing competing demands during droughts and this body of knowledge is likely to be a major source of policy as they prepare for climate change. Despite the fact that they are often responding to similar biophysical conditions water managers in these regions have usually worked in isolation from each other. This project will assess the possible benefits of closer cooperation.

A SYSTEMS MODELLING APPROACH TO MANAGE DISCHARGE TO RIVERS

COTE Claire, MORAN Chris

Centre for Water in the Minerals Industry (CWIMI), Sustainable Minerals Institute (SMI), The University of Queensland

Session – B2C

Mine sites manage releases of water to ensure compliance with regulation of the use of water resources and the protection of surrounding environment. License conditions restrict discharge to downstream watercourses to specific conditions of flow and concentration to minimize impacts on receiving waters. Traditionally, mine sites comply with discharge restrictions by undertaking detailed hydrological analyses of relevant catchments. Such studies can predict which rainfall event may lead to non-compliance. The underlying assumption is that the only factors that can influence the discharge risk are rainfall and runoff. However, a mine water system is not limited to its catchment. It also comprises additional inputs and outputs, stores and tasks, such as ore processing and dust suppression. These connected elements constitute a complex system with feedbacks, so that a perturbation in the water system leads to changes in the water balance status. We demonstrate that a systems modelling approach can be used to design a site water management system that balances the dual risks of discharge and running out of water. The approach has been applied to a range of coal mines resulting in the capacity to understand the implications of wide spread implementation of leading practice water use and loss rates.

DIVERSIFYING SOUTH EAST QUEENSLAND'S WATER SUPPLIES THROUGH PURIFIED RECYCLED WATER

DAVIES Keith, TRAVES Warren

Western Corridor Recycled Water Project Pty Ltd

Session – C3F

The Western Corridor Recycled Water Project is the largest recycled water project in Australia and the third largest advanced water treatment project in the world. When finished in late 2008, the project will have the capacity to supply up to 232 megalitres of purified recycled water a day to power stations, industry, agriculture and the Wivenhoe Dam system. More than 200 km of pipeline, three advanced water treatment plants, six storage tanks and nine pumping stations combine to make up the project, which is being delivered in three stages by five Alliances. "First Water" began flowing to Swanbank Power Station in August 2007. A number of innovations have already been achieved as part of the \$2.4 billion project, which is being constructed in world record time in response to South East Queensland's sustained drought conditions. These innovations relate to design, pipeline and plant construction and the application of water

treatment processes. The advanced water treatment processes used on this project are world's best practice. The project is designed to help meet the needs of the region's growing population and economy in a time of drought and climate change, and should improve water quality in Moreton Bay by significantly reduce the nutrient load from wastewater discharge.

WATER FOR FOOD AND FUEL IN A CHANGING WORLD

DE FRAITURE, Charlotte

International Water Management Institute

Session – B1

Globally there are sufficient land and water resources to produce food for a growing population over the next 50 years. But it is probable that today's food demand and environmental trends, if continued, will lead to crises in many parts of the world. Changes in diets as a result of increasing incomes and improved living standards will lead to higher agricultural water demand. Further, demand for biomass in transport fuels (i.e. biofuels) will expand due to rising energy prices, geopolitics and concerns over green house gas emissions. This will further drive the demand for agricultural products and hence agricultural water. Some forecasts foresee a doubling of agricultural water demand in the coming 50 years. This is reason for concern as already 1.2 billion people live in areas where water is insufficient to meet all demands (including environmental flows). Fortunately, there seems much scope to improve productive use of water and get more out of a unit of water. So far, the discussion on reducing agricultural water demand focused on how to produce more food with less water, without questioning if the produced food can be used more efficiently. This paper argues that with new challenges in a rapidly changing world, the narrow focus on food production is no longer sufficient. Looking beyond more "crop per drop", this paper concludes that there is considerable scope to save water by making the food chain more efficient.

GLOBAL LESSONS FOR ACHIEVING HEALTHY WATERWAYS: THE LEGACY OF RIVERPRIZE

DENISON Bill¹, GREENFIELD Paul², ALBRECHT Martin³

University of Maryland Center For Environmental Science¹, University of Queensland², International Riverfoundation³

Session – C4B

For the past decade, the International Riverfoundation has celebrated achievements from around the globe by awarding the Riverprize to those programs that have made demonstrable progress toward achieving healthy waterways. Interviews with prize winners and finalists have revealed a few key similarities that constitute global lessons for environmental programs. A common attribute that became evident was that the programs had a cadre of committed people who cared more about the accomplishments of the program than their own advancement. The leaders of these programs came from all walks of life (e.g., architect, doctor, teacher, or scientist) and were invariably passionate, knowledgeable and persuasive people. They all stressed the long term commitment needed and the importance of building a wide coalition of supporters. An insight into the persona of the Riverprize recipients (aka, River Heroes) is that the cash value was not viewed as the most important attribute of the Riverprize, rather the attribute most valued was the international recognition, providing a validation for their efforts. Further testament to the leadership qualities of the recipients was that they delighted in sharing the award with their community, they used the prize monies in different, but strategic ways to further their programs, and they were willing to create twinning partnerships to aid other less well resourced programs. The grand challenge that we face is how to replicate these isolated successes, and creating global lessons that can be emulated by existing or new programs. One aspect of the International Riverprize stories that emerged from the interviews was the obstacles that they overcame can provide inspiration to other groups who face similar challenges. Examples include overcoming cultural differences (e.g., Alexandria and Mekong Rivers), creating long term investment strategies (e.g., Mersey and Sha Rivers), engaging the broad community (e.g., Blackwood, Grand and Drome Rivers), and tackling long standing problems (e.g., Danube and Siuslaw Rivers). The global lesson in what constitutes best management practice is in the diversity of approaches used to achieve success; one size does not fit all. The common denominator was the quality of the people involved, rather than the code of practice, planning process or institutional structures created. A group of committed and passionate people can and have overcome existing challenges like degraded waterways and institutional barriers as well as future challenges like population pressure and climate change. In the words of Margaret Mead "It is amazing that a small group of committed people can change the world, in fact it is the only thing that has".

IMPACT OF ALTERNATIVE DYKE MANAGEMENT STRATEGIES ON WETLAND VALUES IN THE MEKONG DELTA

DO Thang Nam

Australian National University

Session – B3C

The construction of *ad hoc* dykes has contributed to wetland degradation in the Mekong River Delta (MRD). To address this problem, proposals to lower the current high dykes have been developed by wetland scientists. However, due to a lack of information on the impacts of dykes on wetland values, policymakers do not have sufficient information on which to make decisions regarding alternative dyke management strategies. This thesis predicts the impacts of the proposed dyke conversion on wetland economic values in the MRD. To this end, bioeconomic modelling involving three steps was employed. First, a biophysical modelling approach involving a hybrid conceptual-empirical model including expert consultations was used to predict the biophysical outcomes of changes in dyke management. Second, the market and non-market values of these impacts were estimated using the production function approach and environmental choice modelling respectively. Third, bioeconomic integration based on a cost-benefit analysis of alternative dyke management strategies was performed. It was found that lowering dykes would impose costs on local farmers through reduced income from rice production, reduced income from raising pigs and cows, and increased infrastructure damage costs. However, it would generate benefits to local farmers in the forms of increased income from aquaculture, capture fishery and duck husbandry. In addition, lowering the farm dykes would generate benefits to respondents living on the periphery and outside the MRD because of the resultant improved wetland biodiversity. The estimated positive net social benefit generated by dyke conversions in the whole MRD suggests that lowering the dykes in the MRD would improve social welfare. Among the policy options available to achieve these outcomes, issuing regulations to lower the current dykes combined with compensation paid to the local farmers was found to be efficient and is thus recommended.

ESTABLISHMENT OF A HYDRAULIC MODEL FOR RIVER BASIN NIGER

DOUMBIA Abdoulaye

Niger Basin Authority

Session – D1E

The study addresses one of the major concerns of NBA: Integrated Water Resource Management. River Niger with a length of about 4,200 km is the third longest river in Africa. Its catchment area is about 1.2 million km² shared by 9 Countries: Benin, Burkina, Cameroon, Chad, Cote D'Ivoire, Guinea, Mali, Niger and Nigeria. It is the 9th world's largest river system. Countries created in 1980, river basin organisations called the Niger Basin Authority, to better manage the water resources. More than 100 million people live in this basin. Since the past 3 decades, the Niger basin has been affected by series of extreme hydrological events causing low flows, droughts and floods as a result of climatic changes, human activities and the so called global warming. During the 1984/85 hydrological year, specifically, in June 1984, River Niger was completely dry in Niamey (Niger) for the first time in history. This phenomenon was almost repeated during the 2002/03 hydrological year. The average discharge at the outlet (station Lokoja, Nigeria) in 2006/07 was 3362 m³.s⁻¹. The modelling system constitutes a simulation and decision support tool, regarding water resources development and management potentials and water requirements in the Niger basin. The use of the model served first of all to provide the hydraulic background required for the development of the Sustainable Development Action Plan of Niger basin.

MANAGING FLOODS AND BIODIVERSITY ON A CROWDED AND SHRINKING ISLAND

DRIVER Alastair

Environment Agency

Session – B4C

The Environment Agency is at the forefront of adaptation to climate change in England and Wales through, for example, fluvial and coastal flood risk management, water resource management, and the enhancement of biodiversity. This presentation examines how the Agency and its key partners are working ever more closely together to create and restore sustainable wildlife habitats through its £650M per annum flood risk management programme. National government targets for habitat creation through flood risk management have driven a move from spasmodic opportunistic projects to

the development of regional habitat creation programmes which require a strategic approach to the acquisition and management of land for flood risk management and biodiversity purposes. In parallel, a multi-organisation 50 year Wetland Vision is being published in 2008 to provide a comprehensive GIS tool for identifying the suitability of potential locations for different types of wetland habitat, taking into account various constraints, including the availability of water. This presentation will also illustrate best practice case examples of large scale wetland creation aligned to urban flood defence schemes and of coastal managed realignment schemes which not only compensate for the losses of habitat through coastal squeeze, but also facilitate additional habitat creation for wildlife and people.

HATTAH LAKES STORYLINES: FACING THE FUTURE KNOWING OUR PAST

DUNCAN Leonie, VOLK Sandra

Environment Victoria, Murray-Darling Basin Commission

Session – A2E

In the past, spring-time floodwaters would have brought much of Hattah Lakes' wetland forests to life every 3 to 5 years. But with no big flood for over 10 years, recent emergency watering has been critical for the survival of this iconic River Murray site's magnificent old river red gums. Climate change and over-allocation threaten to leave the Ramsar-listed lakes dry for even longer in the future, which means the waterbirds that make the site internationally significant won't breed in their lifetimes. Without secure protection of environmental flows, future generations may never experience first-hand the ecological richness of Hattah Lakes. The Hattah Lakes Storylines project, funded by the Murray-Darling Basin Commission and delivered by Environmental Victoria, brought together a group of young adults, teachers, farmers and artists for a 4-day workshop where they recorded the story of their personal connection to Hattah Lakes as 3-minute digital stories for distribution on DVD both along and beyond the River Murray. Through the process of sharing their story, participants revealed what it is people value in a place like Hattah Lakes. This project demonstrated the power of storytelling in activating community stewardship and in achieving broader support for the protection of environmental flows, particularly in the face of climate change.

COMMUNITY CARE IN A CATCHMENT

DUNDABIN Sandy

NRM South and Glamorgan Spring Bay Council

Session - Poster

Caring for the natural resource needs of any river catchment should be about caring for the people that live, work and play within it. Effective 'on ground' NRM progress is best initiated by local land managers that are well informed, well supported and fully committed to the task at hand. In the past, property owners have become frustrated in our region by the short term nature of government funded projects driven from 'the top down'. A hit and miss approach. Projects have been managed by strangers to the catchment with little knowledge and/or understanding of the region. Often, this has resulted in aims not being met or monies wasted. Boxes have been ticked with little real change in the landscape. Extensive research findings have remained housed outside the catchment with no practical dissemination or implementation. Our local catchment committee, and the two councils that support it, believe that successful, strategic, long term NRM progress is best made by working with, rather than against, a community. Staff assisting with this progress should be individuals (or brands) that landowners know and trust - local paid personnel taking a genuine interest in a property manager's situation and working along side them. By providing increased support at a grass roots level for a much longer period of time we can build up the essential trust required to facilitate significant change. Over the past 18 months an extension officer was funded by NRM South to assist land managers in the Little Swanport Catchment. This has allowed a variety of land managers to become re-engaged in NRM activities. It has allowed them to access information, talk honestly with someone about their strengths and weaknesses, discuss funding and/or project options, implement on ground works and begin to take some small but significant steps towards the better environmental management of their land. At the River Symposium we would like the opportunity to share some of the ways we built a solid foundation for significant change in the landscape: A successful partnership between local government and the NRM region.

A STATISTICAL TOOL FOR SETTING WATER QUALITY GUIDELINES, ASSESSING CURRENT CONDITIONS AND TESTING WATER QUALITY TARGETS

FARTHING Brendan¹, TENNAKOON Sunil²

CSIRO Land and Water¹, Queensland Environmental Protection Agency²

Session – B4B

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC) (ANZECC 2000) describe methods for determining locally relevant guideline values for the protection of ecosystem health. We have developed a statistical software tool, based on the ANZECC methods, which can calculate locally relevant guideline values; store guideline values in a searchable database for later recall; and, test new datasets against guideline values to provide a statistically sound indication of the health of a site. The tool can also assist in the development of water quality targets by providing a method to calculate proportional improvements in a measured variable. It comes with existing water quality guideline values from ANZECC and the Queensland Water Quality Guidelines 2006 (QWQG) (EPA 2006). The system has been developed under The Invisible Modelling Environment (TIME) and the .NET framework to be compatible with other tools being produced by the eWater Co-operative Research Centre. This paper will outline the statistical theory used in the calculation of, and testing against, guideline values. It will then apply a practical example to demonstrate the use of the software.

ADAPTING TO CLIMATE CHANGE – BUILDING RESILIENCE IN A WATERSHED

FARWELL Joe

Grand River Conservation Authority

Session – B2E

This paper examines one watershed management organization's response to changing climate. Faced with uncertain climate and large projected population growth, the Grand River Conservation Authority (GRCA) is preparing for the future. The Grand River is a managed system that depends on large reservoirs for flood control, and supplying water to the river for parts of the year. Conflicting management objectives of flood control and providing environmental flows pose a special challenge in a period of change. An update the 1982 basin plan has been initiated. The update will include a systematic monitoring plan that will provide decision makers with the information they need to weigh alternative water management strategies. The plan will help set the framework for future actions that will build resilience in the watershed, and assist with responding to a changing world.

THE IMPACT OF LOW FLOW EVENTS ON FLOOD FREQUENCY IN THE LOWER YELLOW RIVER

FOSTER Jean¹, NI Jinren², GAO Xiaowei², LI Tianhong², BORTHWICK Alistair GL¹

Department of Engineering Science, University of Oxford¹, Department of Environmental Engineering, Peking University²

Session - Poster

High sediment concentration coupled with decreasing discharge have helped create unique circumstances in the Lower Yellow River (LYR) in China, where previous deposition from low-flow events has raised the riverbed, thus lowering the discharge threshold at which a flood occurs. This paper investigates whether there is a causal relationship between low flow and flood events in the LYR, in attempt to enhance understanding of the drivers for modern-day flood events. A peak-over-threshold (POT) method is used to obtain a series of minimum and maximum discharge events, and a suite of probability distributions are applied to the POT results. The results suggest that low flow events have higher occurrence probabilities than flood events, and that the probability of a flood event has reduced from 1950s-1990s despite a reduction in flood discharge capacity. There is insufficient evidence to conclude that low flow events and the subsequent raising of the riverbed through sediment deposition by themselves increase flood frequency or floodwater quantity. Factors such as precipitation, water consumption, and engineering countermeasures also play primary roles in determining flood events. Given the non-stationary nature of the hydrological data, forecasts of floods and no-flow events in the LYR should be treated with caution.

LARGE-SCALE HYDROLOGICAL METRICS: A COMPOSITE RIVER SUSTAINABILITY INDEXFOSTER Jean¹, BORTHWICK Alistair GL¹, TAYLOR Paul¹, GAO Xiaowei²Department of Engineering Science, University of Oxford¹, Department of Environmental Engineering, Peking University²**Session – C2D**

River management is increasingly based on the concept of sustainability. This paper considers the use of a composite river sustainability index (CRSI) to measure the capability of a large sediment-laden river to meet competing human, ecosystem, and instream flow demands. Sustainability is defined and an assessment index is developed via quantification of river performance with regard to five primary river functions: ecosystem support, self-purification (i.e. water quality), flood discharge, sediment transport, and socioeconomic water supply. Sub-indices for each function are constructed, normalized, aggregated, and weighted to develop a composite index that models the holistic behavior of the river system over time. The analytical hierarchy process (AHP) is employed to produce weightings. A principal component analysis (PCA) is performed to assess which river functions contribute most significantly to the variance of the composite, and to visualize redundancy of components in measuring driving principles governing the behavior of the system. A case study is presented for the Lower Yellow River in China. Results are examined with respect to regional geophysical indicators and river control anomalies. The CRSI and the methodology used in its construction should prove valuable as novel approach to conceptualize, model, and assess large-scale hydrological systems.

CHARACTERISING EXISTING RIVERINE CONDITIONS PRIOR TO ENVIRONMENTAL FLOW RELEASESFOY Sarah¹, HEATH Rachel¹, VERHOEVEN Mirella¹, COLLINS Emma¹, SULLIVAN Martin¹, CARTY Andrew¹, BLOCKWELL Stephen²Sinclair Knight Merz¹, Sydney Catchment Authority²**Session – C3B**

Sydney Catchment Authority is implementing new environmental flow releases from Avon Dam, south-west of Sydney, as detailed in the NSW Government's Metropolitan Water Plan 2006. For the last 15 years the only water from Avon Dam was, apart from a small spill in 1998, small discharges from the dam, including when valves are opened for maintenance. The only significant contributions to flows downstream of Avon Dam are from catchment run off and groundwater inflows, very different to the high energy flows experienced prior to the construction of the dam. Accompanying the introduction of environmental flows is a comprehensive monitoring program specifically designed to test a series of hypotheses. Reference and impact sites have been established to assess existing physical, hydrological, physio-chemical and biological characteristics of these sites prior to the introduction of environmental flows. This will be followed by a post release assessment for use in a BARI experimental design. This paper presents preliminary water quality, macroinvertebrate, diatom and habitat structure results from the pre-release monitoring program.

THE NATURE CONSERVANCY AND THE PARAGUAY-PARANÁ BASIN CONSERVATION

FREITAS Glauco, REUTER Michael, CAMPARI João, PETRY Paulo, VEIGA Fernando, ARAÚJO Albano

The Nature Conservancy

Session – B1

The Paraguay-Paraná river basin drains a million square miles of Brazil, Argentina, Paraguay, Bolivia and Uruguay, making it the second-largest basin in South America after the Amazon. TNC is leading an ambitious basin-wide conservation Program for the Paraguay-Paraná, starting with classification and mapping of freshwater ecological systems. The classification is a surrogate for freshwater biodiversity and is an essential source of information in the decision making instances of watershed management and freshwater conservation. In Mato Grosso State, Brazil, 200.000 hectares of the Pantanal's headwaters are being preserved. TNC, the State government and ranchers, are mapping degraded sites and implementing ecological corridors associated with best management practices programs to control soil erosion in agricultural lands. In the Piracicaba watershed, São Paulo State, an innovative payment for environmental services scheme was implemented to restore 100.000 hectares of headwaters that provide drinking water for 9 million people of São Paulo

megalopolis. TNC and partners are developing decision support tools to help decision makers evaluate scenarios of land use changes and freshwater habitat improvement at watershed level. TNC's contribution for the Paraguay-Paraná conservation is to engage communities, decision makers, private sector and test concepts on-the-ground allied with the most up to date scientific knowledge.

ANALYSIS OF LOW FLOWS IN SELECTED NEW ZEALAND CATCHMENTS

GAMAGE Nimal P.D.

GHD Ltd., New Zealand

Session – A2C

Understanding of low-flow statistics of streams is essential for development and management of surface water resources. Low flow statistics also are useful as a basis for forecasting seasonal low flows, as indicators of the amount of groundwater inflow to streams, and as legal indexes for maintaining water quality standards. Low flows of a stream can be affected by mining, urbanization, land-use practices such as logging and farming; and construction of small detention reservoirs for flood control, recreation, and low-flow augmentation. The flow statistics of selected catchments in New Zealand were studied to quantify the magnitude of statistical variability of low flows. Biologically based low-flow frequencies were determined using a daily series of average n-day daily mean flows. Unlike the hydrologic ally based statistics, the biologically based statistics are computed by identification of "excursions" in the record. The excursion concept relates to the biological concept of aquatic-life recovery after a period of stress. The n-day series is evaluated for the desired frequency of occurrence of the excursions on the basis of number of years of record. The results of this study are used identify the capacity of each watersheds to meet current and future water supply demands and ecological health.

INFORMATION MANAGEMENT OF POINT SOURCE MONITORING

GARNETT Corinne, RAMSAY Ian

Environmental Protection Agency

Session – C4C

With increasing pressure on waterways from urban development and climate change, better information systems are required that allow more rapid and comprehensive access to data on environmental pressures and waterway condition. The Queensland Environmental Protection Agency has been working on such a system that receives and stores electronic data on monitoring of licensed discharges in Queensland. The system is underpinned by an Oracle-based database but also includes a visualisation tool which allows data to be graphically displayed. In addition to accessing raw data on effluent water quantity and quality, it allows comparison with licence limits and estimation of loads over various time scales for contaminants such as nutrients or sediments. In addition, a spatial layer of the plants and discharge locations and discharge limits has been generated and will be automatically updated by the system. The system is currently being used to better inform state of environment reporting, licensing decisions, catchment planning and water recycling projects. The development and features of the information system will be presented with some discussion of future development and applications.

COMPARATIVE STUDY OF THREE METHODS FOR THE CALCULATION ENVIRONMENTAL FLOWS IN THE SANTIAGO RIVER, MEXICO

GONZÁLEZ-VILLELA Rebeca

Mexican Institute of Water Technology

Session – C3B

A comparative analysis of three methods for the calculation environmental flows in the Santiago river was carried out: 1) Tennant method, modified for tropical areas, 2) Habitat Simulation method (software Physical HABItat SIMulation system), and 3) Multivariate Analyses considering hydraulic, physico-chemical and biological (fish community) characteristics of the river. The Tennant method provided water flows based on the seasonal climatic variations and on the annual and monthly averages of the ten years previous to the construction of the dam. The Habitat Simulation method (PHABSIM) indicated the available habitat when the river flow changed in response to the operation of the Aguamilpa and San Rafael dams. The multivariate analyses, including Principal Components and Clusters, described the river habitat and determined the scenarios of optimal flow for species in the Santiago river. The Analysis of Canonic Correlations (ACC) showed that 62.48% of the variation was explained by the conductivity, dissolved solids, oxygen, current velocity and depth, in contrast with

the substrate, submerged vegetation and plant cover. Results pointed to current velocity, depth and substrate as the variables that explained the greatest percentage of the variation using the three methods.

ENVIRONMENTAL FLOWS - ASSESSMENT AND MANAGEMENT IN THE PROVINCE OF ONTARIO, CANADA

GOODYEAR Don, BROWN Holly, WALTERS Michael, BALDWIN Robert

Lake Simcoe Region Conservation Authority

Session - C2C

The Province of Ontario, Canada, has recognized the challenge of maintaining environmental flows in the face of increasing water demand. Several technical initiatives have been commissioned to investigate e-flow requirements, and two pieces of legislation loosely address the need to maintain e-flows and continue granting water taking permits. Initially, the Province funded a review and synopsis of the science appropriate to evaluate the environmental impacts associated with water taking. This project was followed by a specific examination of e-flow requirements in various hydrologic and water-taking settings. This paper will summarize both of these projects, each of which draws upon international examples of best practice. Attempts to transfer the results of these technical projects into management are evident in the *Ontario Water Resources Act*, specifically amendments to water taking regulation, and the *Clean Water Act*. The *Clean Water Act* was introduced to safeguard the quality and quantity of drinking water supplies. Water budget and water quantity stress assessments have been required in watershed-based planning units throughout the Province, which must account for ecological needs. This paper will consider the effectiveness of these legislative instruments in managing e-flows, and opportunities for better integration of water resource science and management.

MANAGING THE LAND TO PROTECT THE REEF

GORDON Iain

CSIRO

Session - A2A

With increases in sea surface temperature and ocean acidification associated with climate change Australia's Great Barrier Reef (GBR) is likely to face increased challenges to its diversity and integrity. Globally we need to increase efforts to reduce greenhouse gas emissions but as far as Australia is concerned the most effective action that can be taken locally is to reduce the pressure on the reef from land-based pollutants that flow out of the rivers into the GBR lagoon. The primary pollutants leaving the land are nutrients (N&P), sediments and pest/herbicides. There is now a policy initiative (ReefRescue), backed by good science and funding, to encourage the agricultural sectors to change management to reduce the amount of pollutants leaving farms. In some cases the adoption of these Best Management Practices (BMPs) may actually increase farm production (e.g. improved grazing practices) or reduce costs (e.g. optimise nitrogen fertiliser application) providing environmental gain at a lower cost to the public purse. Whilst the investment of \$200M in ReefRescue over 5 years may seem a lot we need to continue to invest in the development of integrated management and policy systems that include wetland and coastal habitat restoration if we are to protect the GBR in the face of climate change.

A TRICI RESPONSE TO CLIMATE CHANGE PREDICTIONS?

GRUN Aniela¹, SLIJKERMAN Johanna¹, DYER Fiona²

¹NRM South, Earth Tech²

Session - C2D

Benchmarking and monitoring the condition of rivers, at a State-wide scale, allows a coherent strategy to be developed for management. The Tasmanian River Condition Index (TRCI) is designed to give a repeatable and rapid snapshot of the condition of rivers across the State. Whilst this may allow the effects of climate change to be identified over long periods of time, it will be more useful to track the anthropogenic responses to climate predictions. The effects of reservoir development, interbasin transfers, and the influence of changed landuse will all be identified within the 5 main sub-indices: Hydrology, Streamside Zone, Physical Form, Aquatic Life, Water Quality/Catchment Disturbance. Existing Australian river condition assessments are often hampered by a poor understanding of reference condition. The TRCI explores

new referential approaches which allow benchmarked data to be tailored to the actual measurements. This paper will present the results of pilot testing of the TRCI, and will discuss the varying ways in which the Index may be interpreted and the information this will provide for management.

A CASE STUDY OF THE DNIEPER/PRIPYAT RIVER BASIN: CONSEQUENCES AND LESSONS OF THE MOST SEVERE MAN-MADE NUCLEAR ACCIDENT

GUDKOV Dmitri

Institute of Hydrobiology

Session - C4A

The Dnieper is one of Europe's great rivers, ranking third in terms of basin area after the Volga and the Danube. The Dnieper River Basin is located on the territory of three climatic zones and within the frontier limits of three countries, sharing the basin, Republic of Belarus, Russian Federation and Ukraine, and has the significant economic, social as well as ecological importance. Within the Dnieper River Basin 7 nuclear power plants and other numerous industrial enterprises are located, which are the sources of radionuclides and other pollutants. Besides as a result of the accident at the Chernobyl NPP in 1986 the Dnieper and its main tributary, the Pripyat River have undergone intensive radioactive contamination. Despite the 22 years since the accident, some territories of catchment area (especially 30-km Exclusion Zone around the destroyed unit of the Chernobyl NPP) still remain an open source of radionuclides into the river systems. The paper describes: (1) main sources and dynamics of radioactive contamination within the Dnieper/Pripyat River Basin during the early stage and the post-accident period of the Chernobyl disaster; (2) migration processes of radionuclides beyond the Exclusion Zone and their distribution downstream the water reservoirs of the Dnieper Hydro-Cascade and in the main components of aquatic ecosystems; (3) analysis of effectiveness of implementation of the water-protection measures within the Dnieper/Pripyat hydro system; (4) effects of long-term irradiation on aquatic biota; (5) redistribution of radionuclides and self-rehabilitation processes in contaminated aquatic ecosystems.

MAPPING AND MONITORING OF DROUGHT SEVERITY IN MURRUMBIDGEE CATCHMENT USING OPTICAL-THERMAL SATELLITE DATA

HAFEEZ Mohsin, KHAN Shahbaz, RABBANI Umair, SONG Kaishan

International Centre of Water for Food Security

Session - A2C

Spatial knowledge of land surface evapotranspiration and root zone soil moisture is of prime interest for optimizing irrigation water use and devising drought mitigation strategies especially in arid and semiarid catchments. The recent drought in Australia has highlighted the need to manage water resources more sustainability especially in the Murrumbidgee catchment which utilizes bulk water for food production. The quantification of drought in space and time is always difficult and challenging with the traditional models. This study focused on estimation of drought severity with remote sensing based estimation of actual evapotranspiration and soil moisture in the Murrumbidgee catchment. Terra/MODIS satellite data products were analysed on a 10 day basis over the period of 2004-05. The ground truth data were collected during the field campaign lasted over a month. Results indicate large scale temporal and spatial characteristics of drought in the study area. Results also demonstrate that remote sensing techniques could be effectively used to detect drought with large scale temporal and spatial variations. Spatio-temporal quantification of drought severity index would help in focusing the target area that needs immediate attention. Further, it would help in redefining guidelines to improve water use efficiency on sustainable basis for the drought affected Murrumbidgee catchment.

CREATIVE SOLUTIONS TO RIVER FUNCTIONING IN A CHANGED CLIMATE

HALES Greg

Blackwood Basin Group

Session - B4E

Climate change practitioners show the public broad environmental and climatic potential variability, and seek to raise awareness of the need to manage the associated risks. While these climatic forecasts indicate a changed environment, sweeping changes to the long water cycles are theorised that quite often have no managerial meaning to the land users. A way of managing the short water cycling is presented showing how the reconnection of rivers to their floodplains will provide suitable microclimates that allow

the Australian landscape to become more resilient to these changes. The creation and management of sufficient soil water storage will allow greater agricultural productivity from degraded systems, long term environmental flows to river systems and opens up the possibility of a constructive solution to the many risks associated with climate change. Protection of our productive lands in the future will require revolutionary contingency planning that must conform to the ecology and landscapes of the Australian extreme climates. For far too long we have ignored the lessons from the Australian landscape, cycles of wet to dry, fire to frost. The plan for saturating the short water cycle through the conservation of rainwater on land and utilising river flows on floodplains presents a revolutionary solution to the given risks and problems of climate change and future agricultural production.

WATERHOLES OF AUSTRALIAN DRYLAND RIVERS: VALUABLE BUT VULNERABLE

HAMILTON Stephen¹, BUNN Stuart², DOUGLAS Michael³

Michigan State University¹, Griffith University², Charles Darwin University³

Session – A3E

Many dryland river systems experience intermittent flows and for much of the time are reduced to fragmented series of river pools that vary considerably in their degree of permanency. These waterholes are critical refugia for aquatic biodiversity yet are vulnerable to increasing water demands and to flow regime changes linked to climate change. This talk synthesizes current scientific information on the hydrological and ecological features of waterholes in Australian dryland rivers, and identifies knowledge gaps that must be filled to understand how they would respond to future hydrological changes. Current research under the Tropical Rivers and Coastal Knowledge (TRACK) program is designed to generate information that is critical for conservation and management of these important ecosystems across northern Australia.

SOUTH BANK SHARC – AN ICONIC PROJECT FOR AN ICON OF BRISBANE

HAMLIN-HARRIS David¹, COLIN Pickering²

Bligh Tanner Pty Ltd¹, South Bank Corporation²

Session – C3F

South Bank is an icon of Brisbane, a focus for the life of the city and home to Australia's only city-centre beach. Water is fundamental to the Parklands: for irrigation, pools and water features. Bligh Tanner is working with South Bank Corporation (SBC) to provide a more secure water supply for the Parklands. SBC evaluated a number of alternative sources, including river water, rainwater and stormwater and is now designing the Stormwater Harvesting and Recycling Centre (SHARC). The SHARC will be one of the first and most significant of its kind in Australia harvesting water from an urbanised catchment. It will also provide great learning opportunities for future similar projects. The SHARC will harvest stormwater from a 30 ha catchment pumping into a 2 ML storage. Initially, the water will be treated and distributed for irrigation and water features. Later uses may include toilet flushing and pool backwash. Construction of the SHARC will commence later this year. The paper will cover the challenges faced in developing a secure water supply for the Parklands and address the background to the SHARC project, including design challenges and risk management. It will describe how the project is configured and how it is expected to perform.

INNOVATIONS IN PROTECTING WATER QUALITY THROUGH IMPLEMENTING A REGULATED NITROGEN CAP

HANIA Jan, BARBER Faith

Environment Waikato

Session – B4D

Lake Taupo is New Zealand's largest lake which, with an area of 620 km², is the largest freshwater lake in Australasia. Lake Taupo is known as having pristine water quality hosting a world renowned trout fishery and adventure tourism industry. However the water quality in Lake Taupo is deteriorating. Land use change in the Lake Taupo catchment, primarily through conversion to pastoral farming through the middle of last century, has seen increases in nitrogen being leached into the lake. Nitrogen availability, rather than phosphorous availability, limits phytoplankton growth in Lake Taupo. New rules are being implemented to cap nitrogen discharges into the lake and to provide for trading or off setting of nitrogen discharges within the

catchment between non-point pastoral sources. The implementation of these rules has provided many challenges, however these challenges are also stimulating many innovative and adaptive strategies both on and off the farms. The systems to regulate and the systems to operate and farm under a nitrogen cap need to be practical and cost-effective in terms of protecting the lake and farming viably. This paper will outline the regulated cap & trade non-point source nitrogen regulatory environment and then cover the strategies and science innovations which are being developed.

TIME RUNNING OUT FOR THE REEF - WILL THE PREMIER HELP OR HINDER?

HEATH Nick

WWF

Session – A2A

Bleaching, acidification, pollution, over-fishing threats are escalating and all need action immediately, yet pollution and fishing reduction are the strategies most within the power of Australian decision makers to action unilaterally without global coordination, such as that needed for significant greenhouse gas reductions. The primacy of pollution reduction as the key reef climate adaptation strategy has been recognised by the Rudd government with a welcome \$200m commitment to spearhead reform of sugar and cattle practices which harm the reef. The commitment has been built on new leadership from farm and NRM bodies working with science agencies to identify the 21st century agriculture which will be profitable and protect the reef from climate change for generations to come. From joint working groups, it has been identified that a 50% reduction in pollution, as measured by on-ground practice change, can be achieved in 5 years with \$300m government and \$340m industry investment. With \$200m involvement from federal government, and likely co-investment by industry, the only missing player is the state government which has neglected, if not indeed breached the commitments it has repeatedly made since 2000 to address this issue. WWF calls on the State government to match the commitment made by the federal government to secure the future of the reef and the 65000 people whose jobs depend on its health.

INCREASING WETLAND IQ – SYNTHESISING SCIENCE FOR MANAGERS

HEYDON Lana, RISSIK David

Environmental Protection Agency, Australia

Session – A3B

Synthesising and integrating current understanding and knowledge of wetlands is a crucial first step in the adaptive management framework. As part of the Queensland Wetlands Programme, we have categorised Queensland's floodplain (and non-floodplain) lakes and swamps into major wetland habitat types. We have developed a series of conceptual models that pull together the best available understanding of the key components and processes of these major types and identify knowledge gaps for future research. Though the models have been developed for a regional, as opposed to local, scale, we have attempted to capture as much of the diversity within these major type groupings as possible. These models, and the process used to create them are useful for identifying knowledge gaps, and presenting complex and vital information to managers and legislators in an accessible and engaging form, and also form the basis for developing a monitoring program. This allows the monitoring program and its suite of indicators to be: based on the best scientific understanding of each wetland type; and applied and interpreted appropriately for each wetland type. These models also demonstrate our understanding of wetland types within a landscape context, which is crucial for successful floodplain river management. This presentation will showcase the conceptual models and the website that they form a part of, as well as detail the process of their creation and share some of the learning's for future projects.

IMPACT OF CLIMATE CHANGE ON FLOODS IN SOLO AND BRANTAS RIVER BASINS INDONESIA

HIDAYAT Fahmi, HARIANTO, WIDYO Parwanto

Jasa Tirta I Public Corporation, the Brantas and Solo River Basin Management Agency, Indonesia

Session – B3C

In late December 2007 and early January 2008, persistent heavy rains led to overflowing rivers, flooding and landslides throughout Indonesia, resulting in numerous fatalities and crop losses. The two largest river basins in Java Island i.e. Solo and Brantas River basins, were the hardest hit on the basins from flooding or landslides. More than 100 people have been killed and hundreds of thousands have been affected

in East and Central Java by the flooding and landslides, which began on Dec 25 2007. Based on Multi-satellite Precipitation Analysis (MPA) produced at NASA's Goddard Space Flight Center for December 24, 2007, to January 2, 2008, the highest rainfall totals for the period were over 250 mm. Although the highest amounts were over water, parts of Java received in excess of 150-200mm. Deforestation in the region may have contributed to the devastating mudslides. This paper will discuss the impact of climate change on increasing flood magnitude and frequency, take into account flood occurrences in the Solo and Brantas River basins Indonesia. The flood magnitude and frequency in the Solo and Brantas River basins have increased significantly and become significant issues in water resources management in the basin. The recent flood occurred in the basin last year has caused economic disturbance in the region.

THE MAINSTREAMING OF WATER SENSITIVE URBAN DESIGN IN SOUTH EAST QUEENSLAND

HOBAN Alan

South East Queensland Healthy Waterways Partnership

Session – C3E

Water sensitive urban design combines the principles of integrated water cycle management with urban design and has emerged as a major lever for transitioning toward urban sustainability in Australia. In recent years water sensitive urban design has built on a foundation of strong research and case studies to the point where some of the objectives of water sensitive urban design are now being adopted as regional and state policies. This is particularly the case for urban stormwater quality improvement and to a lesser degree the management of hydrologic impacts of urbanisation. Well crafted policy is widely regarded to be ineffective unless coupled with effective programs to build the capacity of the sector, especially in private industry and local government. The Sustainable Urban Water Capacity Building Program of the South East Queensland Healthy Waterways Partnership works in a collaborative partnership with state government agencies, local governments, research institutions, industry stakeholders and the community to build institutional capacity. This paper draws on the feedback from stakeholders and presents an assessment of the current state of capacity to deliver sustainable urban water management in the region, the key hurdles faced by the sector, and the strategies in place to overcome these hurdles.

CORAL REEFS IN AN OCEAN OF CHANGE

HOEGH-GULDBERG Ove

Centre for Marine Studies, University of Queensland

Session – A2A

Coral reefs are among the most biologically diverse ecosystems on the planet, with one in every four marine species living in and around these extraordinary carbonate structures. Despite their importance to billion dollar industries and in feeding an estimated 100 million impoverished people worldwide, coral reefs are disappearing at a rate of 2% per year. These changes are occurring as the result of the local and global impacts associated with rapidly expanding human populations. Local factors such as declining water quality from disturbed coastlines and the over-exploitation of key functional groups such as herbivores are now being joined by rapidly warming and acidifying seas. Most evidence points to a crisis point in about 20 to 30 years when global concentrations of carbon dioxide rise above 450 ppm. At this point, the carbonate structures that typify coral reefs will begin to deteriorate and the thousands of reef-associated species will start to disappear. While it is not too late to respond and preserve the majority of coral reefs, current global efforts do not match the scale of the threats and will be mostly ineffective in terms of maintaining these rich ecosystems. A major rethink must occur in how we approach conservation of coral reefs, especially with respect to how we underpin solutions to land-based issues. We need to take a line on the extractive industries that currently threaten the resilience of coral reefs to global change.

WILLOWS: FRIEND OR FOE? A NATIONAL APPROACH TO WILLOW MANAGEMENT IN AUSTRALIA

HOLLAND CLIFT Sarah

Department of Primary Industries Victoria

Session – A2F

Willows (*Salix* spp.), familiar icons of the Australian landscape, are listed as one of Australia's 20 Weeds of National Significance (WoNS), due to their highly invasive nature and negative impacts on stream and wetland hydrology and biodiversity. Although listed as one WoNS, there are more than 30 naturalised willow taxa in Australia and over 300 taxa worldwide. As some willows can spread long distances by seed across regions and states, national coordination is proving critical to ensure management is effectively coordinated between areas. Lack of knowledge of the extent and impact of different willow species, however, impedes effective management. To prioritise willows for management at the national, state and regional levels, the National Willows Program has conducted a detailed weed risk management process, with input from over 650 people across Australia. To further improve management, a detailed best practice management guide and resource kit have been developed, several research projects undertaken and a national information sharing network established. This paper outlines some of the outcomes achieved by the National Willows Program to date, the processes used to achieve such outcomes, and how these can be utilized by regions, states and other nations in protecting and improving their waterways for the future.

EUROPEAN INITIATIVES FOR ADAPTATION TO CLIMATE CHANGE IN RIVER BASIN MANAGEMENT

HOLZWARTH Fritz¹, WELLER Philip²

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Bonn, Germany¹, International Commission for the Protection of the Danube River, Executive Secretary²

Session – B2E

Water authorities in the European Union (EU) have recognized the increasing importance of developing and applying adaptation strategies in response to climate change. The Greenpaper on Adaptation presented by the European Commission in June 2007 and the Communication on Water Scarcity and Droughts stresses the fact that existing EU water legislation provides a good framework to address adaptation to the impacts of climate change in water management. Various initiatives have been taken to make more specific the responses that can be taken. In particular a Workshop on Climate Change and EU Water Policy was organized in Germany to see how these responses could be built into the existing work being undertaken to implement the EU Water Framework Directive. A checklist of ideas for implementing climate change adaptation into River Basin Management Plans has been developed and is being applied. The Danube river basin in particular has responded to this initiative and is now incorporating these ideas into the Danube River Basin Management Plan which is under preparation.

DOING THE RAP IN SOUTH EAST QUEENSLAND

HOUGH Paul, MAYGAR Brad, MAXWELL Paul

QLD EPA

Session – B4B

The Riparian Assessment Program (RAP) is a new method to quantify the "naturalness" of estuaries using an innovative software tool developed by the Queensland Environmental Protection Agency Freshwater and Marine Sciences Division. The Riparian tool links data (referring to riparian attributes entered onto a touch screen computer) with GPS points, producing a map of vegetation types and dimensions, land use types, soil, structures and bank modification in the intertidal and supra tidal zones of estuaries. The Riparian Assessment Program produces highly detailed data with 98% accuracy. Interpretation is clear and concise, making it a useful tool in habitat restoration and protection. The tool is transferable, allowing multiple users with limited knowledge of riparian characteristics to use the program. The speed and accuracy of this program is efficient, significantly reducing field time and concomitant costs. This presentation demonstrates the outcomes of this tool used to assess 18 estuaries in South East Queensland for Riparian attributes indicative of modified and natural habitats.

EPISTEMOLOGICAL GYMNASTICS: CHALLENGES TO KNOWLEDGE SYSTEMS OF WATER CYCLE UNDERSTANDINGHOVERMAN Suzanne¹, ROSS Helen¹, POWELL Bronwyn², CHAN Terence³The University of Queensland¹, International Water Centre², Monash University³**Session – C4B**

This paper discusses some of the knowledge systems challenges which have arisen from research to develop an integrated systems understanding for catchment risk assessment using the Kongulai Catchment in the Solomon Islands as a case study. The Kongulai Catchment supplies the majority of water for the capital city Honiara but faces competing social and economic demands, significant geological challenges and multiple management objectives. The Kongulai catchment study has used a broad participatory process to develop a catchment model to assist water managers to identify risks and prioritise management actions. The research has been carried out over several years by an interdisciplinary team. At the core of the research methodology is the participatory process which has sought qualitative data about different perspectives, to augment the (limited available) set of quantitative indicators. Efforts were made to bridge different knowledge systems in ways that helped to equalise the power differentials that have traditionally privileged certain resource managers' approaches over others. The research has also maintained a commitment to resolving scale issues incorporating local with global/scientific knowledge. The process has brought together western analytical, traditional tacit and managerial knowledge systems. Some concepts continue to pose conceptual challenges, such as the term 'sustainability' to traditional inhabitants and 'demand management' to water engineers. This paper explores the participant's explanations for these epistemological challenges, explanations which in themselves demonstrate a new integration across knowledge system boundaries and which explain the most recent local initiative -- the joint development of a catchment management plan with consultative.

BRINGING ABORIGINAL PEOPLE INTO WATER PLANNING – LESSONS FROM THE DALY RIVERHUNTER-XENIE Hmalan¹, COLLIER Neil¹, LIDDY Mona², FOSTER Michael², WHITE Mark², GARNETT Stephen T.¹, SITHOLE Bevyline³School for Environmental Research - Charles Darwin University¹, Daly River Aboriginal Reference Group², Private Consultant³**Session – A2E**

With increased demands on water resources, and potential threats from climate change, there is an increased awareness across Australia of the importance of water planning. Water planning processes are complex and time consuming requiring engagement from all stakeholders, especially in the north. Ensuring input from Indigenous stakeholders in this process is crucial where water planning should endeavour to address the concerns and views of Aboriginal people. In the past Aboriginal people have had limited engagement and participation. In this project visioning and scenario tools are being developed and tested to facilitate greater engagement in water planning by Indigenous people in the Daly River region in the Northern Territory of Australia, (in particular the Daly River Aboriginal Reference Group (ARG)). The project aims to build Indigenous peoples capacity to engage on equal terms in catchment planning processes and to develop the skills required to participate in cross-sectoral water planning processes. The project is empowering members of the ARG with skills necessary to undertake participatory simulation modelling. In this paper we will discuss – 1. The visioning and scenario tools selected and employed; 2. The development of scenarios for the Daly River catchment; and 3. The perceptions of ARG members regarding the role of Aboriginal people in influencing water policy.

THE FUTURE OF OUR RIVERS: GLOBAL PERSPECTIVES ON COLLABORATION, INTEGRATED WATER MANAGEMENT AND CLIMATE CHANGE

International Riverfoundation

Session – D1A

This session will be interactive in style, participants breaking into groups to discuss issues with experts such as Thiess Riverprize representatives and other practitioners. Issues discussed will include:

1. Stakeholder participation, science, and decision-making in Integrated Water Management

Integrated water and catchment management involves the collaboration of scientists and 'non-scientists' to best manage water resources. Participants will discuss how the involvement of different stakeholder groups, integration of different forms of knowledge and the sharing of power, resources and responsibility results in better management of water and river resources.

2. Partnerships in catchment/watershed management

Development and maintenance of effective partnerships for long-term sustainable management of river systems and catchments will be vital to mitigate and combat climate change. Participants will discuss the elements that define successful partnerships to achieve best practice management of river systems.

3. Climate Change and mitigating the effects through river and catchment management

It is clear that climate change is, and will continue to have, a major impact on rivers world-wide through changes to precipitation, evaporation, snow pack, flood and drought. Participants will discuss these and other emerging impacts whose effects have only been rudimentarily estimated, as well as potential impacts that are yet to be formally identified.

OPTIMIZATION OF IN-BANK CHANNEL SURVEY FOR FLOOD RISK MAPPING FOR FUTURE CLIMATE CHANGE CONDITION

ISLAM Mouludul, CAFFERKEY Brian

WSP Development and Transportation, UK

Session – C2B

Flood Risk Mapping in the flood plain studies is largely required to support development control, maintenance and asset planning. Planners and designers are now facing new challenges to adopt new policies and guidelines in delineating a more accurate flood risk mapping particularly for future climate change and projected future developments for a particular design horizon. However, to assess these future floodplain hydraulic consequences in detail, a state-of-the-art technology with cost-effective approach is of utmost importance. In the present paper, utilization of channel bathymetry using the LiDAR (Light Detection and Ranging) data for a very steep river system in UK has been investigated for flood risk mapping against climate change condition. The results have been successfully compared with the flood outlines delineated utilizing the channel surveyed cross-sections with the results of two different modelling approaches. The results thus proved towards optimization of channel survey in flood risk mapping in the flood plain for existing or future climate change conditions.

MONITORING RIPARIAN ZONE CONDITION USING IMAGE AND FIELD BASED ASSESSMENT METHODS

JOHANSEN Kasper

The University of Queensland

Session – B2D

Government agencies responsible for riparian environments are assessing the combined utility of field survey and remote sensing for mapping and monitoring indicators of riparian zone condition. The objectives of this research were to:

- (1) develop a method for mapping riparian condition indicators (RCIs) related to water quality using high spatial resolution remote sensing; and (2) compare a rapid on-ground riparian assessment method (Tropical Rapid Appraisal of Riparian Condition (TRARC)) with the developed image based method in terms of mapping representativeness, cost-effectiveness, and suitability for multi-temporal assessment. Two QuickBird multi-spectral images captured in 2004 and 2005 and coincident calibration field data covering sections of the Daly River in the Northern Territory, Australia were used. Both field and image data were processed to map RCIs including percentage canopy cover, organic litter on the ground, canopy continuity, bank stability and flood damage. Spectral vegetation indices and object-oriented supervised classification were used to produce RCI maps. The results present an operational remote sensing mapping and monitoring approach for assessing RCIs related to water quality. Results showed that the TRARC scores for each RCI were estimated with an accuracy within 20% of the true TRARC scores when sampling 3% of the study area. The mapping costs of the image based approach were compared to those of the TRARC approach. TRARC was found more cost-effective at smaller spatial scales (1-200km stream length), while image based assessment becomes more feasible at regional scales (>200km stream length). Change detection analysis demonstrated that image data can provide detailed information on gradual change in RCIs, while the TRARC method can only detect broad scale changes. The results of the remote sensing approach is currently being adjusted for implementation in Victoria in 2010 for mapping streamside vegetation and bank characteristics relevant to stream condition for 26,000km of streams.

CHALLENGES IN RIVER MANAGEMENT DUE TO EXCESSIVE SAND MINING

KAMALADASA Badra

Irrigation Department of Sri Lanka

Session – B3D

The land area of Sri Lanka is comprised of 103 river basins. All these rivers can be categorized as the live wire of a large cross section of the community that depends not only on irrigated agriculture but also on construction industry and many other trades. Demand for river sand was increased remarkably during the past few years due to construction boom taken place in post-Tsunami re-construction programs. River sand is traditionally an essential raw material in the construction industry and hence introducing of alternate materials has not been successful. Uncontrolled sand mining has caused destruction to the natural morphology of many rivers, which had instigated structural problems to structures across the rivers such as bridges, barrages and domestic water intakes. Quality of fresh water in many rivers is affected due to intrusion of saline water from the sea as the level of the river beds gets lowered. This paper records few case studies of such incidents and implications of them. It further highlights the role played by media, civil society and some advocacy groups to agitate the authorities to control the unauthorized sand mining in the absence of proper legislations for conservation of river system.

ETHICAL ARGUMENTS FOR TRANSBOUNDARY RIVERS PROTECTION

KAMALOV Yusup

Union for Defense of the Aral Sea and Amudarya, NGO

Session – C2E

Those who live downstream do not have real influence on upstream issues although both of them have the same rights. Nevertheless the upstream subjects are continuing to use rivers as a free of charge convenience and hidden transport to remove many kinds of waste, trash, drainage and sewage waters away from their own county, state or region. Nowadays rivers are not able to self-clean the waters. The concentration norms of pollutants are overreached many times. The rights of downstream subjects for water with the same quality as on source are destroyed. The invisibility of waste and lack of controls promote violations of water quality. Such behaviour is criminal and it is unworthy of human beings. It should be overcome as has racism, slavery and gender inequality. Recognizing water as a sacred staff should become a property of high culture and respecting of neighbors for any nation. It is necessary to implement legislation along transboundary rivers with enforcement for polluters. Equality of rights of downstream and upstream people have to be realized in practice and become a norm of behavior.

EPHEMERAL WETLANDS: THEIR ECOLOGICAL FUNCTION & RESILIENCE AND CLIMATE CHANGEKATH Jarrod¹, LE BROCCQUE Andy¹, MILLER Craig²Faculty of Sciences/Australian Centre for Sustainable Catchments, University of Southern Queensland¹, CSIRO Sustainable Ecosystems²

Session - Poster

Ephemeral systems dominate the landscape in Australia, although they are often undervalued both intrinsically, and in terms of their contribution of ecosystem services to the broader landscape compared to other wetland systems. In the face of climate change, a lack of understanding of how ephemeral systems function and their ecological resilience, the ability of the system to adapt to significant (directional) change, represent significant knowledge gaps. Ephemeral systems in inland Queensland are highly dynamic, with species generally well adapted to relatively unpredictable climates. However, ecosystem degradation through the direct impacts of land use such as eutrophication, grazing, salinity, erosion, and indirect interferences on flow rates and hydroperiod has greatly simplified these systems and reduced their resilience and hence their ability to adapt to climate change. Decreased resilience in ephemeral wetlands coupled with inadequate knowledge of how these systems function, could have serious implications for the future sustainability of agricultural landscapes. In order to address these issues a sound understanding of the ecological and social factors important for maintaining these systems resilience to degradation and climate change needs to be developed. This presentation describes a proposed study examining aspects of ephemeral wetland ecological function and resilience to climate change.

IMPACTS OF CLIMATE VARIABILITY AND CHANGE ON VICTORIAN WATER RESOURCES

KIEM Anthony, CLIFTON Craig

Sinclair Knight Merz

Session – A2C

Water management in Australia has traditionally been carried out on the assumption that the historical record of rainfall, evaporation, streamflow and recharge is representative of current and future climatic conditions. In many circumstances, this does not adequately address the potential risks to supply security for towns, industry, irrigators and the environment. This is because the Australian climate varies markedly due to natural cycles, that operate over periods of several years to several decades, and is also being increasingly affected by anthropogenic influences. Both factors will continue to influence Australia's climate, even if immediate action is taken to curtail greenhouse gas emissions. Long-term water resource planning must account for both climate variation and climate change to avoid over-allocation of water resources and to ensure economic activity based on utilisation of water resources is not unnecessarily restricted. This presentation will demonstrate an approach that takes advantage of recent insights into natural climate variability and up-to-date anthropogenic climate change projections to provide improved information on water security. Results from two south-east Australian catchments will be presented as indicative case studies.

SCIENCE INFORMING THE DEVELOPMENT OF THE TULLY WATER QUALITY IMPROVEMENT PLAN

KROON Frederieke

CSIRO Sustainable Ecosystems

Session – D1B

To halt and reverse the decline in water quality entering the Great Barrier Reef (GBR) within 10 years, the Australian and Queensland Governments jointly developed and launched the Reef Water Quality Protection Plan (the 'Reef Plan') in 2003. The development of local Water Quality Improvement Plans (WQIPs) is one of the actions outlined in Reef Plan. Under Reef Plan, the Tully catchment has been identified as a high risk catchment, due to extremely high rainfall and proximity to the GBR, combined with extensive clearing and drainage of the coastal floodplain for agricultural land uses. This made the development of a Tully WQIP a high priority. The development of the Tully WQIP has been underpinned by a major science program comprising three components. First, social, cultural and economic values of the GBR were identified by consulting with the local community, using a series of interviews, surveys and workshops. Based on the values identified by the community and water quality guidelines associated with these values, draft water quality targets were established. A combination of water quality monitoring and modelling was used to identify the current status of sediment, nutrient and herbicide loads, and to compare these loads against the draft targets. This information was used to develop a list of key pollutants and critical land use sources. Finally, the cost-effectiveness of changes in land management on reducing key pollutant loads from sugarcane, horticulture (banana), beef grazing, plantation forestry, and native forest was examined. The most cost-effective changes in land management to achieve water quality targets were identified and prioritised for implementation. The Tully WQIP has been delivered in 2008, outlining specific, measurable, achievable, relevant and timed management actions to halt and reverse the decline in water quality entering the GBR by 2013.

THROUGH PRESERVATION OF URAL RIVER STURGEON HABITATS TO SUSTAINABLE WATERSHED MANAGEMENTLAGUTOV Viktor¹, LAGUTOV Vladimir²Central European University¹, Research and Consultancy Agency "DonEco"²

Session – A2F

Sustainable development of watershed should consider three main components: economic, social and environmental, which is hard to achieve in real-life watershed management. Using sturgeon species as a natural indicator and an incentive for transboundary IWRM cooperation in the Ural river basin is suggested. The only free-flowing river in the Caspian basin, the Ural River, is a unique ecosystem with a preserved natural hydrological regime and the last sturgeon spawning habitats. It contains the only self-sustaining, viable sturgeon population capable of natural reproduction. The presence and well being of this worldwide flagship species in a river network indicates the "good quality" of a river ecosystem's health. Activities towards successful integrated water management will secure preservation and restoration of

sturgeon population and vice versa. Community-based management of sturgeon stocks also resolves social and economic problems by restoration of the traditional life style of local communities, exclusively focused on sustainable utilization of floodplain resources, e.g. fishing. High economic and social values of sturgeon allow the combination of both ecological and socio-economic aspects of sustainable development. The Ural River Basin Project (<http://uralbas.ru>) aims at the establishment of an international Ural Sturgeon Park, sustainable basin development, IWRM and sturgeon restoration. Special attention is paid to stakeholders involvement, crossdisciplinary integrated assessment and modelling of the Ural River hydrology coupled with sturgeon life cycle.

ENGAGING VISIONS: COMMUNITY, ART, ENVIRONMENT. AN UPDATE

LAMBERTS Rod

The Australian National University

Session – A2F

This paper presents results from two of four stages of the Engaging Visions Project, outlined at the 10th River Symposium. Engaging Visions identifies and evaluates best-practice procedures for engaging visual artists with catchment community natural resource management (NRM) issues. Its history will be covered before results from the pilot, and first evaluation, phases are presented. From 2007-2009, Engaging Visions is evaluating the effectiveness of interactions between community, art and environment on NRM issues in four case catchments: St George, Tumut, Renmark, and the Kiewa River Valley. Funded by an Australian Research Council Linkage grant, the Project has three partners: the Murray Darling Basin Commission, and the ANU School of Art and Centre for Public Awareness of Science. Progress on the final product of the three-year Project will also be presented. This combines community-wide surveys and interviews with data gathered from participating artists. Ultimately, we aim to create a model procedure for artist involvement in catchment NRM that will empower communities and artists to address critical NRM issues. This will underpin a partner 10-year investment plan for cultural practitioner and community engagement to achieve increased adoption and accelerated up-take of environmentally sustainable practices in the Murray Darling Basin.

LET THE INFORMATION FLOW: A MURRAY-DARLING BASIN CASE STUDY

LANE Chris

GHD Pty Ltd

Session – C2C

Often the ecological value of an asset and its environmental water requirements is determined from scientific information that contains gaps and inadequacies. So how do policy makers and water resource managers ensure that sufficient environmental water is provided to the right asset and at the right time, but with limited information? This paper reviews the findings of a project conducted by GHD on behalf of the Department of the Environment, Water, Heritage and the Arts. The principle aims of this project were to identify the ecological water needs of water-dependent ecosystems in the Murray-Darling Basin, and to identify gaps in the available knowledge. That is, what is currently being done to address the information gaps and what still needs to be done. The results of this project were examined as a case study to highlight the typical areas for improvement in the scientific knowledge base. The outcomes of the case study are likely to provide greater links between those on the ground, and water resource managers, and policy makers.

THE ROLE OF UNESCO-IUGS-IGCP'S PROJECT "GROWNET" IN WATERSHED MANAGEMENT IN LOW-INCOME COUNTRIES IN VIEW OF FORTHCOMING HARSH CLIMATIC PATTERN

LIMAYE Shrikant

Ground Water Institute (NGO)

Session – B4E

Recently, the population pressure in India and many other low-income countries has resulted in encroachment on forests and pasturelands for agricultural purpose. Moreover, the uncontrolled exploitation of forests for timber and firewood has caused degradation of watersheds. The streams draining these watersheds, which were once perennial, now give rise to hydrographs of sharp peaks and narrow time base. They are also loaded with considerable amount of silt. The forthcoming climatic pattern is going to be harsher and erratic and is sure to accentuate the

hardships felt at present in water resources management in low-income countries for providing food and safe drinking water to the growing population, especially in the Monsoon region. The climatic changes would make Monsoon rains more erratic, causing frequent flash floods in some areas and severe droughts in others. Under these circumstances, there is a need to create a buffer, a cushion or a resilient interface to absorb the shocks of the climatic changes and to provide some insurance for the water managers. A properly managed watershed, preferably a micro-watershed of a first order stream, provides such a resilient interface. The soil surface with its cover of grass, bushes and trees, properly tilled farms with contour bunds, farm ponds, check-bunds on small streams or gullies, and contour trenches on hill slopes, are the meeting points of climatology on one side and hydrology/hydrogeology on the other side. India and also other low-income countries should therefore give priority to land-use planning and watershed management with people's active participation. This would be an effective tool for conjunctive management of surface and ground water resources so as to combat floods or droughts. In a year of good rainfall, it would adequately recharge the ground water reservoir and reduce the peak floods. The hydrographs of the streams would then have subdued peaks and broad time base. In a drought year, the ground water resources could be fully used, thereby creating enough capacity for accepting recharge during the next year's Monsoon rains. UNESCO-IUGS-IGCP Project no 523 is titled "GROWNET – Ground water network for best practices in ground water management in low-income countries". The Project's freely accessible website www.igcp-grownet.org lists several 'best practices' which include forestation and watershed management for soil and water conservation so as to create a resilient interface between climate and hydrology/hydrogeology. The Author is the Project Leader for GROWNET.

FRESHWATER TURTLE CONSERVATION MANAGEMENT STRATEGIES IN RESPONSE TO DROUGHT AND RIVER MODIFICATION

LIMPUS Col, LIMPUS Duncan

Queensland Environmental Protection Agency

Session – D1C

The Mary, Burnett and Fitzroy Catchments of south Queensland support the highest levels of freshwater turtle biodiversity: 6 genera, 7 species, and endemism (3 species, all threatened species) in Australia. These same catchments are among the most modified rivers in Australia with respect to the number of dams and weirs and the proportion of river converted from flowing stream to impounded waters. The endemic turtles are cloacal ventilating specialists that should be favoured within flowing streams and disadvantaged within deep standing water bodies. The dam and weir infrastructures can cause increased death and injury to turtles as well as being barriers to the movement of turtles within the waterways. Raised or fluctuating water levels inside impoundments and reduced downstream flood regimes are expected to change the distribution and structure of traditional turtle nesting banks. During droughts, the increased extraction of water from streams to service agricultural, pastoral and mining use in surrounding lands can result in overcrowded turtle populations in the diminished water bodies. These waters are often of poor water quality. Management strategies will be explored that address the maintenance of sustainable turtle populations within modified catchments under stress from climate change and society's increasing demand for water.

JOINT MONITORING OF A SHARED INTERNATIONAL RIVER BASIN – THE DANUBE

LISKA Igor, PHILIP Weller

International Commission for the Protection of the Danube River

Session – D1E

The Danube basin is the most international river basin in the world shared by 19 countries. The TransNational Monitoring Network (TNMN), launched in 1996, constitutes the main data source on water quality of the Danube and its major tributaries. It provides a structured and well-balanced overall view of the pollution status as well as of the long-term development of water quality and pollution loads in terms of relevant determinants for the major rivers in the Danube River Basin. Recent monitoring upgrades are further helping to ensure that the TNMN will meet the requirements of the EU Water Framework Directive (WFD), especially by broadening its scope to consider biological monitoring and the EU priority substances. To get a satisfactory overview of the water quality, especially in reference to the information needed for WFD implementation a complementary monitoring activity has been established: longitudinal surveys on the whole stretch of the river. Joint Danube Survey 1 was carried out in 2001 and its results were a key information source for WFD implementation. Joint Danube Survey 2 has been organized in 2007. During this survey 96 sites were sampled along the 2500 km stretch of the Danube. The survey brought

not only a large data set on chemistry, biology and hydromorphology but it strengthened the basin-wide cooperation of the scientific community and increased the awareness of public towards the need for water quality protection.

THE GROWING POPULARITY OF ECOSYSTEM HEALTH REPORT CARDS: A MANAGEMENT, COMMUNICATION AND ADVOCACY TOOL

LONGSTAFF Benjamin, DENNISON Bill, WILLIAMS Michael, CARRUTHERS Tim, FLORKOWSKI Lisa

University of Maryland Center of Environmental Science

Session – C3C

Ecosystem health report cards are gaining popularity as tool for assessing and communicating the condition of waterways. This is not surprising considering their many benefits, the most notable being their ability to impart a simple message to a large audience. Report cards are also likely to play an increasing role in assessing and reporting the effects of climate change and associated impacts such as floods and droughts. Report cards are being produced by a variety of organizations (non-profits to government agencies), representing a diversity of waterways (e.g. streams, rivers, bays) of varying spatial scale and complexity. At present the quality and transparency of methods used to assign report card grades differ greatly. If ecosystem health report cards are to continue growing as a communication and management tool, we need to work towards more consistent quality assured approaches that will facilitate comparisons and maintain user confidence. This presentation will provide an overview of ecosystem health report cards, methods currently being used, some success and failures, and application to assessing climate change. The presentation will draw on our experience of producing report cards for a diversity of waterways ranging from small creeks to large bays in the U.S. (Chesapeake Bay, Chester River, MD Coastal Bays and Rock Creek Park), Australia (Moreton Bay and estuaries), and the Republic of Georgia (South Caucasus watershed).

ASSESSMENT OF FLOOD RISK OF THE CARDRONA RIVER FLOODPLAIN

MALE John¹, GAMAGE Nimal P.D.¹, LAMPERT Guy²

GHD Limited - New Zealand¹, GHD Limited - Australia²

Session – C2B

The Cardrona catchment, located in Queenstown Lakes District, New Zealand is mainly farmland, but includes the townships of Cardrona and Albert Town. These townships are expanding to meet the demand for residential development in the area. The rural area is continuing to be subdivided into lifestyle blocks with residential dwellings. The community exposure to flood hazard is a concern for authorities, especially as the situation is complicated by the mobile alluvial river bed continually aggrading, degrading, or avulsing making flood risk ever present, and the different land uses within the valley, each of which has a different tolerance to flooding and potentially conflicting approaches to mitigation of the flood risk. The flood hazard in the Cardrona Valley was assessed in terms of the hydrologic and hydraulic response, and the geomorphic processes that operate in the valley. The reaches were characterised and historic changes were determined from aerial photography. The MIKE11 model was used to simulate the hydrologic and hydraulic responses of the catchment, and sediment transport. This study has established the dynamics of the runoff process, the extent of flooding, and the significant influence that sediment loads has on the flooding footprint.

WATER RESOURCES IN UKRAINE UNDER CLIMATE CHANGE: ASSESSMENT AND MEASURES OF ADAPTATION

MANUKALO Viacheslav

State Hydrometeorological Service

Session - Poster

The goals of the paper are: a) to present the effects of climate change on water resources of the main rivers of Ukraine; b) to determine the most likely affected sectors by impact of climate change; c) to present the possible adaptation measures in order to eliminate the effect of negative impact of climate change. The investigation shows the different degree of the present and expected changes in the hydrological regime of rivers located in the different parts of the country, and during the different seasons. The most likely affected sectors by impact of climate changes are: agriculture, human health, human settlements, environment. However, there are

still many uncertainties relating to the effects of climate change on water resources. These factors will determine the general long-term strategy in the development of water resources management and protection. In order to eliminate the effects of negative trends in the water resources, a number of legislative, organizational and technical measures aimed at protecting the water resources should be undertaken. These measures include: institutional strengthening, continuous monitoring and evaluation, development of researches, use of modern technologies in water resources management.

MANAGEMENT OF WATER QUALITY WITHIN TRANSBOUNDARY RIVER BASINS: CASE STUDY OF UKRAINE

MANUKALO Viacheslav

State Hydrometeorological Service

Session – C3D

Ukraine is an important area for international co-operation in water management and protection on a basin-wide scale. The Danube River Protection Convention which is the good basis for development of water quality management and water protection within transboundary river basins. There are the following directions in the area of development of water quality management: a) creation of the transnational water quality monitoring network in order to provide a structured and well-balanced overall view of the pollution status, as well as of the long-term development of water quality and pollution loads for the major rivers; b) prevention and control of accident pollution. The accident warning system is elaborated in order to provide a warning message downstream the Danube in case of a significant accident in the basin. Development of effective water quality monitoring system within transboundary river basin is the essential component of elaboration and implementation of the river basin management strategies for pollution abatement and river protection. Taking in account that the State Hydrometeorological Service operates the most extensive water quality monitoring network in Ukraine, the measures of improvement of water quality monitoring are considered in this paper.

IT'S GETTING DRIER? PALAEOCLIMATIC EVIDENCE FROM COOPER CREEK, CENTRAL AUSTRALIA

MAROU LIS Jerry

University of Southern Queensland

Session – C3C

The Cooper Creek floodplain in semi-arid southwest Queensland, central Australia, represents one of the most unique and perplexing riverine environments in the world. The exhibited river patterns and channel processes continue to contradict and confound established models of river hydrology and river behaviour developed in other well-watered areas of Australia and of the northern hemisphere. At ground level, the vast, flat desolate landscape of the Cooper Creek floodplain is in stark contrast to the spectacular and intricate river channel patterns evident from aerial imagery. In addition, sub-surface excavations and extensive dating of sediments reveals evidence for river behaviour and climates quite different to the present. This paper presents palaeoclimatic evidence of climate change over the past million years for the natural history of the Cooper Creek floodplain and riverine environment in southwest Queensland and poses some challenging questions about current/future climate change.

GIS-BASED DECISION SUPPORT SYSTEM FOR CONJUNCTIVE IRRIGATION MANAGEMENT IN INDIA

MARR Andy¹, RAUT Ashok², BANSAL Anish³, VERMA Visnu⁴

SMEC Australia North Sydney International¹, SMEC International Australia², SMEC India³, Uttar Pradesh Department of Irrigation⁴

Session – B2F

Uttar Pradesh, the most populous state of India, is endowed with immense water resources. Himalayan snowmelt feeds perennial rivers, while a deep alluvial aquifer underlies the vast plains. Over the past century, one of the largest canal irrigation systems in the world has been constructed, supporting predominantly rice-wheat cropping. Sustainability of agriculture in irrigated areas is threatened by water-logging, with resulting soil salinity-sodicity in some areas. Ground water depletion is also occurring in some areas. As part of a broader World Bank-funded water sector restructuring project, SMEC was commissioned in 2004 by Irrigation Department to

develop a Decision Support System (DSS) for basin planning on a 600,000 ha pilot area. Spatial and time-series data are managed in an ArcHydro geodatabase. A specially developed model of canals, soils and shallow ground water simulates hydrological and other processes over the command area on daily, weekly and seasonal time-steps. Salient features of the model are rainfall-runoff module, cropping pattern design and crop water requirement, canal seepage, groundwater recharge and irrigation shortage, post-processor economic module, seamless integration of the model with the geodatabase and customized GIS-based user-friendly GUI. In this paper, the model concepts are elaborated with several graphic illustrations. A few typical scenarios are discussed to demonstrate the model application in basin planning.

RANKING AND APPORTIONING A COST SHARE TO CATCHMENT SCALE ENVIRONMENTAL WORK PROGRAMS

MARTIN Finlay

Lachlan Catchment Management Authority

Session – A2C

As part of implementing environmental onground works programs in the Lachlan Catchment, a project called Boorowa River Recovery offers incentives for priority onground works in targeted sub catchments for riparian restoration and problem willow removal. In association with this, a useful methodology was developed for prioritizing projects that ranks them in order of effectiveness to meet designated targets and determines the public and private cost share arrangement. This contestable allocation process called the Environmental Services Ratio (ESR) uses transparent and evidence based indices to compare projects. By using a matrix of available data and rapid collection of data on-site, similar projects in different parts of the catchment can be compared. Better projects gain a higher ranking and a greater proportion of project funding with lower ranked projects funded at a reduced rate or culled to enable maximum return on investment at a catchment scale. The ESR process was well accepted by project applicants and coordinators alike, as it was transparent, and resulted in improved project understanding and natural resource management appreciation.

MANAGING URBANISING CATCHMENTS FOR WATERWAY RESILIENCE

MATHEWS Maurice

Maroochy Shire Council

Session – B4B

It is generally accepted that the catchment urbanisation process inevitably creates adverse changes to the quality and quantity of stormwater runoff to streams. However, while there has been much activity to attempt to mitigate these impacts, there are few

examples of successful intervention in terms of maintenance of pre-development water quality at both stream and catchment level. Urban stream syndrome is a widely recognised phenomenon. Other researchers have noted that retro-fit control measures in segments of degraded catchments are unlikely to be successful, and hence prevention of degradation is better than cure. Accordingly, it is clear that implementation of effective erosion and sediment controls and accompanying water sensitive urban design features is essential at the very beginning of and throughout catchment urbanisation, and across jurisdictional boundaries. This may be simply impractical: for a start, there are now few, if any "pristine" catchments in the high growth regions of Queensland. There appears to be a gap between what the community expects, as expressed in our planning schemes (usually achieve water quality objectives"), and what best-practice control measures can deliver. These limitations have always been understood within industry ("cant make an omelette without breaking eggs") and now should be openly acknowledged, so that we can move forward to develop new strategies resulting in streams resilient to the urbanisation process.

TRANSBOUNDARY FLOODS IN THE TERRITORIES OF FERGANA VALLEY OF UZBEKISTAN

MAVLYANOV Pulat

Institute of Hydroengeo

Session – B3C

For the last years in a number of cities and villages, on transboundary territories of Fergana valley, flooding processes occur. As a result, basements of dwellings are periodically flooded with ground waters, irrigated lands are been salinated. The soil productivity in this region is reduced and farmers are not able to gather enough crop. The flooding processes on transboundary territories of Fergana valley are caused by particular geological conditions. All the water formed in upper parts of the flow out (in gravel zone) collects at definite places and exits to the surface on lower parts of the flow out (in clay zones). Up to recent years, natural drain provided stabile conditions and did not allow the development of flooding processes. But, nowadays, Kyrgyzstan began the irrigation of upper parts of the flow out. This resulted in increase of water amount at lower parts of the flow out. And at lower parts of the flow out, farmers from Uzbekistan flattened the territory and liquidated the natural drain. Thus, all the water collected here and over flooded the territory. The basements of all dwellings are totally flooded. And this resulted in migration of the population. Field study consisted of the observation of flooded sites, regime wells and measurement of river consumption as well as careful observation of saved drainage system and its efficiency.

MANAGING SOUTH EAST QUEENSLAND'S ECOSYSTEM SERVICES FOR THE FUTURE

MAYNARD Simone, DAVIDSON Andrew

SEQ Catchments

Session – B2E

Ecosystem services are the benefits people obtain from ecosystems. They include the production of food and medicines, the regulation of climate and disease, provision of productive soils and clean water, and landscape opportunities for recreation and spiritual benefits. In response to a growing interest in ecosystem services and their role in supporting the sustainability of South-East Queensland (SEQ), SEQ Catchments has been working to develop a framework for ecosystem services. The Framework aims to provide the tools to enable government, industry, business, non-government organisations and land managers to incorporate the concept of ecosystem services into their current management and planning practices. The SEQ Ecosystem Services Framework is based on the Millennium Ecosystem Assessment established by United Nations Environment Programme (UNEP). The approach has been to identify and map the ecosystems and ecosystem functions occurring in SEQ; establish relationships between ecosystem functions and ecosystem services; map ecosystem services in SEQ; and identify the benefits (constituents of well-being) and beneficiaries of ecosystem services. Possible applications of the Framework can include: informing the review of the SEQ Regional Plan (a statutory plan to guide development in the fastest growing region in Australia); identifying strategic locations for offsets, rehabilitation and restoration, and climate change mitigation sites; identifying potential alternative land uses with multiple values; and guiding the regional application of federally funded ecosystem services and natural resource management schemes. In 2008, work will include finalising the ecosystem services maps; identifying where and by whom ecosystem service benefits are received; identifying relationships between ecosystem services and constituents of human well-being; and applying the framework to specific case studies in SEQ.

THE POTENTIAL FOR TROPICAL WETLANDS TO IMPROVE WATER QUALITY

McJANNET David

CSIRO Land and Water

Session – D1B

With the implementation of Water Quality Improvement Plans (WQIPs) across catchments which drain to the Great Barrier Reef lagoon, there is a need to identify potential 'on ground works' for improving water quality. The preservation and construction of wetlands is often suggested as a means by which to improve water quality as there is a commonly held perception that wetlands are the filters of the floodplain. This perception has arisen from extensive research in agricultural and effluent disposal fields that has shown that wetlands can be used to greatly improve water quality. Much of the existing research has been undertaken in highly managed

systems where the flow and volume of pollutants can be monitored and controlled. Very little is known of potential for natural wetlands, particularly those in the tropics where flows are very seasonal and extreme in nature, to improve water quality. In response to this lack of knowledge and the need to assign future funds for on ground works, we have established a field instrumentation program which is monitoring the water and nutrient balances of a naturally occurring wetland on the floodplain of the Tully River in tropical north Queensland. Initial results from this monitoring will be the basis for this presentation.

ADAPTIVE MANAGEMENT OF A CRUCIAL WATER SUPPLY SOURCE IN A BIODIVERSITY HOTSPOT

McKIERNAN Steven

Conservation Council of Western Australia

Session – D1C

Water in the Gngangara Groundwater Aquifers is crucial for a wide range of wetland ecosystems, supplying approximately 60% of public water supply for 1.5million people, irrigation water extraction estimated at 200Gl.yr⁻¹ and plantation forestry in the biodiversity hotspot (1) of the south-west of Western Australia. The draw of water from the aquifers has steadily increased since the relatively wet-climate 1970's. The impact of climate change and future climate predictions for the south-west of WA has made the continued high levels of water extraction unsustainable, resulting in wetland loss, eutrophication, acidification of groundwater due to acid sulfate soils, vegetation death and fauna loss. This paper examines the statutory mechanisms put in place by the WA Government and the responses by differing agencies to adaptively manage the draw of water. It examines the proposal for a 2 year \$A7 million Gngangara Sustainability Strategy and the implications for the continued viability of wetlands and groundwater dependant ecosystems across the 2,200 km² that overlay the Gngangara Aquifers. The paper proposes an alternate management emphasis that focuses upon the unique 'Sense of Place' (2) of the Swan Coastal Plain, and calls for immediate reductions in groundwater extraction while promoting water literacy.

BASIN SCALE DROUGHT MANAGEMENT IN KIRINDIOYA RIVER SYSTEM

MEEGASMULLAGE Sirisena

Ministry of Irrigation and water Management

Session – D1C

This report through a case study of the Kirindi River system, provides evidence of the uncertain and inadequate inflow in to the reservoir due to climatic variability-drought, and their impact on to the seasonal planning, agricultural production and to the economic development in the project. It examines, irrigated agriculture combined many parallel functions, meeting basic domestic needs, sharing water resources with industries, townships, generating hydro electricity, fisheries, wild life habitat, environmental preservation with the increasing population. It also reveals the coping mechanism adopted by the agency officials and stakeholders, in alleviating the negative impact of the water stress situation, was the both parties agreed decision making system and the higher management efforts done by the Project Management Committee. It consists of the team work, close communication and consultation between and among the stakeholders and agency officials, combining with improved cultivation practices and innovative ways to save water, and the motivation changes of appropriate parties through awareness and training. There is a large potential of water resources development and rural development in any of the water sheds, if it is managed by the community organized groups with the highly motivated people.

BUILDING THE CLIMATE RESILIENCE TO RIVERS IN SRI LANKA

MEEGASMULLAGE Sirisena

Ministry of Irrigation and water Management

Session - Poster

Climate change is very likely to increase the frequency and magnitude of extreme climate variability, such as droughts, flash floods and storms. These strongly affect the river system and also indirectly affect water related hazards. Now, economic and insured damages have increased manifolds compared to the 1960 decade. 2004, tsunami inflicted US\$ 12 billions of economic damage, including river systems and 40000 fatalities in Sri Lanka alone. This poster will show how focus on attitudinal change can make people building climate resilience in to rivers in Sri Lanka. "The

National Committee Integrating Environment and Development Policy" promulgated in 2004 under new government set in motion a complete change of highly centralized system in order to devolve management responsibility to the river basin. The new system has adopted many instruments for floods and drought management strategy, such as river basin plan, water management plan adopting holistic Integrated Flood Management approach, which allows for coordinated massive public investments instead of fragmented, partial interventions implemented through deferent departments. This is coherent at all levels, national or local, maximizing the net benefits from flood plains and minimizing loss of life from flooding and droughts, balance economic development and preservation of ecosystem services.

ENVIRONMENTAL FLOWS: LEGAL POSSIBILITIES IN BRAZIL

MENESES CARDOSO DA SILVA Luciano, TOSETTO VENTURA DHALTON Luiz

National Water Agency

Session – C3B

This paper discusses the legal possibilities for environmental flows implementation in Brazil. Since the promulgation of the National Water Resources Policy – NWRP, in 1997, the continental waters have been treated basically as a resource, that is, an anthropocentric and utility good. For example, the NWRP doesn't regard the management of water for ecosystems protection, but only to human supply (drink water, industry, irrigation, mining, electricity, etc.). At the same time, the NWRP determines that water resources management must be integrated with environmental management, which is based upon the National Environmental Policy, promulgated in 1981. Recently, some ways to integrate these policies have been studied. This paper concludes that the most promising way is the agreement about environmental flows among decision makers from both policies. This agreement would take place in the Water Resources Plans, one of the NWRP's instruments. This challenge requires a technical, legal and institutional endeavour which has no precedents in both policies. Based on the current legislation, this agreement probably becomes the only way to implement the environmental flows in Brazil and to aggregate ecological concerns to water resources policies.

MERSEY – THE RIVER THAT CHANGED THE WORLD

MENZIES Walter

Mersey Basin Campaign

Session – A4

The Mersey played a key role in the development of global trade and the industrial revolution. By the nineteen eighties it was severely polluted and famously described as "a disgrace to a civilised society". By 1999 its transformation was recognised worldwide through the accolade of the inaugural World Riverprize being awarded to the Mersey Basin Campaign. This case study will draw out the critical success factors and the challenges for the next twenty five years in delivering sustainable development in the Mersey Basin.

A RISK-BASED ASSESSMENT OF THE VALUE OF WATER IN MINING

MORAN Chris, EVANS Robin, KRISTINA RINGWOOD Rio Tinto

Sustainable Minerals Institute, University of Queensland

Session – A3F

In many situations mines must access water outside water markets. There is a need to understand and quantify the value of water so that business needs (securing water at a reasonable cost) can be met without compromising company sustainable development goals. To meet the latter it is necessary to take into account the social, cultural, spiritual and environmental services the water provides as well as its production value. On top of this a full estimate of true costs is needed. A process was developed to quantify the value of water across a range of operating environments in Rio Tinto around Australia. By establishing a register of "difficult to value issues" and embedding these in a risk assessment process it became possible to answer well posed questions regarding the value of water. This process has been implemented in a practical tool to assist decision makers take account of the full costs of water in deciding the best course of action to secure supply. Examples are provided from aluminium, iron ore, coal and base metals mining in a range of environments where river protection and community respect are central to maintaining the social license to operate mines.

ARID AND SEMI-ARID REGIONS' RIVER UNDER STRESS: THE CASE OF KAROUN RIVER IN WEST OF IRANMOTIEE Homayoun¹, NADIM Farhad²Power and Water University of Technology (PWUT) ¹, University of Connecticut, Department of Civil and Environmental Engineering²**Session – D1C**

Originating from the Zagros Mountains in western Iran and discharging into the Persian Gulf, Karoun is the main source of water supply for southwestern part of Iran. With the length of 840 km and average annual flow rate of 450 – 500 m³sec⁻¹, Karoun has the highest flow rate of all rivers in Iran. The total fresh water balance (surface and groundwater) in Iran is estimated at 100 to 130 × 10⁹ m³, of which, the Karoun River accounts for 20 to 25 × 10⁹ m³ of this water balance alone. Hydraulic structures constructed for hydropower (large reservoir dams), plant, irrigation, domestic and industrial water supply, and water transfer systems built in upstream sections of Karoun to transfer water to arid and semi-arid regions of central Iran have significantly changed the hydrologic and hydraulic behavior of the Karoun River. With an introduction on river systems under stress in arid and semi-arid parts of the world, this paper focuses on factors that disrupt the natural purification and filtration of Karoun, particularly during drought periods. River water pollution, sedimentation, and salt intrusion are also discussed to shed light on the factors that place the health of the population living in cities located on the banks of Karoun at serious risk, and factors that destroy the natural ecological system of this river. In the conclusion section, recommendations are made on actions and methods that can be utilized to revitalize the Karoun River and minimize the anthropogenic impacts.

A NEW PARTNERSHIP FOR ESTABLISHING WATERWAY ECOLOGICAL VALUES AND PRIORITIES FOR PROTECTION

MOULTON Dane, PLATTEN John, ZANN Maria, CONNOLLY Niall, BENNETT John, WATSON Fiona, HEWAVISENTHI Cham, KELTON Mark, NOLAN Vince

Queensland Environmental Protection Agency

Session - Poster

The Australian National Water Quality Management Strategy (NWQMS) details a water quality (WQ) management framework that underpins environmental protection policies for water (EPPW) in all Australian States and consequently, water quality management plans for catchments around Australia. In Queensland, the Environmental Protection Agency (EPA) has legislative responsibility for the EPPW which includes a schedule for environmental values [EVs] (i.e. waterway values and uses) and water quality objectives [WQOs] (i.e. WQ targets) for Queensland waterways. The process of working with communities to establish the values and uses for their waterways is a key step in the WQ management process. Human uses and values (e.g. recreational and primary industry uses) are straightforward to establish. However, for ecological values, the community needs to be given information on the specific values to be able to understand what needs to be protected and improved. Over the last three years, the Australian Government, through its Coastal Catchment Initiative, has contracted regional natural resource management bodies to develop WQ Improvement Plans in five Great Barrier Reef basins/catchments (Tully, Ross-Black, Burdekin, Mackay-Whitsunday and Burnett-Baffle), using the basic process in the NWQMS's WQ management framework. The EPA has taken this opportunity to work with these regional bodies in establishing the EVs and WQOs for their waterways with their catchment communities. A key component of the EPA's contribution is assisting with the process and information used for establishing ecological values and, from these assessments, identifying high ecological values (HEV) waterways for protection. The process for identifying HEV waterways is based on nationally agreed criteria (e.g. diversity, rarity, naturalness, representativeness and special features). However, in Queensland, the key limitation is in the data available on relevant measures for indicators of the criteria. Hence, expert workshops are a key component of the process. The EPA's assistance is firstly with collating the available information and establishing a GIS product that can be used interactively with technical experts at the workshops. The EPA then assists with running and reporting on the workshops with the experts, then in taking these outputs to public consultation meetings and finally in reporting on the whole process. This paper will provide background to this process; outline the process used in establishing the ecological values and HEV areas by the EPA and the regional bodies; analyse the benefits of the process and the products for waterway planning and management; and show the benefits of working with the community in not only establishing ecological values and HEVs but also in developing management actions to protect them.

EXAMINING THE IMPACT OF CLIMATE CHANGE ON RESERVOIR RELIABILITY

MUJERE Never

University of Zimbabwe

Session – C3C

This paper presents results of a study conducted to evaluate the possible impacts of climate change due to doubling of atmospheric carbon dioxide (CO₂) on the reliability of Mazowe reservoir in Zimbabwe. The reservoir supplies most of its water to citrus plantations. Thirty years (1961-1990) of hydrological data (reservoir inflows) and meteorological data were collected from the Zimbabwe National Water Authority (ZINWA) Department of Meteorological Services respectively. Outputs from the Canadian Climate Centre (CCC) model for the 2CO₂ temperature and rainfall scenarios were used in the study. The Penman model was used to calculate potential evapotranspiration while reservoir catchment runoff was simulated using the Pitman lumped conceptual model. Research findings revealed that doubling of CO₂ would significantly increase mean annual temperature by 3°C, potential evapotranspiration (11.8%), rainfall (15%), runoff (36.9%) and reservoir yield (20.4%) at the 10% risk level. Based on the research findings, appropriate mitigation measures should be employed to minimise high rates evaporation from the reservoir. On the other hand, the predicted high reservoir yield requires an increase in water use activities such as extension of irrigated area.

HEAVY METALS POLLUTION IN THE SHAR CHI RIVER (URMIA IRAN)

NANBAKSH Hassan

Urmia University of Medical Sciences

SESSION – Poster

Heavy metals are the significant pollutants in the rivers due to their toxicity and potential to accumulate in the environment. Shar Chai River is the biggest river in the Urmia Northwest of Iran. The aim of this study was to assess heavy metal contamination (As, Zn, Pb, and Cr) at various times over one year and compare with WHO drinking water guidelines. Along the Shar Chai agricultural, urban and industries drain their wastewater into the river. Samples were collected from six stations along the river, from April 2002 up to March 2003. Heavy metals concentrations were measured by graphite furnace atomic absorption spectrometry. Results showed that the annual minimal, maximal, mean and standard deviation concentration of lead in site1 and 6 were 0.009, 0.17, 0.05, 0.079 mg/l and 0.012, 0.2, 0.07, 0.081 mg/l respectively. The seasonal mean concentration of lead in summer and autumn was 0.11, 0.12 mg/l respectively. In comparison, all remaining heavy metal results are relatively low and well below international standards. Analysis of the relationship between pH and concentration of metals in the river water (As, Zn, Cr, Pb) showed that lead displays a slightly higher correlation with pH. Findings also showed that the concentration of lead displayed greater seasonal variation than the other metals investigated. It is concluded that it would be an advantages to store water in a reservoir during winter in order to reduce lead concentrations in the drinking water.

IMPACT OF GEM MINING ON A RIVER IN SRI LANKA

NANDALAL K D Wasantha

University of Peradeniya

Session – A3F

Sri Lanka has been famous for its great variety and abundance of gems. Gem mining activities have been practiced for centuries and presently are increasing due to growing demand. Several hundred thousand people are engaged in this foreign exchange earning industry. Gem mining methods practiced are pitting and riverbed mining. In pitting, about 5 to 15 m deep shafts are excavated and tunnels are made to collect gravel around its base, which is washed and examined for gems. Though it is illegal to leave pits unfilled at the end of mining, most miners leave behind unfilled pits and heaps of soil, which destroy environment and breed mosquitoes. Also, miners dump earth, sand and rubble into rivers without any concern to environment. In riverbed mining, gems are mined from riverbed material either manually or using suction pumps. It makes the river bed deeper and wider. Rivers get severely damaged due to excavation and deposition of excavated soil in a haphazard manner. Implementation of rules and regulations to control damage to rivers has not been successful. Based on a study carried out on impacts of gem mining on a river, systematic measures that could be adapted to sustainable development of the gem industry with minimum damage to the river are proposed.

RIVER OF RICHES-STUDY OF GREAT FLOOD PLAIN RIVER: GANGES

NANDY Supriyo

Moksha

Session – B4C

The paper tries to evaluate how India's biggest challenge in sustainable development will lie in the ways it learn to use the Indo-Gangetic flood plains, which have the potential to feed not just India but large parts of Asia. The ecologically appropriate water utilization model is yet to be developed, but the region's rich traditions should provide some useful pointers. However, to use this rich annual Tift appropriately, what is also needed is political will and discipline. Dams and embankments have now become an important cause of floods. With the meltdown of the Himalayan glaciers, embankments tend to break when river rises suddenly. According to Sir William Willcock's account of 1920 the silt laden Himalayan flood waters not only enriched the soil and provided bumper crops but the fish brought down by it kept malaria down. The British steadily destroyed the system by making permanent embankments. Traditional irrigators, regularly breached embankments to draw flood waters down canals to every field and pond. But the British made breaching illegal and reduced productivity in most districts of Bengal resulting the infamous famine. Willcocks' analysis certainly needs to be sharply debated in these days of 'sustainable development', of this great flood plain river.

CHOOSING FORAGES TO IMPROVE WATER USE EFFICIENCY FOR DAIRY PRODUCTION

NEAL James

The University of Sydney

Session – B3B

Potential milk production of Australian dairy farm systems is directly related to the dry matter yield utilized, and nutritive content of the forages grown. In the production of forages, the dairy industry is the second largest user of irrigation water in Australia, using some 19% of all irrigation water, in doing so, irrigated dairy production contributes some \$1.63 billion to the Australian economy. Irrigation water is becoming increasingly scarce and more expensive, with water shortages due to drought on the Murray system reducing water allocations to 5% of water right in some areas at start of irrigation 2007/08 season, with temporary water trading prices exceeding \$1000/ML. These water shortages have placed increased pressure on farmers to use irrigation water as efficiently as possible and, as a result, forage water use efficiency (WUE) has become an important performance indicator for sustainable dairy production. While perennial ryegrass is the dominant forage used for irrigated dairy production, there are numerous alternative forage species which can be used as a source of fodder, although basic information on seasonal and annual water use characteristics are lacking. Thus the objective of this study was to evaluate the yield and WUE of 30 forages, under optimum and deficit irrigation. Not only is there a 2-3 fold variation in yield between forages under optimum irrigation, but there is a 2-3 fold difference between potential pasture yield and what is currently being utilised on the average irrigated dairy farm. Similarly on a seasonal basis there is up to 4 fold difference in WUE between forages, but also there is also 2- 3 fold difference between potential forage WUE and, that which is being realised on the average irrigated dairy farm.

LANDSCAPE CHANGE – IS IT WORTH THE PAIN?

O'KANE Bill

Goulburn Broken Catchment Management Authority

Session – B2D

The Goulburn Broken Catchment Management Authority's regional catchment introduced the concept of Landscape Change in 2003. To quote from the Strategy: *"We need to supplement our existing efforts, the best management approach alone, will not deliver the outcomes we seek. We have identified landscape change as the new direction for the next five years. Our existing programs remain very important and will be continued; and if funds are available – accelerated. We must look to new ways of addressing some of the most intractable issues facing the region such as salinity, biodiversity decline and floodplain management."* This paper looks at the three landscape change projects that have been resolved since 2003: 1. The Lower Goulburn Floodplain; 2. Decommissioning Lake Mokoan, 3. Foodbowl Rehabilitation

Project. The paper will describe the magnitude of the projects and the community anxiety generated by changes of this magnitude. The key issues to be explored are: Can change of this magnitude be achieved without high levels of anxiety?; and Can these anxieties be managed to acceptable levels?

CLIMATE CHANGE AND DRYING DAMS – COMMUNITY ACTION TO IMPROVE WATER SECURITY IN RURAL KENYA

OGONJO Olita¹, ONYANGO OKAKA Michael², ALLETSON Tom³

Tweed Kenya Mentoring Program¹, Gona Safe Water Users Association², Tweed Shire Council³

Session – B4E

The Alego areas in the southern part of Siaya district of western Kenya is water stressed, and as a result several Yawo (local name for dam or pan) were constructed by Government and have become an important source of water for the people of the area. The few rivers in this region have dried out due to deforestation, farming and settlement activity. Wells and boreholes have been sunk by the Government, NGO's and individuals but the water is often saline. Communities who rely on the Yawo as a sole source of water are affected by diseases associated with poor water quality. This is because the dams receive contaminated runoff from their catchment and also serve as the water supply for cattle herds. At Gona Yawo the community is now able to purify its water supply with a micro-filtration system, however the dam itself has dried out. There is an active campaign to install additional water purification units at more Yawo in the locality, via the Tweed Kenya Mentoring Program. This paper will present the social, environmental and engineering work necessary to tackle the problem of water supply uncertainty in semi-arid landscapes where water supplies and communities are most vulnerable to increasing impacts of climate change.

REGULATION OF RIVER FLOW MAINTAINS HEALTH IN THE BARRON GORGE

OLDS Andrew, THOROGOOD John, THORBURN Lauren, MORTON Ashley

Frc Environmental

Session – B4D

Flow in the Barron River is regulated by the operation of the Barron Gorge Hydro Power Station. Water is diverted to the station from the Barron River at the Kuranda Weir, and returned to the river below the Power Station. To maintain the connectivity and health of aquatic communities in the gorge, Stanwell Corporation Limited (SCL) manages the release of water from the weir to the Barron Falls. Frc environmental assessed the likely impact of power station operation on the ecosystem health of the river in response to the draft ROP, and have monitored the health of aquatic communities in the gorge, since 2004, to assess the adequacy of the environmental release. Locations above, within, and below the Barron Gorge are surveyed annually. Water quality, in-stream habitat, riparian and aquatic flora, macro-invertebrate and fish communities are surveyed at each location. To detect changes to aquatic communities over time, data are analysed with a range of univariate and multivariate analyses. Monitoring has found no decline in the health of aquatic communities, and indicates that the regulated environmental flow is sufficient to maintain connectivity and ecosystem health in the gorge. Ongoing targeted monitoring and assessment will support and direct adaptive management in a future of extreme rainfall and flow events.

LAKE CHAD: A STUDY OF A DRYING FRESHWATER BODY

ONYEKAKEYAH Luke

Guardian Newspapers Ltd

Session – D1E

Concern that the capacity of the Lake Chad to provide adequate water supply has drastically reduced in the last three decades led us to investigate what management actions have been employed to ensure sustainable use of the shared water system. Lake Chad is Africa's fourth largest lake with a maximum length of 25,000 km² from a previous 388,500 km² some 600,000 years ago. During the last four decades, the Lake has been susceptible to increasing variability and irregularity in rainfall. Dry spell, excessive evaporation and sandstorm have impacted negatively on the water body. Consequently, the Lake has shrunk appreciably by up to 80 per cent in 1985 but reaching 19,000 km² in 2001. Given the critical importance of the Lake, its capacity to ameliorate extreme aridity in a desert ecosystem, the Lake as a source of livelihood support to more than 20 million people, the Lake Chad as habitat to a wide range of

biodiversity, we assessed relevant case study and references from accessible documentation pertaining to the Lake. We found that the Lake is under severe stress rising from several factors, which include drought. To reverse the trend and ensure sustainability, a deliberate and coordinated international action is required.

WATERSENSE: REDUCING WATER USE IN THE U.S. VIA MARKET TRANSFORMATION

OTTO Betsy

American Rivers

Session – A3C

Launched in 2006, WaterSense is an effort of the U.S. Environmental Protection Agency to build the market for water-efficient products. In a country where many leaders and the public are just waking up to the need to conserve water, and where marketplace strategies are generally preferred over regulatory ones, the program has tremendous interest. WaterSense seeks to make it easy to purchase water-efficient products by partnering with manufacturers, distributors and retailers of plumbing fixtures, irrigation systems, and water-using appliances. The program develops technical performance criteria and seeks to build broad consumer awareness of the label, works with manufacturers and retailers to certify their products, and encourages utilities to provide incentives to consumers to buy labelled products. USEPA is also developing specifications for a "WaterSense for New Homes" label to include advanced indoor and outdoor water-saving techniques. WaterSense is modeled on the successful U.S. ENERGY STAR efficiency labelling program that saved consumers \$14 billion on energy bills in 2006 with only \$50 million in government expenditures. American Rivers works to protect natural river flows. We serve on the advisory board that helped create WaterSense and we have a unique perspective on the benefits and failings of the WaterSense approach.

LESSONS LEARNT FROM AN INTERNET BASED PUBLIC FLOOD WARNING SYSTEM

PARKINSON Tyrone

Wallingford Software

Session – C2B

This paper describes the public flood warning system provided by Vlaamse Milieumaatschappij (VMM), the Environment Ministry of the Flanders Regional Government, for the citizens of the Flanders Region of Belgium and all public and private organisations involved in flood preparedness, flood fighting and disaster relief. The system comprises numerous and disparate technologies from fields of instrumentation, communication links, disaster tolerant multi-processor computer hardware, computational modelling and mapping and the Internet. These technologies are commonly found in modern flood warning systems throughout the world. However, there are certain key aspects of the way these technologies have been used by VMM that differentiate their system from any other. Of particular interest is: the detail of the hydrological modelling, generating runoff forecasts for sub-catchments as small as 55ha; the use of long range rainfall predictions from both deterministic and ensemble forecasts; generation of 1m resolution flood inundation maps; and the dissemination of very detailed warning products via a public web site. Allowing the general public intimate access to the forecast system inputs, results and maps has significantly raised awareness of flooding generally, the specifics of the flood warning process and the pro-active role of VMM in providing advance warning of flooding.

SMALLHOLDERS' CONTRIBUTION ON CLIMATE CHANGE MITIGATION AND WATER QUALITY

PASA Arturo

College of Forestry and Natural Resources, Visayas State University

Session – C3C

A study was conducted to assess carbon storage and water quality within the 2,236-ha Community-Based Forest Management (CBFM) Project in Cienda, Gabas, Baybay, Leyte, Philippines. Results revealed that the CBFM project area stored an average amount of 333.28 Mg.ha⁻¹ carbon from aboveground biomass down to the soil complex (0-1m depth). The upper storey biomass had an average carbon density of 166.146 Mg.ha⁻¹ while 1.94 Mg.ha⁻¹ for the understorey biomass. Floor litter carbon density ranged from 1.27 Mg.ha⁻¹ to 2.69 Mg.ha⁻¹, root carbon density from

11.03 to 17.43, and soil carbon density from 111.14 to 221.73 Mg.ha⁻¹. On the average, streamflow velocity was 0.30 m.sec⁻¹, streamflow volume 0.32m³/sec, turbidity 2.96 ntu and the associated sediments 16.0 mg.L⁻¹. Odor and taste were unobjectionable. pH ranged from 7.50 to 7.0 while total hardness from 7.84 to 15.16 mg.L⁻¹. The average nitrite (NO₂) content was 11.115mg.L⁻¹ while nitrate (NO₃) was 1.05 mg.L⁻¹. The concentration of nutrients was also very low. Phosphorous (P) ranged only from 2.20 to 4.46 mg/kg or parts per million (ppm) while potassium (K) ranged from 3.71 to 3.90 ppm. Sodium (Na), calcium (Ca), and magnesium (Mg) concentrations were also very low. Heavy metals were detected but also at low concentrations. The huge amount of stored carbon and the superior condition of water within the CBFM project is attributed to the smallholders who are protecting the area against illegal logging, slash and burn farming and river poisoning. Rewarding smallholders for their environmental services is viewed as an important element in sustaining the CBFM Project under this study.

DEVELOPING MAPPING TOOLS TO IDENTIFY FLOOD VULNERABLE FEATURES FOR EMERGENCY RESPONSE

PAYNE Jennifer, **WALTERS** Michael, **DU** Peng, **BENNET** Janice, **HOGENBIRK** Tom

Lake Simcoe Region Conservation Authority

Session – C2B

In recent years the frequency of significant flooding events has increased within highly populated urban centers within the Lake Simcoe watershed. Recognizing the need to minimize the risk of potential loss of life and property damage a method to identify flood vulnerable buildings and infrastructure under a variety of model storm scenarios was developed. The method combines Hec-Ras computer modelling and GIS applications to provide a tool which can display the flood vulnerable buildings, existing municipal and private infrastructure, and quantify the flood water elevation and velocity. The tool has become invaluable to municipal Emergency Management Systems Coordinators in the development of emergency and flood control plans. Some specific applications involve the creation of evacuation plans including developing safe transportation routing, and flood protection planning to address and flood-proof where possible significant infrastructure. The insurance industry has also expressed interest in using the tool to reduce their capital risk associated with structures located within establish floodplains. The technology involved in developing the methods and tool can be easily transferred and adapted for use anywhere in the world.

UPSTREAM MINING IN THE SEPIK RIVER, PAPUA NEW GUINEA

PETER David

WWF Papua New Guinea

Session - Poster

The Sepik River in Papua New Guinea (PNG) is one of the largest pristine rivers in the Asia/Pacific region with high biological significance. The River travels for 1,126 km before draining into the sea covering a catchment area of about 80,000km² which includes six provinces in PNG and West Papua Province of Indonesia. There are about 430,000 rural people representing well over 110 languages groups within the catchment that depend mostly on the river for their survival (food, water and transport). The Sepik River has a number of tributaries and over 150 lakes and oxbows, which are important breeding and feeding grounds for crocodiles and migratory birds. Recently a huge mine has been proposed in one of the major tributaries of the Sepik by the government but environmental groups such as WWF have been working with the local communities downstream to stop the mining from proceeding without having in place proper environmental management plans. The downstream communities felt that they would not benefit from the mining in anyway but would suffer severely from environmental pollution from the mine so they formed forces to campaign against the mine. Consequently, the government made a decision to delay development of the mine until proper environmental plans are in place. In the meantime, WWF and its partners are developing a catchment management plan to address to such threats within the Sepik River basin.

PROVIDING ENVIRONMENTAL FLOWS THROUGH INCREASED IRRIGATION PLANNING

PETHYBRIDGE Matthew

Goulburn-Murray Water

Session – A2D

Environmental flow requirements of priority unregulated rivers and creeks in Victoria will be provided for by the development and implementation of Stream Flow Management Plans (SFMP). Meeting these requirements will mean that restrictions on the extraction of water will occur more often, limiting access to water, during Victoria's dry summers. In order to maintain current irrigation production, work on viable onfarm adjustment options is needed for irrigators, both to secure reliability of supply to targets through the planning process and to minimise potential socio-economic impacts to the viability of communities. Adjustment options that are likely to succeed are those which not only save water but, are affordable, maintain productivity and can be readily incorporated into existing farming systems. This paper looks at an irrigation trial within the Upper Yea River catchment in Central Victoria conducted with the irrigation community to assess the relative benefits of using drip tape irrigation against traditional sprinklers on high value horticultural crops. The aim will then be to build community confidence and aid the development of a co-investment package for affected users to maximise benefits for the environment, community and irrigators by providing for environmental flow requirements whilst also helping to address broader catchment planning objectives.

THE TRAFFIC SAFETY AND ENVIRONMENTAL PROTECTION FOR THE NAVIGATION CHANNEL IMPROVEMENT PROJECT OF THE LANCANG-MEKONG RIVER.

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LaoNational Mekong Committee

Session – C3D

The Lang-Mekong River is an international river in Asia that links six countries, namely, China, Laos, Myanmar, Thailand, Cambodia and Vietnam with the total of 4,880 km length. The waterway transportation development costs the least investment and gains the most to all the riparian countries. Waterway is the most environmentally sound mode of transport. Therefore, meanwhile, following the signed Agreement on "The Navigation improvement on the Lancang-Mekong River Project" the Government of China, Laos, Myanmar and Thailand had eventually completed to regulate mostly some main rapides, shoals and scattering reefs from borderline between China, Myanmar, downwards to Chieng Sene (Laos-Thailand frontier). Anyhow, nevertheless the aids to navigation installation work have been partly made to improve the navigability of the Lancang Mekong River for safe navigation. The harmonization of aids to navigation is broadly being discussed among the riparian countries. Besides the environment protection is the key issue to be identified clearly, particularly a solid scientific report on the Environment Impact Assessment (EIA) should be carried out with a comprehensive study. Moreover, two trials of petroleum transport have recently been undertaken from Chieng Sene (Thailand) to Kuane Lei (China Yunnan). The mentioned oil transport could further proceed while the reliable information would be provided. The two late pending issues are being largely taken up to the world for comments, suggestions and questions.

WHAT IS SO SPECIAL ABOUT THE MARY RIVER AND ITS THREATENED ECOLOGICAL COMMUNITIES?

PICKERSGILL Glenda, BURGESS Steve, WEDLOCK Brad

Save the Mary River Coordinating Group

Session – B2D

The Mary River catchment is home to many internationally and nationally threatened species. It has been identified as an aquatic biodiversity hotspot containing unique endemic endangered species. Australia has a responsibility to rehabilitate and restore degraded ecosystems, and to promote the recovery of threatened species, rather than allowing additional threats to incur on these species through environmentally damaging projects. To do this requires quantitative data on the species' population size, structure and dynamics, its areas of occupancy and critical habitats (feeding and breeding areas) that will be affected, and comparisons with past records or with other known populations. Without quantitative data or knowledge of its population ecology in the area, there is no way of assessing the risk of extinction should a project go ahead and therefore no meaningful assessment of impacts or

mitigation / management of environmental flows. This presentation will use the proposed Traveson Crossing Dam as a case study to demonstrate how this poses an additional threat to incur on these threatened ecosystems in the face of climate change. An alternative catchment based approach is proposed for water security to achieve a better overall outcome for SEQ and threatened aquatic ecosystems of the Mary River catchment.

CONSERVATION FOR RESILIENCE: GLOBAL AND LOCAL PERSPECTIVES WITH SALMONPINKSY Malin¹, SPRINGMEYER Dane², GOSLIN Matthew³, AUGEROT Xanthippe⁴Stanford University¹, Riverchange GeoSpatial², Ecotrust³, Pangaea Environmental, LLC⁴**Session – B4E**

Conservation planning for climate change is particularly difficult in freshwater ecosystems because data on species are sparse and typically limited by political boundaries. Ideally, one would focus conservation efforts on populations most likely to show resilience to future climate impacts. To begin to identify such populations for six species of Pacific salmon (*Oncorhynchus* spp.), the Wild Salmon Center compiled abundance and life history data from Russia, Japan, Canada and the United States for 1046 catchments of the North Pacific. We then developed methods to interpolate missing data and calculated a proxy measure of population resilience. The set of catchments with high potential resilience stretched from California to northern Russia and was concentrated in areas with limited agriculture and dams. Degree of human influence (as measured by agriculture, dams, hatcheries, and protected areas) explained a small ($r^2=0.29$) but significant ($p<0.00001$) amount of the variation in potential resilience. We simulated uncertainty in our own data, but found that the set of highly ranked catchments changed by less than 3%. The abundant and diverse salmon populations identified by this analysis provide initial guidance on where to focus proactive salmon conservation efforts to provide resilience to the species in the face of climate change and other stressors.

FRESHWATER CONSERVATION & CLIMATE CHANGE ADAPTATION LESSONS FROM WWF PROJECTS

PITTOCK Jamie

WWF & Australian National University

Session – A3E

WWF has assessed the conservation, socio-economic and (unplanned) climate change adaptation outputs and outcomes from seven of its freshwater field projects globally. The projects assessed are: wetland restoration at Doncaster, United Kingdom; river flow restoration in the Great Ruaha River, Tanzania; village tank restoration on the Deccan Plateau, India; floodplain lake restoration along the Yangtze River, China; Sao Joao river basin management, Brazil; Rio Conchos river basin restoration, Mexico; and the lower Danube River floodplain restoration. Lessons are drawn from this assessment as to practical means of accelerating climate change adaptation in river basin management. Three key lessons are: a) identify means of adapting to current extremes and enhance implementation of these resilience measures, b) build on existing institutions where possible rather than establishing new ones, and c) facilitate collaboration between relevant stakeholders at different geo-political scales to get the best outcomes.

THE THREAT TO FRESHWATER CONSERVATION FROM CLIMATE CHANGE POLICIES

PITTOCK Jamie

WWF & Australian National University

Session – B4E

Climate change is now commonly regarded as a major threat to conservation and sustainable use of freshwater ecosystems, based solely on the forecast direct impacts of climate change. This paper looks at the non-climate threats to sustainable freshwater management and the likely impacts in climate change mitigation and adaptation policies of additional hydroelectric projects, water storage and transfer projects, and increased biofuel production. Case studies from China, India and Australia are considered. It is concluded that there is a need to compare the likely direct impacts of climate change to other threats to freshwater ecosystems and to the severe impacts likely from the climate change mitigation and adaptation policies of

many governments. This is essential if societies and governments are to better integrate water and climate change management, to focus investments to better sustain freshwater ecosystems and services.

RIVER SAND MINING IN SOUTHERN SRI LANKA AND ITS EFFECT ON ENVIRONMENT

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University of Colombo¹, University of Ruhuna²

Session – B3D

Rapid sand mining in the Nilwala river bed and river bank have caused serious problems to various sectors of natural and anthropogenic environments. The research study aimed to identify corrective and behavior of the environmental impacts in Nilwala river basin due to river sand mining. Nilwala River located in the southern province of Sri Lanka and originates from the Sinharage highland Natural forest. The river is the largest in Southern province of Sri Lanka covering the distance of 72 km. Dug wells in the right bank of the Nilwala river basin were selected to identify groundwater quality changes due to sand mining in the river. GIS package Arc View was used to identify the water quality changes in river and as well as flood plain area. Nilwala river bed degradation from in stream sand mining lowers the elevation of stream flow and the floodplain groundwater table is decreased up to 5-6 meters below mean sea level. Over sand mining of Nilwala River causes many problems like salinization of urban drinking water supply scheme due to the sea water intrusion into the river up to 8 km from river delta and electrical conductivity change up to 2500 micro siemens per centimeter. There are success programs of mitigating river sand mining in southern province of Sri Lanka conducting in Nilwala River. These succeeded due to people's participating and integrating research outputs, following the legal frameworks and Community Based Organizations networking.

VARIATION OF SALINITY IN POLWATHUMODERA RIVER WITH LUNAR PATTERNS- CASE STUDY IN SRI LANKA

PIYADASA Ranjana¹, WEERASINGHE Kariyawasam Don Nandasiri², WEERASINGHE Arachchige Don Chathura Sahan²

University of Colombo¹, University of Ruhuna²

Session – Poster

Distribution and variation of salinity up to 4km were measured along Polwatumodera River during a period of 4 months. Polwatumodera River is located in the Southern Province of Sri Lanka and covering a distance of 28 km. The study area is situated in Weligama and Denipitiya urban areas close to the river mouth. For measurement of salinity variation a new instrument was devised so that salinity could be measured avoiding disturbance of water columns in the river. The results helped in the preparation of salinity distribution along the river using the Arc View GIS software. The results revealed that the salinity and pH distribution was directly related to Lunar Patterns. During the full moon days the EC levels were found to be at a maximum of 60000 μ siemens per centimetres along the river depending on the depth of the river. On new moon days and quarter moon days EC levels were found low than the full moon day and varying between 15000 and 20000 μ siemens per centimetres. As a result of the variations in salinity the groundwater quality in river bank area showed an increase of salinity in dug wells. Groundwater salinity in river bank areas was monitored for a period of 12 months and variation of salinity were mapped using GIS. The groundwater salinity increase directly affected the urban community in the river bank area.

COLLIE RIVER SALINITY RECOVERY – IMPROVING WATER RESOURCES IN A COMPETING ENVIRONMENT

PLATT John, TINGEY Wayne, SPARKS Tim

Department of Water, Western Australia

Session – C4C

Salinisation of the Collie River in the south-west of Western Australia has rendered the river unsuitable for public water supply. Competing for water in the Collie catchment are key industries of mining, power generation, irrigated agriculture, public water supply, forestry and recreational tourism. With good data, good science, extensive stakeholder consultation and using a scenario planning process, the social, economic and environmental issues of managing the catchment for water quality have been identified. Thus, in developing a recovery plan, the trade-offs and

compromises for key stakeholders involved in reaching a river salinity target are understood at the property, catchment and state-wide levels. Negotiation led by the Department with key stakeholders has resulted in a package of potential water resource initiatives that could result in sustainable irrigation, regional industrial water supply, potable water supply and improved environmental outcomes. There are opportunities for public-private partnerships in the implementation of these initiatives. This paper will outline the approach taken, the recovery project, results to date, and how this project has integrated competing values into a unique water resource management opportunity potentially important to the state of WA.

MINING IN THE MIDDLE DON RIVER BASIN: THREATS AND COUNTERACTION

POPOV Sergey

Centre for Ecologic Adversity Counteraction

Session – B3D

The Middle Don River Basin is one of the most important territories for the Russian economy due to significant deposits of iron ore, phosphates and granite. Mining activities cause appreciable damage to agriculture and food quality reduction as well as pollution of Middle Don River System. These pollutants are bioaccumulable so their concentration in fish and other aquatic organisms are not only a biological monitor of environmental pollution, but also as sentinel human health indicator and monitor of potential human health hazard. Within the Middle Don River Basin 521 thousand people live in conditions of polluted water. The Centre for Ecologic Adversity Counteraction (CEAC) is a non-government organization, rendering information, medical and juridical assistance. CEAC founded a water quality research laboratory and worked out new system of human health monitoring in the zones of mining activities. Application of suggested methods contributes to early and complete revealing of ecology caused diseases. The considerable efforts have been made to predict the consequences of putting into commission new mining enterprises and expanding already working ones, initiate public discussion on carrying out certification of wastewaters and production wastes, revising the current sanitary norms and regulations. Environmental degradation and human health hazard are the painful matters for interaction between local authorities and community activists. Only coordination of their activities will allow to get the positive changes of ecologic situation in the Middle Don River Basin. According to present challenges the regional state establishments have to pay more attention to mining-related issues.

ENVIRONMENTAL FLOWS FOR FIGHT AGAINST DESERTIFICATION IN RIVER DELTAS

POPOV Yuriy, STARODUBTSEV Volodymyr

Ecotera Ltd

Session – D1D

Land desertification in river deltas has become a global problem for last decades. Intensive irrigation caused landscapes aridization. Dams' construction and irrigation has instigated water inflow into deltas decrease and landscapes aridization. Productivity of hydromorphic landscapes and their environmental role decrease for the period of 10-15 years. Only measure for desertification prevention is an environmental flow into deltas. We consider this problem on the results of our many-years investigations in Central Asia and analyzing of space images and published materials related with river basins in other regions. In the Ily River delta the terrestrial research and space images analysis have shown that the Kapchagay reservoir creation and irrigation development in China and Kazakhstan have caused fast desertification processes. Serious ecocatastrophe occurred in the lower reaches of the rivers of the Aral Sea basin. Powerful land desertification occurred there in 70-80s. Long-term observations and space images has allowed to zoning this territory according to a degree of landscapes desertification. Fast land desertification in the inland delta of the Chu River has captured in 70-80s the huge territory. Experience of fight against strong salinization and desertification processes with environmental flows take place in deltas of the Colorado, Heihe, Tarim river as well.

UNEXPECTED OUTCOMES: BENEFITS FROM A CATCHMENT SYSTEMS UNDERSTANDING IN THE SOLOMON ISLANDS AND BROADER IMPLICATIONS

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International Water Centre¹, The University of Queensland²

Session – A2E

A research project to develop a systems understanding for catchment risk assessment, with a case study in the Solomon Islands (SI), has now traversed a number of stages. Working with an interdisciplinary team, we have developed a theoretical conceptual framework, applied this through a catchment risk assessment of a SI catchment and developed a model for managers to prioritise actions. The process described so far will be familiar to those working on adaptive management endeavors. What is unique from our experience arises from the cultural complexity of the SI, the challenge of developing a systems model covering socio-economic factors, and unexpected benefits that have arisen through a participatory model development process. This paper explains in detail these unexpected outcomes: the social learning, network building and trust building elements that have emerged. The research has facilitated discussion between parties with long-standing conflict, leading a participant to comment: 'Before the two groups were not talking. Before there was no path through the grass and today we made the first path through the grass. The more it is worn, the clearer the path becomes.' The paper offers a step-by-step process for practitioners to analyse catchment and water systems in an integrated way.

ECOLOGICAL RISK ASSESSMENT OF WATER RESOURCE SYSTEM IN THE HAI RIVER BASIN

QIN Yan, YANG Zhifeng, CHEN Bin

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Session – Poster

To improve the water resources utilization mode of the river basins in northern China, we present an ecological risk assessment model of water resource system using GIS technology, in which the risk sources and endpoints are identified with relativity analysis. Risk sources include the uncertainties of water resources, environmental flows and water for industry and agriculture, while endpoints cover the water quality, reed and *Microcystis aeruginosa*. The proposed ecological risk assessment model aims to assess the relative ecological risk of aquatic environment of the integrated ecological system of river basin according to exposure and effects filters. Then, uncertainty analysis and sensitivity analysis are employed to modify the former results and construct the distributed relative ecological risk of the river basin. With a case study of the Hai River Basin, we classify the concerned river basin into two hierarchies based on the ecological risk assessment results, and thereafter, propose corresponding water resources utilization suggestions according to specific ecological objectives.

ECOLOGICAL LAND CLASSIFICATION FOR RIVER BASIN MANAGEMENT

QIN Yan, YANG Zhifeng, CHEN Bin

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Session – Poster

To improve the mode of land management of the river basin, we present an integrated way of ecological land classification based on GIS in this paper. The index system encompassing land use, slope and DEM as the natural factors, population density, economic density and urbanization level as the socioeconomic factors is put forward to construct the distributed ecological map of the river basin. The fuzzy c-means (FCM) clustering method identifying the natural clusters and groupings of the input data in the unsupervised geographical space is also employed to classify the land both on the grid with natural factor values and on the administrative division with socioeconomic factor values. Thereafter, an integrated ecological land classification framework is established for the sustainable administration of the river basin. Applying the method to a northern river basin in China, we distinguish the ecological land units in two hierarchies with specific ecological objectives and propose corresponding management suggestions.

RIPARIAN WOODLANDS IN CRISIS? DISTURBANCE ECOLOGY ON THE CONDAMINE FLOODPLAIN

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Session – B4D

The Condamine River, at the headwaters of the Murray-Darling basin, drains one of the most intensively-farmed landscapes in eastern Australia. Riparian woodland remnants on the floodplain sections of the upper Condamine are widely recognised as being in generally poor condition, with evidence of significant dieback and limited recruitment of canopy species, as well as widespread invasion by the introduced perennial herb *Phyla canescens* (lippia). These communities, in keeping with most remnant ecosystems of agricultural landscapes, are poorly understood in terms of their diversity, function and dynamics (resilience) under altered disturbance regimes. This research investigates the condition (health and function) of *Eucalyptus tereticornis/camaldulensis* riparian woodland communities of the Condamine floodplain in relation to selected natural and anthropogenic disturbance factors (e.g. climate variability, changes in land- and water-use, weed invasion) operating at a range of spatial and temporal scales. The study takes a multi-dimensional approach aimed at developing an integrated understanding of key drivers and mechanisms of ecosystem change in these environments. It also investigate the potential of simple conceptual tools (e.g. State-and-Transition and Bayesian Belief Network approaches) to model system dynamics and predict outcomes of future climate and land and water management scenarios, including environmental flow restoration. A Study of Narayani River Course, Central Nepal.

A STUDY OF NARAYANI RIVER COURSE, CENTRAL NEPAL

REGMI Prakash

Friends for Peacebuilding and Development

Session – Poster

Nepal lies in the south Asia ranges terai to higher Himalayas. It is developing, facing many problems for development. Himalayan region has faced the problem of glacier melting and expanding the Glacier Lake and in the terai the floods threatens the country. Narayani River is one of the major river originated from the Himalayas and it irrigated to terai. It has 26300 Sq. Km. catchments accumulated water flows in the terai. The prime focus of the study is in terai extended from 84° 25' 40" and 27° 42' 18" to 83° 54' 24" and 27° 26' 36" east and north longitude and latitude respectively. It has 82.11 Kilometer channel length and 55.15 basin lengths calculated the sinuosity ration to 1.489. The study based on Arial photography and topographical map. GPS survey and Focus group discussion in the field. The river has 7 tributaries. It discharges 1598 Cusec water in average, ranges 163 to 25700 Cusec. The sediment discharge is 294 mg./liter in average. The water gauge varies 0.30 meter to 10.12 meter. It has been intense river shifting affecting to thousand of households and thousands hector of agriculture land and expended its course to 21.904 Sq. Km. within the 36 years of period. The gradient is gentle and deposition takes place. The sedimentation process has increased its bed by 3 CM annually. The adjoining metrological station shows the temperature (by 1 °C) and humidity has been increasing. It invites to extreme weather events. It has been losing the survival capacity poor people.

AND THE RAIN CAME FALLING DOWN: MONITORING THE EFFECTS OF FLOODING IN THE LOGAN ALBERT ESTUARY.

RISSIK David

QLD EPA

Session – B3C

In January 2005 the long dry period in South East Queensland came to an end with some substantial rainfall in some parts. The catchment of the Logan Albert River received +40mm in 3 hours. This presented a good opportunity to examine the effect of flooding on southern Moreton Bay and a team was formed to undertake monitoring in the area. A 12 week long, intensive monitoring program was undertaken with samples collected at 32 sites with weekly to two weekly intervals between sampling runs. Nine data loggers were deployed in the complex channel system of the lower bay to detect the major flow paths in the system. Initial data show the massive influx of sediment from the catchment and the influence of freshwater input on salinity in the bay. Dissolved oxygen in most of the Logan Albert estuary declined considerably soon after the flood, probably a result of the discharge of organic material into the bay and its subsequent breakdown. The bay recovered to pre-flood salinity levels fairly quickly and

the salinity gradually increased up the length of the estuary. Several other variables were also monitored and will be discussed. Contingency monitoring is an essential component of a monitoring program particularly when trying to understand the effects of diffuse sources within the catchment.

LESSONS IN MAINTAINING TRANSBORDER PROGRAMS

ROBERTS Les

Murray-Darling Basin Commission

Session – C2A

The Murray-Darling Basin Commission has been successfully implementing multi-jurisdictional transborder Natural Resource Management Programs, applying Integrated Water Resource Management principles, for more than twenty years. This paper looks at the approaches behind the ongoing successful implementation of programs and the methods needed to ensure long term outcomes are achieved. In particular, this paper examines the implementation and ongoing application of the Basin Salinity Management Strategy, Sustainable Rivers Audit and the Cap on Surface Water Diversions. We look at the preconditions for successful implementation, the requirements for ongoing management, and the critical importance of monitoring, reporting and audit frameworks. The paper will also look at lessons learned, how they have been applied in the development of emerging programs and their relevance to river basin management more generally.

THE CHALLENGE OF ADAPTIVE GROUNDWATER MANAGEMENT IN AUSTRALIA AND SPAIN

ROSS Andrew

Fenner School for Environment and Society

Session – A3C

Many irrigators have turned to groundwater as an alternative source or a buffer to cover peak, seasonal and drought water demands. This paper examines the application of design principles for managing common property resources and institutional diagnostics to four case studies of groundwater management in the Murray Darling Basin in Australia and the Upper Guadiana Basin in Spain. These examples share some favourable features for internal self management, including well defined resource boundaries and long term resource tenure. Other aspects are more problematic, including agreement on sustainable resource yields, users' involvement in setting resource management rules, and users' capacity to establish their own resource management arrangements (effective monitoring and sanctions). The institutional diagnostics approach is useful in analysing these groundwater management systems, the relationships between parties involved in managing the systems and a range of implementation issues. Further efforts are needed to establish effective collaboration between water authorities and water users, taking account of the issue framing, interests and capacities of system participants. Transitions to sustainable management systems can be assisted by implementation of a phased package of measures with full participation of affected parties

RESILIENCE IN NORTH QUEENSLAND CATCHMENTS

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The University of Queensland

Session – A23

We present work in progress on ways of understanding resilience in catchments, through a set of case studies on people's relationships with water in Tropical North Queensland. The study area is recognized internationally for its iconic UNESCO World Heritage areas: the Great Barrier Reef and the Wet Tropics rainforests. Here catchment management challenges are compounded by the diversity of social-ecological systems, involving urban, rural, extractive, production, protection and multiple use landscapes, associated with a rapidly growing population and high levels of tourist visitation. The region seeks to prepare itself for climate change and other challenges through investment in the resilience of individuals, groups and organizations, to enhance societal adaptability and transformation in the face of regional change. We present a framework to analyse the social, ecological, cultural and economic dimensions of the complex social-ecological systems of the region's catchments, and to identify specific factors that must be enhanced to strengthen their resilience. We present initial profiles of two case study catchments, considering four zones within each: upper, middle and lower catchment, and nearshore and reef

areas. Different issues have been selected within each of these, as foci for analysis of the systems and social resilience.

A FUZZY REGRESSION MODEL FOR ESTIMATION OF THE FALL VELOCITY

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Session – Poster

Fall velocity has a strong influence on river morphology, suspended sediment transport, and beach profile shape. In this research a fuzzy regression analysis is performed to study the fall velocity of natural particles. Estimating the fall velocity of natural particles is related to some parameters. Especially, size of the particle plays an important role in the estimation of fall velocity. In addition, such parameter is difficult to precisely evaluate for natural particles and many uncertainties in measurement are existent. Deviations between the observed values and the estimated values and existent uncertainties are regarded as the fuzziness of the system's parameters and coefficients. A fuzzy regression model and definition of fall velocity as a fuzzy number might be very convenient and useful for finding a fuzzy structure in estimating the fall velocity of natural particles. In this paper, the fuzzy regression concept and its application in estimation of the fall velocity of natural particles by using experimental data are developed.

RECONCILING ECONOMIC, SOCIAL AND ENVIRONMENTAL WATER NEEDS IN PANGANI BASIN, TANZANIA

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Session – C4A

The Pangani Basin in Tanzania generates nationally important agricultural and hydro-electric power outputs and hosts nationally and globally important biodiversity. These goods and services from the basin depend on adequate water supplies. Pangani Basin, however, is water-stressed and the current demand for water is not met. Expected climate change projections exacerbate the situation. Pangani Basin Water Office (PBWO) with technical support from the International Union for the Conservation of Nature (IUCN), and mentoring from the Southern Waters – Anchor Consortium, is piloting an Integrated Flow Assessment (IFA) in Pangani River Basin as part of the Tanzania Water Sector Development Program. The IFA considers economic, social and environmental water needs in the basin as well as the trade-offs among these sectors under different water allocation regimes and expected climate projections. The various phases of the initiative, from planning, selection of methods, evolution from an environmental flow assessment to an integrated flow assessment, data collection and preliminary results from the 10 scenarios developed to date will be presented. Special consideration is given to climate variability. The way forward, with respect to additional modelling, stakeholder consultation and development of an Integrated Water Resources Management plan will be outlined.

RIVERS POLLUTION IN OIL PRODUCTION AREAS IN SIBERIA

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Novosibirsk Region Social Committee for Water Protection

Session – A3F

West Siberia is the main area of oil production in Russia. The most part of oil wells are situated in the Ob River basin which is the largest basin in Russia. Khanty-Mansiysky Autonomous Region (KMAR) produces 56.9% of Russian oil and 7.5% of global oil production (about 300mn tons every year). The growth of oil extraction is about 5% every year. It's well known that total oil loss in Russia is 5% of oil production. It means that 5% of produced oil escapes into the environment (officially!). Community doesn't have access to real data of environmental hazards. The most part of oil flows to the surface natural waters from catchment area. Russian Government agrees that the territory of West Siberia, and particularly Ob River basin in KMAR, is the most oil polluted area in Russia. The main reason of high contamination is the absence of a proper regulating base. There are very large territories which are not populated now. And because of that almost all oil-producing companies declare an environmentally oriented policy but act the wrong way. But there is a big probability that in future these areas will be the most attractive places on our planet because of global warming. Local

community tries to prevent fresh water degradation. Our Public Committee applied to Regional Government with special ecological legislation projects of the Ob River conservation in oil-production regions. We offered new technologies of waters quality monitoring and special public control with the purpose to conserve fresh waters for future generations.

LINKING RIVER BASINS FOR AGRICULTURE DEVELOPMENT: INSIGHTS FROM INDIA

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Session – B2F

Increased demand for water in agriculture, domestic and industrial use, compels to search for alternative sources, particularly in water scarcity regions. Inter-basin water transfer from surplus to deficit river basins is one of such alternatives. Sujalam Suphalam Yojana an irrigation project implemented in Gujarat State in India inter-links river basins through a canal, transferring surplus water during rainy season in South Gujarat river basins to that in North Gujarat, to address problems like meeting water demand for agriculture, domestic and also arresting groundwater depletion. This study conducted a rapid assessment of socio-economic and ecological impacts of the project. North Gujarat characterized by less rainfall, over developed groundwater, poor water quality, poverty, migration, etc. is a water scarcity area. The canal diverts surplus water from rivers, Mahi and Narmada, to command areas in North Gujarat. A rapid survey of villages in the year 2006-2007 revealed that farmers observed benefits like increased agricultural production, rise in water level in their wells neighbouring to canal, due to heavy rainfall during the year. Assessment of economic viability (cost – benefit analysis) considering direct and indirect costs and benefits, covering agriculture, animal husbandry, agricultural labourers etc., across different scenarios indicated the economic viability when both direct and indirect costs and returns are considered; and water saving and efficient water using agricultural systems are adopted.

STRENGTHENING ENVIRONMENTAL WATER GOVERNANCE IN AUSTRALIA

SCHOFIELD Nicholas, SIH Kristen

Sinclair Knight Merz

Session – D1D

Australia has entered a new era of water planning with the inception of the Intergovernmental Agreement on a National Water Initiative (NWI) signed by all states and territories as of April 2006. The NWI requires 'statutory provision for *environmental and other public good outcomes*, and improved environmental management practices'. This is to be achieved through identifying environmental outcomes within statutory water plans, establishing and equipping accountable environmental water managers, and optimising cost-effectiveness. This paper proposes 'optimal' institutional structures and legislative and administrative arrangements for achieving environmental water outcomes. We go on to describe the extent to which the optimal governance model is in place or is planned across Australia, and the roles and effectiveness of the newly created 'environmental water managers'. At the conclusion we suggest how the strengthening of environmental water governance can be encouraged, supported and evaluated over time.

KARNALI RIVER AND LOCAL COMMUNITY

SHAH Thark Bahadur

We Organisation

Session – Poster

Nepal is being a small and underdeveloped country. Nepal's water resources potential can be easily understood by the world's fresh water 2.27% of the possessed by this land locked country with in area 1,47,181km², and the main source being precipitation, surface runoff and groundwater. More than 6,000 rivers in Nepal. Karnali River is Main River and longest river of Nepal. In plain area water user's local community group managed river through their traditional management system. Participation, donation, leadership, discuss, new membership, fee, fine, supply maintenance and other all river and water related issue and subject decide community their traditional system. Karnali River is Main River & source of nearly one millions peoples all domestic purpose water resources supply. Karnali River is one of

the worlds' biggest estimated hydropower potential river and valuable bio-property river, which is start in China and end India.

KARNALI RIVER AND PEOPLE

SHAH Thark Bahadur

We Organisation

Session – Poster

Karnali River is longest River of Nepal and World's second largest Hydro power potential River. Karnali River Originated in China and end India. Its water flows pass Snow Mountain, mountain and plain terai area. Millions people depends in Karnali River for their everyday life activity. River side people Bathing, Drinking water, Agriculture purpose, religious purpose, fishing, cleaning, cattle drinking depends in Karnali River.

SUSTAINING ENERGY AND FOOD SECURITY IN TRANSBOUNDARY RIVERSYSTEM: CASE OF INDUS BASIN

SHAHEEN Farhet Ahmad, WANI Masoodul Haq, WANI Shabir Ahmad, SARAF Sajad Abdullah

Sheri-Kashmir University of Agricultural Sciences and Technology

Session – C2E

The Indus basin states are going to face huge energy crunch and food crisis in coming years. Indus system of rivers is shared by two nuclear South Asian countries, viz., India and Pakistan. Indus Water Treaty (IWT) fixed and delimited rights and obligations of India and Pakistan in relation to each other concerning use of waters of Indus system of rivers. The IWT has been hailed for decades as a model for conflict resolution; however, there has always been a measure of dissatisfaction with treaty for different reasons in both countries. Most of the hydro-projects got stalled due to differences over inherent controversial technical clauses within treaty- resulting into unresolved disputes. Growing population, industrial growth and mounting water problems accompanied by over all fall in waters of Indus basin due to climatic change, warrants redefining treaty in order to benefit people of both countries in terms of energy and food security. The principle of sharing of benefits and responsibilities on all the rivers between two countries rather than simply sharing water may be envisaged. Due to hostility between two countries, idea may appear remote at time, but very exercise of looking ahead would reveal opportunity cost of non-cooperation and confrontation.

VALUES AND THE BRISBANE RIVER

SHAW Sylvie

The University of Queensland

Session – C4B

Brisbane and the river environment are rapidly changing. This paper reviews these changes through an examination of the values and attitudes of residents, especially 'river carers', about the perceived water quality and natural amenity of Brisbane River's urban waterway. River carers are defined as residents involved with the river via river protection and water resource issues. The urban riverway is experiencing increasing pressure through rapid urban development, a growing demand for water, a decline in river quality and a decrease in urban habitat including old growth trees and established gardens. But what is the effect of these changes on local residents, particularly those active in river protection? The paper examines the values and perceptions of the riverway and the role the river plays in the lives of river carers, particularly as it relates to their health, wellbeing and quality of life. It aims to build an understanding about the potential relationship between urban river engagement (e.g. walking river trails, bike riding, rowing, bush care involvement) as a significant indicator for the public's continuing support for sustainability and environmental responsibility.

THE FUTURE IN WATER TRADING

SIEBENTRITT Mark, PEEVOR Stuart

Waterfind Pty Ltd

Session – D1D

With continued scarcity of Australian water resources, the role of water markets continues to grow in importance. While water markets form a cornerstone of the national water initiative - and are maturing rapidly, there remains significant room for improvements across issues such as: liquidity, transparency, regulation and administration. Based on the experience of Waterfind Pty Ltd, Australia's largest water brokerage firm, it aims to scope out the future structure of a mature Australian water market and some of the changes that need to be made to achieve this vision. Consideration is given to a broadening of the concept of water markets being able to help move water from "low value" to "high value" use. It is argued that the commonly applied, single indicator measure of gross value (e.g. 'farm gate' price) may be inappropriate and that a range of considerations need to be made. Current water registry deficiencies that may negatively impact the water market are discussed. The required functionality of a national water register is also explored and some discussion around its development is suggested. This includes some suggested governance arrangements relating to user and intermediary access.

MICROCLIMATIC EXTREMES UPSET MACROINVERTEBRATES IN TROPICAL, MONTANE, LOW ORDER STREAMS

SKRANDIES-MARTIN Jane

The University of Queensland

Session – A3E

Microclimates are vital to endemic aquatic ecosystems, especially in the extreme seasonality of wet and dry periods, so typical of the Tropics. Existing shading of low order, montane streams is of utmost importance to aquatic biota because for these temperature sensitive taxa, riparian vegetation offers a buffer from extreme climatic conditions. To investigate the likely future impacts on these aquatic communities, baseline knowledge on how microclimatic conditions are affecting existing aquatic taxa is crucial. To test this idea, twelve stream segments within three ecotone site types were selected for analysis: rainforest/stream edge, regrowth/stream edge and grazed/stream edge in two tropical headwaters of the Barron and North Johnstone River in the Wet Tropics of North Queensland, Australia. Within each 1-ha site microclimatic measures were captured simultaneously at paired midstream and orthogonal transects (water and air temperature, RH, solar radiation). Concurrently, aquatic macro invertebrate kick net samples were taken in five pools and five riffle habitats along the included 100m stream section as including other physical ecotone data. Thermal environments along grazed stream edges were found to be significantly hotter than those existing in regrowth forests. In contrast, native tropical rainforest-stream edges were quite dynamic and often unpredictable. The dominant aquatic macro invertebrate groups found, showed distinct sensitivity responses (changes in persistence, stability, community structure) to the thermal extremes in these trialed ecotones. These results indicate that closed forest-stream edges provide thermal protection to headwater streams and their thermal sensitive aquatic fauna, reducing in-stream channel thermal conditions by up to 1.5 degrees compared to just 30m of exposure without substantial tree cover. Improvements in water quality, using macro invertebrate communities as surrogate, are not only strongly linked to decreases in water temperature, but also to local climatic conditions created by lateral and longitudinal ecotone vegetation. Thus suggesting healthy stream biota is strongly linked to canopy closure with long riparian buffers and protection of headwaters. Expectations of riparian buffer zones, to uphold stream conditions and support their aquatic biota, under increasing pressures of climate change in the Wet Tropics needs to be moderated by knowledge about the (1) quality and dynamics of the riparian vegetation and (2) spatial arrangement of riparian networks within a catchment.

IMPLEMENTING THE SEQ WATER STRATEGY: TOTAL WATER CYCLE MANAGEMENT IN SEQ

SPILLER, Daniel

Queensland Water Commission

Session – C2F

The draft South East Queensland Water Strategy is currently being finalised, following three years of preparation and consultation from March to July 2008. The

Strategy outlines a framework to secure water security for the region, employing total water cycle management at the heart of its approach. The Strategy includes a suite of policies and actions that will promote total water cycle planning at the regional, sub-regional and local scales. The Strategy is underpinned by new institutional arrangements for SEQ, covering water policy, planning and service delivery. Daniel Spiller will provide an overview of the Strategy and Institutional framework highlighting progress to date on key actions. These actions relate to the demand management program, operation of the SEQ Water Grid, planning for potential desalination and purified recycled water facilities, and improved water cycle planning at the sub-regional scale.

FRAMEWORK TO SUPPORT IRRIGATION DECISION-MAKING IN COMPLEX AND CHANGING TIMES

STORY Justin, CAMKIN Jeff, BRISTOW Keith

CSIRO Land and Water

Session – B2F

Irrigation areas in southern Australia have been under a high degree of stress due to drought, climate change and increasing urban demand. Whether these areas are able to fulfil future food production needs is in doubt. With 60 to 70 percent of Australia's fresh water discharging from northern tropical rivers there is rapidly growing interest in the land and water resources of the north as a possible solution to maintaining food production. NAIF has worked with governments and stakeholders to develop tools to aid understanding of the many uncertainties and risks involved in making decisions about the future of irrigation in northern Australia. Key to this was developing a framework to help the community progressively build and tell the story of how the catchment operates in a biophysical, social, economic and governance sense. A prototype framework was developed for the lower Burdekin catchment consisting of an ESD Component Tree system, a web-based catchment knowledge platform and processes for improving the integration of science, policy, stakeholders and industry. These tools and processes developed by NAIF will assist decision-makers and the community to ensure that if irrigation is increased in northern Australia it will be done in a sustainable manner.

MANAGING KRASAK RIVER AS WATERWAYS AND CHANNEL FOR VULCANO MERAPI ERUPTION IN CENTRAL JAVA-INDONESIA: BETWEEN ENDEVOUR AND DISASTER

SUSILOWATI Indah, MAYANGGITA Kirana

Diponegoro University

Session – Poster

Merapi is considered as the most active volcano in Java, situated in the border of Central Java and Jogjakarta provinces. However, administratively belong to Central Java province. Merapi is very rich with the legend and mystic and it is remain believed by many of people who lived in the adjunction. The most popular legend of Merapi volcano is related with the love story between the last ten Kings of Jogjakarta and the imaginer Queen of the south ocean since longtime ago. *Kali* (in English: river) Krasak is the one river that has a dual function. During a day time, Kali Krasak has a function as a waterway, from spring in Merapi volcano to water peripheri of many small rivers or water channel in the lower places. But when the volcano performed in active condition, kali Krasak will work for dual function, as waterway and at the same time as a channel to bring down all materials that vomitted or erupted from Merapi volcano. This study aims to explore the effectiveness of kali Krasak to perform her dual functions mentioned above for todate. The value of kali Krasak is also estimated using the economic valuation method (see www.EEPSEA.org; Susilowati, 2006; 2007). The prospect of Co-Management approach with institutional analysis (Pomeroy and William, 1994; Susilowati; 2002, 2005, 2006; 2007; 2008) was also applied in this study to find out the better strategy for river management for Krasak river. Kali Krasak is divided into three segments in this study, namely: (1) upper, (2) middle and (3)lower. The primary and secondary data were collected. There were 60 respondents who selected using quoted cluster sampling along the river. Descriptive statistics (Mason et al, 1999; SPSS Manual) and Analysis of Hierarchy Process (AHP) were employed to analysis the data. The results indicated that during normal condition (no volcano activity), Krasak river is still capable to accomodate her function as a waterway. It seems Krasak river will no longer sufficient to accomodate the materials overflowed from Merapi volcano. This is mainly due to economic motive more far stronger than environmental consideration paid by the stakeholders. The river is really deteriorating, especially from the activities in mining (sand, gravel and stone). It is true that from the last activities of Merapi volcano (2005-2006) materials erupted are abundant but there is no sufficient responsible management in place done by the stakeholders (government, business, commuity and academician) to take care of Merapi and Krasak river. It is really hard to say no to the people for over-exploiting Krasak river. In fact, it is understood that they

need to feed their family and this is just only ing onshouldered by mining activities from kali Krasak nowaday. But without thinking for conservation of kali Krasak since now, they will more suffering in the future because the river will no longer able to accomodate the materials flowing down while eruption (small or big) due to degradation in capacity. Now the choice is between endeavour or disaster for Krasak river management.

BLUEPRINTS**SWIREPIK Jody, BURNS Ian, EVERINGHAM Penny**

Murray-Darling Basin Commission

Session – C3A

The Living Murray began in 2003 with the First Step decision to recover 500GL of water for use at six Icon sites, and invest \$150 million in 'works and measures' to make best use of that water. Since 2003 efforts in the 'works' program have focused on understanding the flood behaviour of the icon sites, and developing works options to facilitate the flooding of sites to achieve agreed environmental objectives. The focus is now on developing "blueprints" for each Icon Site. Blueprints outline the preferred package of works at each Icon Site, and potential water requirements, to meet The Living Murray Ministerial Council First Step objectives. These are then modelled to assess if the requirements can be met drawing on the water that is expected to be recovered under TLM. This paper looks at the issues, the development of the blueprints and how the trade off decisions will ultimately be informed.

VILLAGER RESEARCH (SALA PHOUM IN KHMER LAGUGAGE)**VANNARA Tek**

Culture and Environment Preservation Association

Session – C3B

SALA PHOUM research in Stung Treng Ramsar Site, Cambodia has been supported as collaboration between the Cambodian NGO, the Culture Environment Preservation Association (CEPA) and IUCN under the Mekong Wetlands Biodiversity Program (MWBWP). The research was conducted by villagers from 4 villages. Each of these villages, from 4 communes and 2 districts, is situated on the Mekong mainstream in the Stung Treng Ramsar Site. These villagers identified research topics and collected field data themselves. The research focused on three main topics – 1. Fisheries (including fish species, traditional fishing gear, fish habitats, fish spawning grounds and migration route; 2. Flooded forest vegetation and herbal medicines; and 3. Sub-ecosystems. SALA PHOUM research has 4 specific objectives – 1. To empower villagers and increase their awareness of the natural resources in their villages through conducting their own research; 2. To describe and monitor changes in natural resources; 3. Train villager-research teams to be able to work as a network in order to exchange knowledge within and between villages; and 4. And to compile and document local knowledge related to the natural resources in their villages. The SALA PHOUM researchers have collected a wide variety of information. The researchers documented local names and key characteristics of all the various fish species and habitats, and flooded forest plants. Specimens were collected and photographed by the SALA PHOUM researchers. As well as taking photographs to support research topics, the SALA PHOUM researchers held groups discussions for peer review, classified and verified the collected information. SALA PHOUM has been an important research process that has generated a wealth of information. It has also provided an opportunity for local people to share their experience and learn from one another. By going through this process local people have gained the confidence to present their own findings and their own insights into the changing conditions of their natural resource base. This is an important step in establishing a collaborative approach to natural resource management, for a unique and important area of the Mekong that is very much under threat.

THE GOULBURN BROKEN WATER QUALITY STRATEGY – 10 YEARS ON**TENNANT Wayne¹, FEEHAN Pat²**

Goulburn Broken Catchment Management Authority¹, Feehan Consulting²

Session – C3C

Development of the Goulburn Broken Water Quality Strategy commenced in 1994. The Strategy aimed to reduce potential catchment Total Phosphorus (TP) loads by 65% (from an estimated 371 t of TP). Implementation began in 1996. A review of the

Strategy and its implementation was commissioned in 2007. The original Strategy focused on phosphorus management as the means of achieving the objectives. The recent review suggests that apart from an increased emphasis on nitrogen and flow management the strategic directions have been largely appropriate. The general approach adopted by the Strategies was one of implementing best management practices (BMP) to achieve nutrient reduction. This approach uses the adoption rate of BMPs as a target that gives a predicted desired nutrient reduction and / or management. A substantial nutrient monitoring and reporting program is being implemented but sediment reporting can be enhanced. Overall, a substantial reduction in TP export from the catchment has been achieved. Analyses of trends generally show improving or stable water quality conditions. A number of sites (major rivers and irrigation drains) show significant downwards trends (ie improvements) in TP and TN concentrations. Load concentrations have also trended down (ie improved) but these may due to a combination of reduced concentration and reduced flows (due to drought). The review highlighted "new" issues to be addressed including climate change impacts on water quality. Implementation of the Strategy improves the resilience of the catchments streams and waterbodies. Development of an integrated and coordinated water quality strategy for the Goulburn Broken catchment has been completed and implementation is proceeding well. Substantial reductions of nutrient outputs have been achieved.

SCIENCE SYNTHESIS AND COMMUNICATION ARE SHOWCASED IN TWO NEW BOOKS**THOMAS Jane¹, CARRUTHERS Tim¹, DENNISON William C.¹, LONGSTAFF Ben J.², LOOKINGBILL Todd¹, WICKS Caroline²**

University of Maryland Center for Environmental Science¹, EcoCheck (NOAA-UMCES Partnership)²

Session – Poster

The parallel processes of science synthesis and science communication are represented by the recent publication of two books. Perhaps one of the most important aspects of these books is the mode of production—an interactive, dynamic, inclusive process. This approach not only leads to improved book content (the product drives the synthesis process) but helps drive issues broader than the book itself, such as new research directions and public engagement in coastal ecosystem issues. Both books are full-color, richly illustrated, and professionally produced in-house by teams of science integrators and science communicators. Applying Science Effectively: Turning data and information into knowledge and applications discusses the use of integrated assessment in coastal ecosystem management in a manner that will lead to an informed and energized public and give managers tools and incentives to make appropriate decisions. The four themes of this book are: Observation Revolution, Information Generation, Knowledge Building, and Application of Knowledge. Shifting Sands: Environmental and cultural change in Maryland's Coastal Bays applies these assessment and communication techniques to a coastal lagoon ecosystem, resulting in the synthesis of the current knowledge of science and monitoring in Maryland's Coastal Bays and highlights management issues and recommendations.

DEVELOPING A RIGOROUS AQUATIC ECOLOGICAL MONITORING PROGRAM AT A CENTRAL QUEENSLAND MINE**THORBURN Lauren, CONACHER Carol, OLDS Andrew, THOROGOOD John**

frc environmental

Session – B2C

Development of a new coal mine in Central Queensland has the potential to impact on the ecosystem health of ephemeral creeks within and downstream of the mining lease in a number of ways: most notably by stream diversion and discharge of groundwater to the creeks. An instream aquatic ecosystem monitoring program has been designed and developed by frc environmental. The program is fully supported by the mine's proponents, reflecting their desire to accurately detect and manage impacts of the mine. In order to provide rigorous and defensible results, the program exceeds agency requirements to use 'standard' broad-scale monitoring techniques such as AusRivAS. It includes replicated sampling of freshwater macro-invertebrates, and the use of both univariate and multivariate statistical techniques to detect impacts. This paper discusses the findings of baseline monitoring and the adequacy of sampling design; and changes required to ensure that a robust, rigorous data set is established. We also explore differences in results found in a dry year (2007) and after a significant wet season (post-summer 2008). These findings provide an interesting insight into how the ecology of ephemeral and intermittent streams may respond to climate change (e.g. increased frequency and intensity of flood events).

REGULATING NON-POINT POLLUTION IN RIVERS AND STREAMS

TISDELL John, CAPON Tim

Australian Rivers Institute Griffith University

Session – C3C

Improving river water quality is the challenge of the 21st century. Point source pollution can be effectively monitored and regulated. Diffuse sources, however, are more challenging. Regulating diffuse source polluters is often difficult or simply cost prohibitive. In most cases only ambient pollution levels are observable from which individual polluting actions cannot be inferred because the ambient pollution is randomly distributed. Solutions suggested in the literature include the imposition of a tax/benefit schemes based on ambient pollution levels; individual contracts and collective and random fining; and a combined individual and collective penalty systems. Taking into consideration action based (BMP) options available to landholders and ambient pollution measurement options available to river managers; this paper evaluates the relative performance of alternative action based/ambient outcome tax schemes in reducing diffuse source pollution entering rivers and streams.

MANAGING BRINE CONCENTRATE DISCHARGES IN DROUGHT CONDITIONS

TRIPODI Neil, RAMSAY Ian

Environmental Protection Agency

Session – C3F

As a result of the drought in South East Queensland (SEQ), there has been a significant increase in approvals and installation of alternative water supply initiatives such as desalination plants and advanced water recycling plants that rely on membrane technology such as reverse osmosis. Such membrane-based treatment produces a waste stream that is many fold more concentrated than the source water. This waste stream is typically called the Reverse Osmosis Concentrate (ROC) and can have high concentrations of salts and toxicants. The salinity of the waste streams can present a challenge as it can make mixing of the ROC with receiving waters difficult and result in dense saline layers that affect benthic communities. For some ROC streams, the major issue is the potential toxic and other environmental effects from metals, ammonia, disinfectants, biocide, antiscalants and detergents. The majority of issues related to brine release appear to be in the near-field, although the combined effect of many brine releases on the salinity and water quality in rivers and estuaries could also be significant. In SEQ, the EPA has been required to approve a number of significant water supply initiatives including the Western Corridor Recycled Water Project and the Tugan Desalination plant, although many other regulated and non-regulated activities are commencing or planned. This paper will discuss some of the environmental issues related to activities that involve brine discharges and the approach that the EPA is using to assess and approve such activities. This will include recent examples from approvals in South East Queensland.

POTENTIAL IMPACTS OF CLIMATE CHANGE ON THE SWAN AND CANNING RIVERS, PERTH, WA

TWOMEY Luke

Swan River Trust

Session – C2D

Climate change is evident as an influence on the Swan Canning river system and has already produced irreversible change. The rate of change is increasing relative to the past century and changes to the familiar river regime will become increasingly evident and significant as the century progresses. Both tidal and non-tidal sections of the river will be altered by significantly diminished stream-flow with warming of the water bodies and surrounding environment. There will be changes in the seasonal timing of flows with smaller and later autumn/winter flows. Tidal reaches will also be affected by sea level rise and by superimposed storm surges. The key impacts on the river will be driven by sea level rise and reduced streamflow, which will increase the period of salinity stratification and penetration of marine water upstream. The social values of the system are likely to be threatened by reduction in passive recreational facilities and aesthetic values through loss of beaches, wetlands and associated vegetation. Economic loss will result from increased costs of water quality management and a need to protect, retrofit, repair or replace infrastructure. To adapt to climate change steps must be taken to develop strategies for protection, accommodation, avoidance or retreat.

DROUGHT RISK IN AUSTRALIA – WHAT CAN THE PAST TELL US ABOUT THE FUTURE?

VERDON Danielle

Sinclair Knight Merz

Session – A3C

Much of eastern Australia suffered from a severe hydrological drought during the period 2002 through to 2007. Critically low volumes were reached in many of the major water storages in the region, with the issue compounded by an overestimate of expected inflows due to record breaking low flows. By accounting for long-term climate variability on multi-time scales (e.g. inter-decadal, multi-decadal, and the palaeo scale) the risk of failure of current drought management practices may be better assessed. In this presentation the role of natural variability in modulating drought risk will be discussed and a simple stochastic framework for use in long-term drought risk assessment presented. The methodology specifically incorporates multi-decadal persistence of rainfall, brought about by changes in the primary climate drivers (on both the instrumental and palaeo timescale). The drought risk framework is then applied to water resource assessment in the Lachlan River Valley (NSW) and is shown to provide greater insight into the frequency, magnitude and duration of hydrological droughts than present approximations that are based on the limited instrumental record.

RIPARIAN BIODIVERSITY STRUCTURE AND FUNCTION: IMPLICATIONS FOR MINE LEASE MANAGEMENTVINK Sue¹, STEPHENSON Greg¹, JOHANSEN Casper¹, PHINN Stuart¹, MORAN Chris¹, MERRITT John²University of Queensland¹, Anglo Coal Australia, Pty Ltd²**Session – B2C**

The mining industry is increasingly recognising that in order to achieve social and environmental sustainability goals waterway management must go beyond simply meeting water quality discharge licence criteria. One of the challenges is to incorporate understanding of riverine ecological and physical processes into mine life planning and operational management in order to mitigate impacts of mining on river systems. Because of the dynamic nature of river systems, land management of riparian and floodplain areas must be integrated into river management plans. Riparian areas represent the interface between land and riverine ecosystems and are particularly important in maintaining river ecosystem function. This paper will present results from an analysis of riparian biodiversity structure and function on a mine lease in the Fitzroy Basin. The work is being conducted as part of baseline information gathering for the EIS. Object-oriented riparian vegetation classification derived from airborne hyperspectral image data analysis is being compared with measures of ecosystem function including soil and vegetation carbon and nitrogen status, potential denitrification and microbiological assemblages. This information can be used over the life of the mine to assess and mitigate mining impacts. Implications for mine site planning will be discussed.

LET IT FLOOD - PROTECTING QUEENSLAND'S VAST FLOODPLAINS

WALKER Glenn

The Wilderness Society

Session – A3B

From the vast channel country floodplains in the West, to the Gulf's great connected wetlands, to the remote and diverse wetlands and floodplains of Cape York Peninsula, Queensland retains some of the most spectacular and healthy river systems in the world. For decades many people, from many sectors of society, have championed the long-term protection of these globally important systems. They have highlighted their immense conservation significance and have continued to demonstrate the critical ecosystem services they play such as the maintenance of fisheries and the provision of fresh water for natural grasslands and pastures. But what are the right policy tools for protection? What is an equitable protection regime? How can we encourage genuine ecologically sustainable development in these areas? Queensland has taken a leap in the right direction with the *Wild Rivers Act*. Combined with good water planning, this policy tool has the tremendous potential to ensure that Queensland's great floodplains will remain healthy for generations to come. But it requires clever advocacy, and an engaged public – something Queensland's conservation movement is well placed to do.

ARTIFICIAL URBAN WATERWAYS: FISH HABITATS, FISH HEALTH AND FISH EDIBILITYWALTHAM Nathan¹, CONNOLLY Rod², TEASDALE Peter²Gold Coast City Council¹, Griffith University²**Session – C3E**

Demand for residential real estate with water frontage has resulted in a recent, massive expansion of artificial urban waterways on every continent. Studies in Queensland show that these estuarine waterways are a major new fish habitat. They have fewer fish species than natural wetlands, but similar numbers to natural, deep estuarine channels. Fish such as garfish that feed on aquatic vegetation in natural wetlands show remarkable plasticity of diet and in canals feed instead on microalgae and insects washed from gardens lining the waterways. Fish in artificial waterways therefore rely on food webs with different carbon pathways. Contaminant surveys show higher levels of copper in canal sediments than in adjacent natural wetlands. This is detectable as higher concentrations in the flesh of fish such as mullet that feed on the sediment. Concentrations nevertheless remain within guidelines for human consumption and all fish analysed were safe to eat. Extensive canal systems suffer hydraulic problems and legislation has shifted waterway design to estuarine lakes with restricted tidal exchange. This hydraulic restriction limits connectivity and alters fish assemblage in lakes. Artificial estuarine waterways clearly support fish populations but their design and extent influence the types of fish that will occur.

A MICRO HYDRO POWER DAM TO CONTROL FLOODS

WAMBAZU MUGOBERA Samuel, GIDUDU Andrew

Masaba Secondary School

Session – A3B

The East African Energy Technology Development Network (EAETDN) - Uganda Chapter is to construct the first community based 35 - 40 kilowatt Micro-Hydro Power Demonstration Project in Sironko District of Uganda. The power plant will have a distribution network to supply village households with electricity for lighting, cooking, grain milling, battery charging, micro industries and recreational activities. The project is seen to contribute to the mitigation of climate anomalies for example, the recent flooding which claimed lives and displaced many settlements and promote environment conservation by enhancing access to environmentally and socially appropriate energy technologies in order to improve livelihoods of the poor within the community. Its objective is to build capacity of the community members in order to be able to link environment management to micro-hydro power generation and sustainability of the project. The paper will deeply discuss the environmental, social and economic effects of the project especially to the flood plain areas of Eastern Uganda.

EFFECTIVE INDIGENOUS INVOLVEMENT IN THE LIVING MURRAY – INTRODUCING A NEW METHODOLOGY

WARD Neil

Murray-Darling Basin Commission

Session – C3A

The Murray-Darling Basin Commission's The Living Murray Initiative recognises that the aspirations, interests and contributions of Indigenous people are an integral component of contemporary natural resource management. It aims to take into account the social, economic and spiritual objectives of Indigenous communities for each of the Murray's icon sites. In order to do this, The Living Murray's Indigenous Partnerships Project is developing and implementing a consultation process that will enable Indigenous communities to effectively participate in the discussion about cultural and environmental flows. Based on experience and expertise from Canada, a rigorous social science methodology, known as Use and Occupancy Mapping, has been adapted and trialed to help determine Australian Indigenous peoples' contemporary use of land. This paper will explore Use and Occupancy mapping and its application for the Indigenous people of the Murray-Darling Basin. The information gained using Use and Occupancy mapping will help Indigenous people articulate their contemporary land and water management objectives in a manner that builds on their traditional knowledge and perspectives and clearly expresses their future association with their country.

ADAPTING TO CLIMATE CHANGE IN CENTRAL QUEENSLAND

WEARING Cameron

Fitzroy Basin Association

Session – Poster

Adapting land management practices and new strategies for the implementation of on-ground works will be required if the natural resources of the Fitzroy River, central Queensland are to be used sustainably under a changing climate. Cobon et al. (2007) investigated the impact of a range of climate change scenarios on central Queensland grazing production systems and sediment transport. Consideration of these results leads to the conclusion that climate change has a significant potential to impact on ground cover and water quality targets agreed to by the central Queensland community. Given this, further work is required in the following areas a) analysis of climate impact risks at scales that reflect local climate variation and patterns from paddock to region, b) identifying what the coping range / tipping points are in regional land use & hydrological systems and c) scenario planning & foresighting that incorporates social and economic trends. An emphasis on local scale modelling is required to ensure the credibility of any messages about climate change impacts and it should also build on the evidence of historical changes in climate and adaptive responses. In this, the Fitzroy River is uniquely served by the Brigalow Catchment Study, a long term (40+ years) experiment.

A CHEAP, RAPID ASSESSMENT OF URBAN WATERWAY HEALTH BASED ON QUANTIFYING RIPARIAN VEGETATION

WEBB Graham, MOORE David, MADDIN Jan, SMITH Mick

Sunshine Coast Regional Council

Session – B4B

The Sunshine Coast region is undergoing very rapid urban densification, with consequent pressures on waterway health, flows and amenity. Waterway health monitoring is crucial for managing waterways in the face of these increasing threats. In traditional monitoring programs, significant time and money are invested in ongoing measurement of many indicators. This paper discusses a rapid and cheap alternative assessment method, focusing on riparian vegetation. Riparian vegetation is critical to waterway health as it regulates water temperature, provides habitat and food for terrestrial and aquatic fauna, and filters water entering streams. Results from a desktop GIS quantification of riparian vegetation within a 10m buffer of waterways across 18 Sunshine Coast subcatchments correlated well ($R^2=0.76$) with overall health grades from an intensive two-year monitoring program that assessed physical-chemical parameters, biota, nutrients, aquatic processes and habitat. These results suggest that spatial quantification of riparian vegetation can provide a meaningful assessment of overall waterway health. The method may benefit organisations that require information to guide waterway management investments, in a short timeframe or for minimal cost. A limitation of the method is that it does not provide site specific information on point sources of water pollution, bank instabilities, biota populations, and aquatic processes.

ENGAGING AGRICULTURAL COMMUNITIES IN NRM WITH RIVERINE MONITORING

WEBB Paul

Queensland Murray Darling Committee

Session – A2D

Community monitoring of river health and pollutant loads has developed as an educational tool in the last twenty years. However, in addition to this, enhanced community monitoring programs are now providing data that can be used in resource condition and trend assessment. Incorporation of community data provides an enhanced, integrated monitoring program with improved monitoring capacity and with improved engagement of agricultural communities in Natural Resource Management. The Queensland Murray Darling Committee (QMDC) has used community monitoring data to provide a platform for integrated river monitoring. Community macroinvertebrate monitoring has been used to provide an indicative condition and trend assessment of individual river catchments where previously only regional assessments were achievable. Community flood event sampling is being used to validate and enhance pollutant load models to help with evaluation of benefits of intervention works and for planning of future initiatives. Community participation in the monitoring programs in association with existing Government monitoring is providing enhanced data sets. Community involvement in monitoring is also improving public understanding and trust in condition reports from scientists and agencies with whom they are working.

ACTION LEARNING - SOIL WATER, WATER QUALITY AND COPING WITH CHANGE

WEBB Paul

Queensland Murray Darling Committee

Session – Poster

The Queensland Murray Darling Committee (QMDC) is working with the community to encourage and support sustainable use of natural resources. With the implications of climate change, an understanding of soil water processes in agricultural systems is ever more imperative. Some simple action learning activities have been used to enhance landholder appreciation of rainfall infiltration and related production and environmental implications. Cover, erosion, water quality, infiltration and salinity are discussed during these activities with equipment including lunch boxes and paint trays. Drink bottles and table salt are also used to demystify landscape salinity. Activities linking productivity and natural resource management issues have helped to build a common understanding of landscape processes providing a platform for coping with change. These simple activities, or tools, can be adapted onsite to suit specific interests or time constraints. They have been delivered with moderate success on kitchen tables, town halls and in the paddock. Beneficiaries have included the young and the not so young, school of hard knocks and PhD graduates, and various NRM agencies' staff. Even those who "knew that" have commented that the perspectives and productivity links are enlightening and beneficial.

IDENTIFICATION OF LAND MANAGEMENT OPTIONS FOR IMPROVING WATER QUALITY IN THE TULLY CATCHMENT

WEBSTER Tony, ROEBELING Peter C., THORBURN Peter J., BIGGS Jody S., VAN GRIEKEN Martijn

CSIRO Sustainable Ecosystems

Session –D1B

In 2003 the Australian and Queensland Governments developed the Reef Water Quality Protection Plan (the Reef Plan) which articulated its goal as to halt and reverse the decline in water quality entering the Great Barrier Reef (GBR) within 10 years. Catchment based Water Quality Improvement Plans (WQIPs) have been developed in priority GBR catchments with local stakeholder input to identify local implementation actions to achieve this goal. This paper describes the identification of land management options for local landholders during the development of the Tully WQIP. Monitoring and long term modelling has identified the highest priority water quality pollutants as nitrogen and agricultural chemicals, with sediment a lower priority issue. The identification and assessment of management practices to reduce these priority pollutants is a goal of the WQIP. The assessment of management practices uses production system simulation models (APSIM, LUCTOR, PASTOR) and a hydrological model (SedNet/ANNEX) in combination with sound cost-benefit analysis. The four most important land uses in the Tully catchment are sugarcane, horticulture (bananas), beef grazing and plantation forestry. Local stakeholders of each industry described the 'typical' management of these production systems and identified best management practices (BMPs) for water quality improvement. These BMPs were assessed for their financial and water quality abatement performance using the combined modelling approach. BMPs for each production system were compared with the 'typical' management of the production system. The most cost effective BMPs that achieve water quality improvement were prioritised for implementation in the WQIP. BMPs that improve water quality and have financial positive gains are more likely to be implemented than those where implementation costs have a negative effect on finances.

ENVIRONMENTAL FLOWS AND CULTURAL FLOWS: WHAT'S THE DIFFERENCE?

WEIR Jessica

Australian Institute of Aboriginal and Torres Strait Islander Studies

Session – A3D

An alliance of traditional owners from the Murray-Darling Basin have developed the term 'cultural flows' to better communicate with water management bureaucrats. With 'cultural flows' they build on the policy paths made by the advocates for environmental flows. A minimal definition of this new concept is that it is a way of returning water to the river country envisioned by the traditional owners. But why are the traditional owners arguing for 'cultural flows' when there is so much work going into returning water to the rivers as environmental flows? Why argue for a separate

flow of water? This talk will explore why the traditional owners persist with cultural flows as an expression of their relationships with the river country. Cultural flows are not a cultural copy of environmental flows – one taking care of culture, the other taking care of the environment – rather, cultural flows are about a conceptual change in understanding our relationships with the rivers. I call this connectivity – which is a way of living in the world as also theorised by traditional owners, environmental philosophers, and ecologists. This research is supported by a research agreement with the Murray Lower Darling Rivers Indigenous Nations.

APPLYING THE EU WATER FRAMEWORK DIRECTIVE IN THE DANUBE RIVER BASIN

WELLER Philip

International Commission for the Protection of the Danube River

Session – C2E

Adopted in December 2000 the EU Water Framework Directive (WFD) has modernized and updated water management legislation in the European Union (EU) and provides a model for other jurisdictions world wide to follow. The WFD requires countries to manage their waters based on river basins and with an acknowledgement of economic factors in management decisions and involvement of the stakeholders. The overall goal is to achieve 'good ecological and chemical status of all waters' by 2015. As regards the Danube river basin all countries put the WFD on top of their water agenda and nominated the International Commission for the Protection as platform for coordination. The fact that all countries of the basin requested this –EU members, accession countries and non-accession countries – indicates the recognized importance and benefits of this key water legislation. A key achievement in the implementation of the WFD has been the preparation of the 'Danube River Basin District Analysis' that performed the characterization of surface waters and groundwater. The report highlighted a number of important challenges for the future river basin management plan that has to be finished by the end of 2009. Four key water management issues will be addressed in the Danube River Basin Management Plan: organic pollution, nutrients, hazardous substances and hydromorphological alterations.

MAXIMISING BIODIVERSITY OUTCOMES FOR WATER QUALITY

WESTCOTT David, METCALFE Dan

CSIRO Sustainable Ecosystems

Session – D1B

Planning and management for water quality is usually undertaken with respect to just one or a few closely aligned goals. However, the landscape for which water quality plans are developed, and in which they are ultimately implemented, are invariably far more complex than just water and are integral to a host of goals and aspirations that lie outside the narrow purview of water quality planning. We focused on identifying empirical indices of the terrestrial biodiversity values and the health of native forest of the Tully floodplain and documented the distribution of both biodiversity and forest health across the floodplain and against the different landuses. Our aim was to provide water quality planners with information on how the alternative management actions under consideration might contribute to or detract from both the terrestrial biodiversity values and ecosystem health of the floodplain. In particular, we focused with those associated with factors that impinge on water quality, e.g. wetlands, riparian areas, and revegetation. Using continuous forest in the floodplain as our benchmark, we found that virtually all land uses in the floodplain retain notable levels of biodiversity. When these land uses contain even relatively small amounts of native vegetation these levels become significant and make significant contributions to the existence of key ecosystem processes at the landscape level. We suggest that by incorporating native vegetation where ever possible in water quality management actions, managers can make significant contributions to a far broader range of issues than just water quality.

BUYING IRRIGATION WATER FOR THE ENVIRONMENT – LESSONS FROM THE MARKET IN A TRANSBOUNDARY PROGRAM

WHITE Lindsay, MAKIN Michael

Murray-Darling Basin Commission

Session – C3A

In 2007, the Murray-Darling Basin Commission (MDBC) undertook a project to trial the use of the water market to 'recover' water for the environment. This pilot project aimed

to purchase up to 20 gigalitres of water from willing sellers along the River Murray system. Developed and implemented as a Living Murray Initiative water recovery measure, the purchased water will be used to improve the environmental health of the River Murray, particularly at six 'icon sites'. MDBC's first venture into the irrigation water market coincided with a period of significant change in the state legislation governing water entitlements, and considerable growth in the water markets. During the pilot project rapid developments in water market policies, systems and processes created some very interesting challenges for all involved. The MDBC considers that the pilot project not only provided first hand experience of government participation, but also the opportunity to assist in maturing an emerging water market.

LESSONS LEARNED IN WATERSHED PLANNING: ALISO CREEK, CALIFORNIA, USA

WILLIAMS Mark

Tetra Tech, Inc.

Session – C4B

Aliso Creek watershed is located in a highly urbanized setting within Southern California, USA. Over the last two decades, a number of water related issues have been independently addressed by various public and private entities. How to solve the downstream water quality problems and beach closures associated with urban runoff, erosion and habitat degradation within a regional park, has been fiercely debated. Over 23 technical documents have been completed and smaller routine problems have been addressed by piecemeal projects implemented by local agencies. Some projects have been successful, and some have failed. Implementation of effective solutions for some of the larger problems has been constrained by conflicting agency jurisdictions and mission statements. Public trust in the competence of the agencies leading the study efforts has been diminished, and blame for no-action has been cast in many directions. There is an increasing desire to see the immediate implementation of projects. In response to the situation, local agencies retained Tetra Tech, Inc. to conduct a review of the watershed planning process, identify successes and shortcomings, and recommend a go-forward strategy for positive results. This paper will address the watershed planning process, constraints to success, and recommended actions.

SUSTAINABLE RIVERS AUDIT – AN ASSESSMENT OF RIVER HEALTH IN THE MURRAY-DARLING BASIN

WILSON Michael, MALIEL Mathew, JOHNSTON Robyn

Murray–Darling Basin Commission

Session – C2A

The Sustainable Rivers Audit (SRA) is an initiative of the Murray–Darling Basin Commission partnership. The river condition assessments provided by the SRA will inform the development and implementation of management initiatives within the Basin and, along with the CSIRO Sustainable Yields project, will provide critical information to address water resource over-allocation. The SRA has completed the first basin-wide assessment of river condition for the Murray–Darling Basin, based on hydrology, fish and macroinvertebrate themes for 2004–2007. River ecosystem health has been assessed by combining information about the status and trends of environmental indicators in each of the 23 SRA valleys within the basin. The paper presents river health assessments for the 23 valleys, river health comparisons among valleys and an overall assessment of the basin's river health. It also includes an overview of the conceptual foundations and framework for the SRA, its methods, compliance and quality assurance, and plans for future enhancements.

ENSURING SECURITY OF WATER SUPPLY FOR REGIONAL QUEENSLAND OVER THE NEXT 50 YEARS

WONG Wai-Tong, GILBEY Peter

Department of Natural Resources and Water (Queensland)

Session – C3F

The state of Queensland occupies an area of about 1.7 million km² and experiences a large variation in climatic conditions. Drought and flood conditions, occurring at the same time across various parts of the state, are a common phenomenon. Hence planning for water supply requires a new, innovative and robust approach, particularly in the face of climate change and increasing demand. To deal with these challenges, the state government is developing regional water supply strategies for various key

regions in Queensland. The Central Queensland Regional Water Supply Strategy has recently been completed and is currently being implemented. Four new strategies are being developed, in collaboration with local governments and key stakeholders; namely, North Queensland, Far North Queensland, Mackay Whitsunday and Wide Bay Burnett. These strategies will enunciate a whole of government plan and actions to provide security of supply for urban, industrial and rural use over the short and long term (50 years). This paper will discuss the challenges in developing the policies to ensure the security of supply, technical studies undertaken and the process employed to achieve an optimum outcome – balancing demand, socio-economic and the eco-system environment. The key issues involved include population projection and demand forecast; urban/industrial and rural use; demand management (given lessons from recent drought); environmental flow; climate change and adaptation policies; water sources (traditional and manufactured water); water balance; timing for introduction of new supply; and level of service requirements.

CAN A RAMSAR WETLAND BE ACTIVELY USED FOR SEWAGE TREATMENT AND SUPPORT OF SUSTAINABLE LIVELIHOODS?

WRIGLEY Tim

The University of Queensland

Session – Poster

The Ramsar listing for the 12,000 ha East Kolkata wetlands, West Bengal, India was based upon the following justification:

(i) It is an example of wise use of wetlands ecosystem where usage of city sewage for traditional practices of fisheries and aquaculture are practiced.

(ii) It is a rare example of combination of environmental protection and development where the local farmers have adopted a complex ecological process by mastering resource recovery activity.

(iii) It is the largest sewage fed aquaculture in the world.

The emphasis on "wise use" which includes sewage treatment and fisheries production supporting a regional workforce of over 8,500 people was a key consideration of the Asian Development Bank investment program for water supply and sanitation for the city of Kolkata. A series of studies were undertaken to establish whether the ongoing "wise use" of the East Kolkata wetlands could be maintained with an additional 10% increase in settled sewage from the upgraded water supply and sanitation program. The studies indicated that the construction of two sewage treatment plants (\$US 25M) could be deferred and that the "wise use" of the wetlands would be enhanced with the additional sewage flow. The factors involved in this decision will be described in this paper.

NUTRIENT APPLICATION RATES AND THEIR EVOLUTION IN THE AUSTRALIAN SUGAR CANE INDUSTRY

WRIGLEY Tim

CANEGROWERS

Session – B3B

The Australian sugar industry lies in the coastal plain from Northern New South Wales to the town of Mossman in Australia's Wet Tropics. The industry established in the 1860's, covers an area of approximately 400,000 ha or up to 20 km x 200 km along 3000 km of predominantly Queensland coast line. Application rates of nitrogen and phosphorus and trace elements for optimal crop production historically were based on greenhouse and field trials. These rates were further refined and reduced in the 1990's by the Bureau of Sugar Research Station (BSES) in Queensland to reflect additional trials and regional climatic and soil conditions. These newer rates have encouraged growers to reduce nutrient inputs by at least 20%. In more recent times, as result of green cane trash harvesting, organic matter and nitrogen mineralization has increased in the soil profile. This has enabled further nutrient rate reductions by another 10–15%. Further research by CSIRO supported by the Sugar Research and Development Corporation is investigating "a nutrient replacement theory" which, if successful, will mean another additional 10-15% rate reduction in nutrient application rates. These combined reductions in nutrient application rates up to 50% deliver enhanced farmer profitability and sustainability and improved water quality outcomes for the receiving aquatic environment. Details of these changes and their ecological significance will be further discussed in the paper.

HOUSEHOLD APPROACH IN REDUCING FLOOD DISASTER EFFECT IN JAKARTA, INDONESIA

WULANDARI Arum, SIRAIT Mita J.

YE Water Program

Session – B4C

Jakarta, the capital of Indonesia, covers 740km² area with 8.69 million citizens (survey on 2006) has suffered at least 4 big floods in the last 15 years. The biggest happened in 2007. The flood caused 48 people to die, 939 diarrhea cases, 210257 people evacuated, 24957 houses damaged, and 8.8 trillion rupiah loss (± US\$ 930 million). Government main program to reduce flood is to make flood canal. In practice, the program shows a slow progress and flood will still happen in the process. YE Water Program aim to reduce and prevent extreme flood impact by educating people in 6 slum areas on water access, solid waste management, and health & hygiene behavior. We increase access to clean water and potable water by building household rainwater collection system and promoting household water treatment i.e solar disinfection, purification and chlorination, and ceramic filtration. To help in flood mitigation and sanitation, we train communities in solid waste management that covers household composting, and recycle plastic trashes to economical value products. Health and education program works closely with the children and adults to educate them on personal and environmental health and hygiene, i.e. hand-washing, waste management, composting, and planting.

WWTP DISCHARGES AS ENVIRONMENTAL FLOWS?

WYATT James, GABAS Stephan, LUKIES Simon

GHD Pty Ltd

Session – B4D

Macroinvertebrate communities were used to assess the potential impacts of Gippsland Water's Waste Water Treatment Plant's (WWTP) discharge into Shillinglaw Creek in Drouin (Victoria) during the Spring seasons between 2004 and 2007. In June 2006 a Dissolved Air Flotation Filtration (DAFF) system was installed at the WWTP. Analysis of the data revealed a significant difference in the macroinvertebrate communities prior to and after the commissioning of the DAFF treatment. Consistently higher SIGNAL indices were found downstream of the discharge point and indicate that tertiary treated wastewater does improve the quality of the effluent discharge and as a consequence the condition of the waterway downstream by providing additional flows. The Victorian Environmental Protection Authority has historically discouraged Water Authorities from discharging wastewater into waterways, instead promoting land based reuse. There is an increasing demand for water in the current and future climate. Environmental flows have in the past been generally regarded as a minor priority. It is therefore suggested that tertiary treated wastewater can be used for environmental flows, provided a risk assessment of each individual discharge is conducted.

AN OPTIMAL ENVIRONMENTAL WATER ALLOCATION MODEL FOR URBAN RIVERSYANG Wei¹, SUN Dezhi², YANG Zhifeng¹State Key Laboratory of Water Environment Simulation - Beijing Normal University¹,
College of Environmental Science & Engineering - Beijing Forestry University²**Session – C3F**

More and more rivers, especially urban rivers, are suffering from reductions in flow rate and water quality deterioration. In this paper, we describe the development of a simulation framework for allocating water from different sources to meet the environmental flows of an urban river. The model develops a rational balance among the utilization of storm water, reclaimed water from wastewater treatment plants, and freshwater from reservoirs. It is designed fully utilize of unconventional water sources for the restoration of river water quality by increasing river flow and improving water quality. To demonstrate practical use of the model, a case study is presented in which the model was used to simulate the environmental water allocation for the rivers in Daqing, China, based on the three water sources mentioned above. The results demonstrate that the model provides an effective approach for helping managers allocate water to satisfy the rivers' environmental flows.

CHALLENGES IN THE APPLICATION OF ENVIRONMENTAL FLOWS IN IWRM IN CHINA

YANG Zhifeng, CUI Baoshan, SUN Tai

State Key Laboratory of Water Environment Simulation - Beijing Normal University

Session – Poster

The water resources management has focused on providing enough water for human needs due to the spatial and temporal variation of water resources and rapid economic development in China in the past years. Ecosystem has been deteriorated due to the change of the freshwater discharge. Since 2007, hydro-ecological protection planning has been considered in the integrated planning at basin level and environmental flows were emphasized in the planning. How to quantify environmental flows has become the main challenge in integrated water resources management (IWRM) in China. In recent years, many researchers have focused on determination of the environmental flows in China. This paper introduces the policy related to maintaining the environmental flows and threshold theory to assess environmental flow in China. Classification and regionalization of ecosystem were conducted to identify multiple ecological management objectives and the spatial variability of the environmental flows in river basin. The environmental flows were determined by identifying the natural and artificial water consumption. Challenges in the application of environmental flows in integrated water resources management in China were proposed by analysing case studies in North of China.

RESEARCH ON ENVIRONMENTAL FLOWS FOR ESTUARIES IN CHINA

YANG Zhifeng, SUN Tai, ZHAO Rui

State Key Laboratory of Water Environment Simulation - Beijing Normal University

Session – A3D

Freshwater shortage is very urgent in most estuaries in China. Maintaining environmental flows has become one of the important tasks in river management. The characteristics and the critical threats were identified for Yellow River Estuary, Yangtze River Estuary, Haihe River Estuary and Zhujiang River Estuary, which are facing the most serious condition. Ecosystem deterioration due to the change of the freshwater discharge was analysed for different estuaries. The policy for maintaining the environmental flows and methodology for quantifying the environmental flows were introduced in the paper. Multiple ecological objectives were integrated to quantify the environmental flows in Yellow River Estuary. Salinity objectives of the critical habitat were considered in environmental flow assessment in Yangtze River Estuary. Annual environmental flow requirements and the monthly temporal variation for environmental flows were analysed in the researches. In order to have a further study on the environmental flows, a project of National Basic Research Program of China has been implemented in China in recent years. The problems and challenges were proposed for the studies on the environmental flows for the estuaries in China.

INTEGRATED ASSESSMENT OF THE LIKELY IMPACTS OF CLIMATE CHANGE AND FUTURE DEVELOPMENT ON WATER AVAILABILITY AND USE IN THE MURRAY-DARLING BASIN

YOUNG Bill, PODGER G., WALKER G. R., CHIEW F. H. S.

CSIRO Australia

Session – A2B

This paper provides an overview of the methodological framework of the Murray-Darling Basin Sustainable Yields (MDBSY) Project and presents the key results. The purpose of the MDBSY project was to (i) assess current and future water availability across the entire Murray-Darling Basin (MDB) in Australia considering climate change and other risks; and (ii) assess the hydrologic implications of future changes in water availability to consumptive water users and the environment. The MDBSY Project is the most comprehensive and the most integrated hydrologic modelling ever undertaken for the entire MDB, and is providing governments with an unprecedented level of scenario-based hydrologic information to guide MDB-wide water resources planning and management. Led by CSIRO, the project involved over 100 professionals from twelve government and industry organisations as well as many individual consultants, and was conducted over a 15-month period. The MDBSY project used outputs from 15 global climate models and considered three global warming scenarios to scale historical climate sequences as inputs to daily rainfall-runoff models and to scale groundwater recharge series. These in turn, provided the basis for modifying river and groundwater models to simulate hydrologic conditions under a range of possible 2030 climates. In addition to likely climate change impacts, assessments were made of the likely growth

in farm dams, commercial forestry plantations and groundwater use — all of which use water and affect streamflow downstream. Key results presented in this paper are for current development and historical climate and for future development and the 'best estimate' (or median) 2030 climate. Results presented include surface water availability and surface and groundwater water use. The results from the MDBSY project provide a strong hydrologic basis on which to begin determination of a new sustainable diversion limit for surface and groundwater for the MDB as required under the Commonwealth Water Act 2007. However, hydrologic information is only one of the important components of a broader assessment which must include the social, economic and environmental consequences of the expected changes in water availability.

CASCADE DAMS, ECOLOGICAL SECURITY, LANCANG-MEKONG RIVER, TRANSBOUNDARY**ZHAI Hongjuan, CUI Baoshan, HU Bo**

State Key Laboratory of Water Environment Simulation - Beijing Normal University

Session – C2E

As the developments of cascade dams may lead to severe consequences, the ecological security of the river has become the hot issue. The construction and operation of cascade dams on transboundary rivers involves bilateral or even multilateral benefits, therefore it is more complex and sensitive. We are working on a variety of approaches that can reduce the ecological risks, guarantee the ecological security of the downstream and help restore the degraded ecological conditions of Lancang-Mekong River. In this paper, we put forward an integrated framework to assess the ecological security of the cascade dams. First, we should totally understand the meaning of the ecological security. Ecological security criteria, the base to assess the ecological security, should be established in this part. Second, the mechanisms of the ecological security under the threats of cascade dams developments should be confirmed. The ecological security of the riverine ecosystem relates to external press (dam numbers, density, operation way, dam height, installed capacity), ecosystem state (restoration capacity, resistance, elasticity, present ecological condition) and the human response (conservation and restoration measures). Third, the mathematic model for assessment and prediction was constructed according to the analysis above. Since the paper discussed the cascade dams, the temporal and spatial cascade cumulative effects should be considered in the model. Last, according to the results of the assessment and prediction, we put forward the measures for ecological conservation and restoration.

THE ECOLOGICAL RESTORATION POTENTIAL OF THE LANCANG RIVER DISTURBED BY HYDROPOWER DEVELOPMENT IN CHINA**ZHAO Hui, CUI Baoshan, HU Bo**

State Key Laboratory of Water Environment Simulation - Beijing Normal University

Session – C2C

Ecological restoration and reconstruction for river ecosystem was one of important contents in the field of water management. This paper tried to study the possibility of ecological restoration of the Lancang River after powerstation construction and estimate ecological restoration potential in the areas disturbed by hydroelectric projects. Manwan and Dachaoshan segments were chosen as the cases to discuss, because Manwan and Dachaoshan powerstations were built in 1987 and 1993. In this paper, their current situations of ecological degradation and limiting factors of ecological restoration were analysed, then the ecological restoration potential was evaluated on the basis of four kinds of ecological indexes, which were the conditions of regional weather, hydrological features of the river, the conditions of riparian and biologic features, and loss rate of ecological restoration potential was calculated finally. The results show that synthetic loss rate of ecological restoration potential of Dachaoshan segment was more than that of Manwan segment, and ecological restoration potential of every index became worse and worse with the increasing of the number of powerstations.

PROMOTING ENVIRONMENTAL FLOW MANAGEMENT IN ASIAN RIVERS - POLICIES, CASES AND LESSONS**ZHOU Yaozhou**

Asian Development Bank

Session – C2C

The presentation will introduce Asian Development Bank (ADB) policies on water management and programs promoting integrated water resources management (IWRM) and environmental flow management in Asian rivers. It will discuss major findings and draw lessons from case studies of ADB's support in the area, including rivers in China, India, Nepal, and Pakistan, etc.

QUICK REFERENCE GUIDE (ORALS)								
Last	First	Theme	Session	Time	Day	Room	Country	Abstract Title
ACMA	Bulent	Transboundary rivers	D1E	08:30	Thur	M2	Turkey	Water security in the Middle East: as a case study The Euphates and Tigris Rivers
ADAME	Fernanda	E-Flows	B4D	15:30	Tues	P2	Australia	Ecosystem services provided by riverine and tidal dominated mangroves: retention of dissolved nutrients.
AHERN	Kathleen	E-Flows	A2D	10:30	Mon	P2	Australia	Toxic cyanobacterium blooms of <i>Lyngbya</i> and links to nutrients in Moreton Bay
AKEGBEJO-SAMSONS	Yemi	Food Production	B3B	13:30	Tues	P2	Nigeria	Climate change impacts on fisheries production in Land-water interface
ALEXANDRA	Jason	FEATURE - MDBC	C2A	10:30	Wed	M3	Australia	Agriculture and water market dynamics
ARTZ	Ira	Urban Waterways	C3E	13:30	Wed	PTR	USA	The Los Angeles River Revitalization Master Plan
ARUMUGAM	Thiru	Food Production	B3B	13:30	Tues	P2	Australia	Countering Climate Change: Maintaining Food Production in Jaffna, Sri Lanka
ASH	Andrew	KEYNOTE	A4	16:00	Mon	PTR	Australia	Climate change and water resources: adaptive responses are needed now
ASIO	Pressy Polah	Flood Plains	C4C	16:00	Wed	M3	Uganda	Dilemma of Managing River Nakivubo as a clean Urban Waterway
AUSTIN	Jeff	Climate Change	C2D	10:30	Wed	P1	Australia	The Great Artesian Basin - a 'River' of Extremes
BAKER	Natalie	FEATURE - Water, NRM	B2A	10:30	Tues	P1	Australia	Partnerships for Improved River Restoration
BALDWIN	Robert	Climate Change	A3E	13:30	Mon	M3	Canada	A Framework for Contemplating Climate Change in the Lake Simcoe Basin
BALDWIN	Claudia	Climate Change	B2E	10:30	Tues	M3	Australia	The Risk in Water Planning
BALDWIN	Robert	E-Flows	B2D	10:30	Tues	P2	Canada	Stormwater Management Concepts to Enhance Environmental Flows
BANSUAN	Abdula	Urban Waterways	B4C	15:30	Tues	M2	Phillippines	Invigorating Local Governance towards Effective River System Management
BARI	Muhammad	Transboundary rivers	A2F	10:30	Mon	M2	Bangladesh	Effect of transboundary flow regulation on wetland and riparian livelihood in the Surma-Kushiyara Basin
BARTON	Alan	Urban Waterways	C3F	13:30	Wed	M2	Australia	Integrated Water Cycle Planning Processes and Systems: a Local Government case study
BARTRAM	Jamie	KEYNOTE	A1	09:30	Mon	PTR	Switzerland	Water and Health - preventable disease and water management
BARWICK	Matthew	FEATURE - MDBC	C2A	10:30	Wed	M3	Australia	Impacts of drought and climate change on native fish communities in the MDB
BEAR	Graeme	FEATURE - Tomorrow's climate	B2B	10:30	Tues	PTR	Australia	
BEHERA	Sandeep	E-Flows	B4D	15:30	Tues	P2	India	Environmental flow requirements vis-à-vis habitat use pattern of freshwater dolphins
BENNET	Paul	FEATURE - Tomorrow's climate	B2B	10:30	Tues	PTR	Australia	
BERGKAMP	Ger	KEYNOTE	A1	09:30	Mon	PTR	France	Into hot water: Adapting to a changing climate
BHUIYAN	Muhammed	Flood Plains	B4C	15:30	Tues	M2	Bangladesh	A case study on participatory management of fishpass in Bangladesh
BLANCH	Stuart	Flood Plains	A3B	13:30	Mon	M1	Australia	Living Rivers policy to conserve floodplain rivers in the Northern Territory

Last	First	Theme	Session	Time	Day	Room	Country	Abstract Title
BLOCKWELL	Stephen	E-Flows	A3D	13:30	Mon	P2	Australia	Delivering and evaluating new environmental flows from Avon Dam, Australia.
BOCHARNIKOVA	Elena	Responsible Mining	B2C	10:30	Tues	M1	Russia	Purification of wastewaters from mining and possibility of regulating heavy metal concentrations in environmental flows
BOHNET	Iris	FEATURE - FEATURE - CSIRO	D1B	08:30	Thur	PTR	Australia	Future visions for the Tully catchment - a participatory planning approach
BONNERJEE	Sobhanlal	Urban Waterways	C4C	16:00	Wed	M3	India	Multifunctional role for urban waterways in changing waterways.
BRUN	Mara / Jamie	Transboundary rivers	C3D	13:30	Wed	M1	Australia	WWF and Green Cross seek urgent ratification of UN Watercourses Convention
BUCHAN	Arlene	E-Flows	D1D	08:30	Thur	P2	Australia	Market Based Instruments for Environmental Water Recovery
BUSIINGE	Ronald	Responsible Mining	A3F	13:30	Mon	M2	Uganda	Free Prior and Informed Consent (FPIC) concept to responsible mining in sustaining rivers and communities
BUTLER	Reid	Urban Waterways	C3E	13:30	Wed	PTR	Australia	Saving Water in Sydney, case studies and lessons learned.
CAMBPELL	Bruce	FEATURE - MDBC	C3A	13:30	Wed	M3	Australia	Drought contingency plan
CAMBPELL	Tom	Transboundary rivers	C3D	13:30	Wed	M1	Australia	Murray Mouth Sand Pumping: slowing the decline of the Coorong
CAMPBELL	Ian	Responsible Mining	B3D	13:30	Tues	M2	Australia	Ok Tedi Mine – leaving time bombs on the Fly River floodplain.
CARLYON	Greg	E-Flows	A3D	13:30	Mon	P2	New Zealand	Science and Regulation in a time of stress – you want it till you get it A regional assessment of the science and regulation underpinning the One Plan
CATTERALL	Kylie	Urban Waterways	B4B	15:30	Tues	M3	Australia	Development of a rapid microbial-based toxicity assay for waters & wastewaters
CHEN	He	E-Flows	C3B	13:30	Wed	P2	China	Application of river classification to define environmental flow in the Liao River
COLLIER	Neil	E-Flows	A2D	10:30	Mon	P2	Australia	Exploring scenarios for a tropical river catchment using system dynamics modelling
CONNELL	Daniel	Drought Management	A3C	13:30	Mon	P1	Australia	An international comparative study of management responses to extreme drought
CONNELL	Adam	Food Production	B2F	10:30	Tues	M2	Australia	On-Farm Water Quality Monitoring for Irrigators in the Lower Burdekin
COTE	Claire	Responsible Mining	B2C	10:30	Tues	M1	Australia	A systems modelling approach to manage discharge to rivers
DAVIES	Keith	Urban Waterways	C3F	13:30	Wed	M2	Australia	Diversifying South East Queensland's water supplies through purified recycled water
DE FRAITURE	Charlotte	KEYNOTE	B1	08:30	Tues	PTR	Sri Lanka	Water for food and fuel in a changing world
DeBONO	Kylie	FEATURE - Tomorrow's climate	B2B	10:30	Tues	PTR	Australia	
DENNISON	Bill	Urban Waterways	C4B	16:00	Wed	M2	USA	Global lessons for achieving healthy waterways: The legacy of Riverprize
DO	Thang Nam	Flood Plains	B3C	13:30	Tues	M3	Australia	Impact of alternative dyke management strategies on wetland values in the Mekong Delta
DOOLAN	Jane	FEATURE - NWC	A2B	10:30	Mon	PTR	Australia	How useful is scientific information in planning
DOOLAN	Jane	FEATURE - Tomorrow's climate	B2B	10:30	Tues	PTR	Australia	
DOUMBIA	Abdoulaye	Transboundary rivers	D1E	08:30	Thur	M2	Niger	Establishment of a hydraulic model for river niger basin

Last	First	Theme	Session	Time	Day	Room	Country	Abstract Title
DREISEITL	Herbert	KEYNOTE	C1	08:30	Wed	PTR	Germany	
DRIVER	Alastair	Flood Plains	B4C	15:30	Tues	M2	UK	Managing floods and biodiversity on a crowded and shrinking island
DUNCAN	Leonie	Climate Change	A2E	10:30	Mon	M1	Australia	Hattah Lakes Storylines: Facing the future knowing our past
FARTHING	Brendan	Urban Waterways	B4B	15:30	Tues	M3	Australia	A statistical tool for setting water quality guidelines and testing water quality targets
FARWELL	Joe	Climate Change	B2E	10:30	Tues	M3	Canada	Adapting to Climate Change – Building Resilience in a Watershed
FOSTER	Jean	Climate Change	C2D	10:30	Wed	P1	UK	Large-scale hydrological metrics: A composite river sustainability index
FOY	Sarah	E-Flows	C3B	13:30	Wed	P2	Australia	Characterising existing riverine conditions prior to environmental flow releases
FREEMAN	Col	FEATURE - Water, NRM	B2A	10:30	Tues	P1	Australia	A catchment management perspective - challenges in stakeholder engagement and the implementation of water quality improvement projects
FREITAS	Glauco	CASE STUDY - Paraguay and Parana Rivers	B1	08:30	Tues	PTR	Brazil	The Nature Conservancy and the Paraguay-Paraná Basin conservation
GAMAGE	Nimal Priyantha	Drought Management	A2C	10:30	Mon	P3	New Zealand	Analysis of low flows in selected New Zealand catchments
GARNETT	Corinne	Urban Waterways	C4C	16:00	Wed	M3	Australia	Information Management of Point Source Monitoring
GONZALEZ-VILLELA	Rebeca	E-Flows	C3B	13:30	Wed	P2	Mexico	Comparative study of three methods for the calculation environmental flows
GOODYEAR	Don	E-Flows	C2C	10:30	Wed	P2	Canada	Environmental Flows – Assessment and management in the Province of Ontario, Canada
GORDON	Iain	FEATURE - Impacts of rivers on reefs	A2A	10:30	Mon	P1	Australia	Managing the land to protect the reef
GRUN	Aniela	Climate Change	C2D	10:30	Wed	P1	Australia	A TRICI response to climate change predictions?
GUDKOV	Dmitri	CASE STUDY - Dnieper River	C4A	16:00	Wed	PTR	Ukraine	A case study of the Dnieper/Pripyat River Basin: consequences and lessons of the most severe man-made nuclear accident
HAFEEZ	Mohsin	Drought Management	A2C	10:30	Mon	P3	Australia	Mapping and Monitoring of Drought Severity in Murrumbidgee Catchment Using Optical-Thermal Satellite Data
HALES	Greg	Climate Change	B4E	15:30	Tues	P1	Australia	Creative solutions to river functioning in a change climate
HAMILTON	Stephen	Climate Change	A3E	13:30	Mon	M3	USA	Waterholes of Australian dryland rivers: Valuable but vulnerable
HAMLIN-HARRIS	David	Urban Waterways	C3F	13:30	Wed	M2	Australia	South Bank SHARC – An Iconic Project for an Icon of Brisbane
HANIA	Jan	E-Flows	B4D	15:30	Tues	P2	New Zealand	Innovations in Protecting Water Quality through Implementing a Nitrogen Cap
HEATH	Nick	FEATURE - Impacts of rivers on reefs	A2A	10:30	Mon	P1	Australia	Time running out for the reef - Will the Premier help or hinder?
HEYDON	Lana	Flood Plains	A3B	13:30	Mon	M1	Australia	Increasing Wetlands IQ – Synthesising Science for Managers
HIDAYAT	Fahmi	Flood Plains	B3C	13:30	Tues	M3	Indonesia	Impact of Climate Change on Floods in Solo and Brantas River Basins Indonesia
HOBAN	Alan	Urban Waterways	C3E	13:30	Wed	PTR	Australia	The Mainstreaming of Water Sensitive Urban Design in South East Queensland
HOEGH-GULDBERG	Ove	FEATURE - Impacts of rivers on reefs	A2A	10:30	Mon	P1	Australia	Coral reefs in an ocean of change

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HOLLAND CLIFT	Sarah	Transboundary rivers	A2F	10:30	Mon	M2	Australia	Willows: friend or foe? A national approach to willow management in Australia
HOLZWARTH	Fritz	Climate Change	B2E	10:30	Tues	M3	Germany	European Initiatives for Adaptation to Climate Change in River Basin Management
HOUGH	Paul	Urban Waterways	B4B	15:30	Tues	M3	Australia	Doing the RAP in South East Queensland
HOVERMAN	Suzanne	Urban Waterways	C4B	16:00	Wed	M2	Australia	Epistemological Gymnastics: Challenges to Knowledge Systems from Water Cycle Research
HUNTER-XENIE	Hmalan	Climate Change	A2E	10:30	Mon	M1	Australia	Bringing Aboriginal people into water planning – lessons from the Daly River
ISLAM	Mouludul	Flood Plains	C2B	10:30	Wed	M1	UK	Optimization of Channel Survey for Flood Risk Mapping
JOHANSEN	Kasper	E-Flows	B2D	10:30	Tues	P2	Australia	Monitoring Riparian Zone Condition Using Image and Field Based Assessment Methods
KAMALDASA	Badra	Responsible Mining	B3D	13:30	Tues	M2	Sri Lanka	Challenges in river management due to excessive sand mining
KAMALOV	Yusup	Transboundary rivers	C2E	10:30	Wed	M1	Uzbekistan	Ethic argues for transboundary rivers protection
KIEM	Anthony	Drought Management	A2C	10:30	Mon	P3	Australia	Impacts of climate variability and change on Victorian water resources
KINGSFORD	Richard	FEATURE - NWC	A2B	10:30	Mon	PTR	Australia	Why is it so hard to get environmental sustainability taken seriously in planning?
KROON	Fredereike	FEATURE - CSIRO Feature	D1B	08:30	Thur	PTR	Australia	Science informing the development of the Tully Water Quality Improvement Plan
LAGUTOV	Viktor	Transboundary rivers	A2F	10:30	Mon	M2	Hungary	Through preservation of Ural River Sturgeon habitats to sustainable watershed management
LAMBERTS	Rod	Transboundary rivers	A2F	10:30	Mon	M2	Australia	Engaging Visions: community, art, environment. An update
LANE	Chris	E-Flows	C2C	10:30	Wed	P2	Australia	Let the information flow: A Murray-Darling Basin case study
LEWIS	Brad	FEATURE - Water, NRM	B2A	10:30	Tues	P1	Australia	Engaging complet NRM?Water issues - possibilities through effective negotiation, facilitation and partnership development
LIMAYE	Shrikant Daji	Climate Change	B4E	15:30	Tues	P1	Belarus	The Role of UNESCO-IUGS-IGCP's Project "GROWNET" in Watershed Management in Low-Income Countries in View of Forthcoming Harsh Climatic Pattern
LIMPUS	Colin (Col)	Drought Management	D1C	08:30	Thur	M1	Australia	Freshwater turtle conservation management strategies in response to drought and river modification
LISKA	Igor	Transboundary rivers	D1E	08:30	Thur	M2	Austria	Joint Monitoring of a Shared Intrnational River Basin - the Danube
LONGSTAFF	Ben	Climate Change	C3C	13:30	Wed	P1	USA	The growing popularity of ecosystem health report cards: a management, communication and advocacy tool
LYNAM	Tim	FEATURE - Water, NRM	B2A	10:30	Tues	P1	Australia	Emerging and innovative approaches to social research / supporting effective environmental decision making - case study water & the Great Barrier Reef
MACKENZIE	John	FEATURE - Water, NRM	B2A	10:30	Tues	P1	Australia	More seats, more tables: Methods for enhancing public participation in water planning & management
MALE	John	Flood Plains	C2B	10:30	Wed	M1	New Zealand	Assessment of flood risk of the Cardrona River floodplain
MANUKALO	Viacheslav	Transboundary rivers	C3D	13:30	Wed	M1	Ukraine	Management of Water Quality within Transboundary River Basins: Case Study of Ukraine
MAROULIS	Jerry	Climate Change	C3C	13:30	Wed	P1	Australia	It's getting drier? Palaeoclimatic evidence from Cooper Creek, central Australia
MARR	Andy	Food Production	B2F	10:30	Tues	M2	Australia	GIS-based Decision Support System for Conjunctive Irrigation Management in India

Last	First	Theme	Session	Time	Day	Room	Country	Abstract Title
MARTIN	Fin	Drought Management	A2C	10:30	Mon	P3	Australia	Ranking and apportioning a cost share to catchment scale environmental work programs
MATHEWS	Maurice	Urban Waterways	B4B	15:30	Tues	M3	Australia	Managing Urbanising Catchments for Waterway Resilience
MATTHEWS	Ken	FEATURE - NWC	A2B	10:30	Mon	PTR	Australia	The NWI and the importance of scientific knowledge
MAVLYANOV	Pulat	Flood Plains	B3C	13:30	Tues	M3	Uzbekistan	Transboundary floods in the territories of Fergana Valley of Uzbekistan
MAYNARD	Simone	Climate Change	B2E	10:30	Tues	M3	Australia	Managing South East Queensland's Ecosystem Services for the Future.
McJANNET	David	FEATURE - CSIRO Feature	D1B	08:30	Thur	PTR	Australia	The potential for tropical wetlands to improve water quality
MCKIERNAN	Steven	Drought Management	D1C	08:30	Thur	M1	Australia	Adaptive management of a crucial water supply source in a biodiversity hotspot
MEEGASMULLAGE	Sirisena	Drought Management	D1C	08:30	Thur	M1	Sri Lanka	Basin Scale Drought Management in Kirindioya River System
MENESES CARDOSO DA SILVA	Luciano	E-Flows	C3B	13:30	Wed	P2	Brazil	Environmental flows: Legal possibilities in Brazil
MENZIES	Walter	CASE STUDY - Mersey River	A4	16:00	Mon	PTR	UK	Mersey - the river that changed the world
MORAN	Chris	Responsible Mining	A3F	13:30	Mon	M2	Australia	A risk-based assessment of the value of water in mining
MOTIEE	Homayoun	Drought Management	D1C	08:30	Thur	M1	Iran	Arid and Semi-arid Regions' Rivers Under Stress: The Case of Karoun River in West of Iran
MUJERE	Never	Climate Change	C3C	13:30	Wed	P1	Zimbabwe	Examining the impact of climate change on reservoir reliability
NANDALAL	K. D. Wasantha	Responsible Mining	A3F	13:30	Mon	M2	Sri Lanka	Impact of Gem Mining on a River in Sri Lanka
NANDY	Supriyo	Flood Plains	B4C	15:30	Tues	M2	India	River of riches: Study of Great Flood Plain River: Ganges
NEAL	James	Food Production	B3B	13:30	Tues	P2	Australia	Choosing forages to improve water use efficiency for dairy production
OGONJO	Ollta	Climate Change	B4E	15:30	Tues	P1	Kenya	Climate Change and Drying Dams - Community Action to Improve Water Security in Rural Kenya
O'KANE	Bill	E-Flows	B2D	10:30	Tues	P2	Australia	Landscape Change – Is it worth the pain?
OLDS	Andrew	E-Flows	B4D	15:30	Tues	P2	Australia	Regulation of River Flow Maintains Health in the Barron Gorge
ONYEKAKEYAH	Luke	Transboundary rivers	D1E	08:30	Thur	M2	Nigeria	Lake Chad: A Study of a Drying Freshwater Reservoir
OTTO	Betsy	Drought Management	A3C	13:30	Mon	P1	USA	WaterSense: Reducing Water Use in the U.S. via Market Transformation
PARKINSON	Tyrone	Flood Plains	C2B	10:30	Wed	M1	UK	Lessons learnt from an Internet based Public Flood Warning System
PASA	Arturo	Climate Change	C3C	13:30	Wed	P1	Phillippines	Smallholders' Contribution on Climate Change Mitigation and Water Quality
PAYNE	Jennifer	Flood Plains	C2B	10:30	Wed	M1	Canada	Developing Mapping Tools to Identify Flood Vulnerable Features for Emergency Response
PETHYBRIDGE	Matthew	E-Flows	A2D	10:30	Mon	P2	Australia	Providing environmental flows through increased irrigation planning
PHOUMAVONG	Sourasay	Transboundary rivers	C3D	13:30	Wed	M1	Lao, PDR	The Navigation Channel Improvement on the Lancang-Mekong River - Traffic Safety and Environment Protection

Last	First	Theme	Session	Time	Day	Room	Country	Abstract Title
PICKERSGILL	Glenda	E-Flows	B2D	10:30	Tues	P2	Australia	What is special about the Mary River's threatened ecological communities?
PINSKY	Malin	Climate Change	B4E	15:30	Tues	P1	USA	Conservation planning for resilience: a case study with salmon
PITTOCK	Jamie	Climate Change	A3E	13:30	Mon	M3	Australia	Freshwater conservation & climate change adaptation lessons from WWF projects
PITTOCK	Jamie	Climate Change	B4E	15:30	Tues	P1	Australia	The threat to freshwater conservation from climate change policies
PIYADASA	Ranjana	Responsible Mining	B3D	13:30	Tues	M2	Sri Lanka	River Sand Mining in Southern Sri Lanka and its Effect on Environment
PLATT	John	Urban Waterways	C4C	16:00	Wed	M3	Australia	Collier River salinity recovery – improving water resources in a competing environment
POPOV	Yuriy	E-Flows	D1D	08:30	Thur	P2	Kazakhstan	Environmental flows for fight against desertification in reiver deltas
POPOV	Sergey	Responsible Mining	B3D	13:30	Tues	M2	Russian	Mining in the Middle Don River Basin: Theats and Counteraction
POWELL	Bronwyn	Climate Change	A2E	10:30	Mon	M1	Australia	Unexpected outcomes: Catchment systems understanding in the Solomon Islands
PUTTASWAMIAH	Sanjeevaiah	Food Production	B2F	10:30	Tues	M2	India	Linking River Basins for Agriculture Development: Insights from India
REARDON-SMITH	Kathryn	E-Flows	B4D	15:30	Tues	P2	Australia	Riparian woodlands in crisis? Disturbance ecology on the Condamine floodplain
RISSIK	David	Flood Plains	B3C	13:30	Tues	M3	Australia	And the rain came falling down: Monitoring the effects of flooding in the Logan Albert estuary
ROBERTS	LES	FEATURE - MDBC	C2A	10:30	Wed	M3	Australia	Lessons in maintaining transborder programs
ROSS	Helen	Climate Change	A2E	10:30	Mon	M1	Australia	Resilience in North Queensland catchments
ROSS	Andrew	Drought Management	A3C	13:30	Mon	P1	Australia	The challenge of adaptive groundwater management in Australia and Spain.
SADIKI	Hamza	CASE STUDY - Pangani River	C4A	16:00	Wed	PTR	Tanzania	Reconciling economic, social and environmental water needs in Pangani Basin, Tanzania
SALMINA	Yulia	Responsible Mining	A3F	13:30	Mon	M2	Russia	Rivers Pollution in Oil Production Areas in Siberia
SCHOFIELD	Nicholas	E-Flows	D1D	08:30	Thur	P2	Australia	Strengthening environmental water governance in Australia
SHAHEEN	Farhet Ahmad	Transboundary rivers	C2E	10:30	Wed	M1	India	Sustaining energy and food security in transboundary riversystem: case of Indus basin
SHAW	Sylvie	Urban Waterways	C4B	16:00	Wed	M2	Australia	Values of the Brisbane River
SIEBENTRITT	Mark	E-Flows	D1D	08:30	Thur	P2	Australia	The Future in Water Trading
SKRANDIES-MARTIN	Jane	Climate Change	A3E	13:30	Mon	M3	Australia	Microclimatic extremes upset macroinvertebrates in tropical, montane, low order streams
STORY	Justin	Food Production	B2F	10:30	Tues	M2	Australia	Framework to support irrigation decision-making in complex and changing times
SWIREPIK	Jodi	FEATURE - MDBC	C3A	13:30	Wed	M3	Australia	Blueprints
TEK	Vannara	E-Flows	C3B	13:30	Wed	P2	Cambodia	Villager Research (In Khmer Language call SALAPHOUM)
TENNANT	Wayne	Climate Change	C3C	13:30	Wed	P1	Australia	The Goulburn Broken Water Quality Strategy – 10 Years On

Last	First	Theme	Session	Time	Day	Room	Country	Abstract Title
THORBURN	Lauren	Responsible Mining	B2C	10:30	Tues	M1	Australia	Developing a Rigorous Aquatic Ecological Monitoring Program at a Central Queensland Mine
TISDELL	John	Climate Change	C3C	13:30	Wed	P1	Australia	Regulating Non-Point Pollution in Rivers and Streams
TRIPODI	Neil	Urban Waterways	C3F	13:30	Wed	M2	Australia	Managing brine concentrate discharges in drought conditions
TURPIN	Jennifer	Urban Waters Plenary Session	C2F	10:30	Wed	PTR	Australia	A flow of Ideas: Water, art and environment
TWOMEY	Luke	Climate Change	C2D	10:30	Wed	P1	Australia	Potential impacts of climate change on the Swan and Canning rivers, Perth WA.
VERDON	Danielle	Drought Management	A3C	13:30	Mon	P1	Australia	Drought risk in Australia – what can the past tell us about the future?
VINK	Sue	Responsible Mining	B2C	10:30	Tues	M1	Australia	Riparian biodiversity structure and function: implications for mine lease management
WALKER	Glenn	Flood Plains	A3B	13:30	Mon	M1	Australia	Let it flood - protecting Queensland's vast floodplains
WALTHAM	Nathan	Urban Waterways	C3E	13:30	Wed	PTR	Australia	Artificial urban waterways: fish habitats, fish health and fish edibility
WAMBAZU MUGOBERA	Samuel	Flood Plains	A3B	13:30	Mon	M1	Uganda	A Micro Hydro Power dam to control floods
WARD	Neil	FEATURE - MDBC Feature	C3A	13:30	Wed	M3	Australia	Effective indigenous involvement in the living Murray - Introducing a new methodology
WEBB	Paul	E-Flows	A2D	10:30	Mon	P2	Australia	Engaging agricultural communities in NRM with riverine monitoring
WEBB	Graham	Urban Waterways	B4B	15:30	Tues	M3	Australia	Rapid assessment of waterway health based on quantifying riparian vegetation
WEBSTER	Tony	FEATURE - CSIRO Feature	D1B	08:30	Thur	PTR	Australia	Identification of land management options for improving water quality in the Tully catchment
WEIR	Jessica	E-Flows	A3D	13:30	Mon	P2	Australia	Environmental Flows and Cultural Flows: what's the difference?
WELLER	Philip	Transboundary rivers	C2E	10:30	Wed	M1	Austria	Applying the EU Water Framework Directive in the Danube River Basin
WESTCOTT	David	FEATURE - CSIRO Feature	D1B	08:30	Thur	PTR	Australia	Maximising biodiversity outcomes for water quality
WHITE	Lindsay	FEATURE - MDBC Feature	C3A	13:30	Wed	M3	Australia	Buying irrigation water for the environment - Lessons from the market in a transboundary program
WILLIAMS	Mark	Urban Waterways	C4B	16:00	Wed	M2	USA	Lessons Learned in Watershed Planning: Aliso Creek, California, USA
WILSON	Michael	FEATURE - MDBC Feature	C2A	10:30	Wed	M3	Australia	Sustainable rivers audit - An assessment of river health in the Murray-Darling Basin
WONG	Tony	Urban Waters Plenary Session	C2F	10:30	Wed	PTR	Australia	
WONG	Wai-Tong	Urban Waterways	C3F	13:30	Wed	M2	Australia	Ensuring Security of Water Supply for Regional Queensland over the Next 50 Years
WRIGLEY	Tim	Food Production	B3B	13:30	Tues	P2	Australia	Nutrient Application Rates and their Evolution in the Australian Sugar Cane Industry
WULANDARI	Arum	Flood Plains	B4C	15:30	Tues	M2	Indonesia	Household approach in reducing flood disaster effect in Jakarta, Indonesia
WYATT	James	E-Flows	B4D	15:30	Tues	P2	Australia	WWTP Discharges as Environmental Flows?
YANG	Zhifeng	E-Flows	A3D	13:30	Mon	P2	China	Researches on Environmental Flows for estuaries in China
YANG	Wei	Urban Waterways	C3F	13:30	Wed	M2	China	An Optimal Environmental Water Allocation Model for Urban Rivers

Last	First	Theme	Session	Time	Day	Room	Country	Abstract Title
YORKSTON	Hugh	FEATURE - Impacts of rivers on reefs	A2A	10:30	Mon	P1	Australia	
YOUNG	Bill	FEATURE - NWC	A2B	10:30	Mon	PTR	Australia	The Sustainable Yield Project - Murray Darling Basin and beyond
ZHAI	Hongjuan	Transboundary rivers	C2E	10:30	Wed	M1	China	Cascade dams, Ecological security, Lancang-Mekong River, Transboundary
ZHAO	Hui	E-Flows	C2C	10:30	Wed	P2	China	The Ecological Restoration Potential of the Lancang River disturbed by hydropower development in China
ZHOU	Yaozhou	E-Flows	C2C	10:30	Wed	P2	China	Promoting environmental flow management in Asian rivers - policy, cases and lessons

QUICK REFERENCE GUIDE (POSTERS)					
Last	First	Theme	Poster #	Country	Abstract Title
BELING	Ed	Urban Rivers	1	Australia	Trading for a better future: Improving the health of Moreton Bay through a nutrient trading scheme
BOBROVITSKAYA	NELLY	Transboundary rivers	2	Russia	Experience of studies on hydrological and hydrochemical regimes of the transboundary rivers in Russia
BUSIINGE	Ronald	Climate Change	3	Uganda	Adaptations for reducing vulnerabilities of adverse climatic conditions on rivers
DUNDABIN	Sandy	Climate Change	4	Australia	Community Care in a Catchment
FOSTER	Jean	Flood Plains	5	Ukraine	The Impact of Low Flow Events on Flood Frequency in the Lower Yellow River
KATH	Jarrod	Climate Change	6	Australia	Ephemeral wetlands: their ecological function & resilience and climate change
MANUKALO	Viacheslav	Climate Change	7	Ukraine	Water Resources in Ukraine Under Climate Change: Assessment and Measures of Adaptation
MEEGASMULLAGE	Sirisena	Climate Change	8	Sri Lanka	Building the Climate Resilience to Rivers in Sri Lanka
MOULTON	Dane	Climate Change	9	Australia	A New Partnership for Establishing Waterway Ecological Values and Priorities for Protection
NADUNGA	Grace Caroline	Food Production	10	Uganda	Constructed Valley Dams For Food Security
NANBAKSHH	Hassan	Urban Rivers	11	Iran	Heavy metals pollution in the Shar Chi River (Urmia Iran)
PETER	David	Responsible Mining	12	PNG	Upstream Mining in the Sepik River-Papua New Guinea
PIYADASA	Ranjana	Urban Waterways	13	Sri Lanka	Variation of Salinity in Polwathumodera River with lunar patterns- Case study in Sri Lanka
QIN	Yan	E-Flows	14	China	Ecological land classification for river basin management
QIN	Yan	E-Flows	15	China	Ecological risk assessment of water resource system in the Hai River Basin
REGMI	Prakash	Flood Plains	16	Nepal	A Study of Narayani River Course, Central Nepal
SADAT	Morteza	E-Flows	17	Iran	A Fuzzy Regression Model for Estimation of the Fall Velocity of Natural Particles
SHAH	Thark Bahadur	Urban Waterways	18	Nepal	Karnali River and People
SHAH	Thark Bahadur	Transboundary rivers	19	Nepal	Karnali River and local community
SULTANA	Shireen	Transboundary rivers	20	Bangladesh	IWRM and Transboundary Rivers: Bangladesh Context
SUSILOWATI	Indah	Climate Change	21	Indonesia	Managing Krasak River as Waterways and channel for Vulcano Merapi Eruption in Central Java-Indonesia: between endeavour and disaster
THOMAS	Jane	Urban Waterways	22	USA	Science synthesis and communication are showcased in two new books.
WEARING	Cameron	Climate Change	23	Australia	Adapting to climate change in Central Queensland
WEBB	Paul	Climate Change	24	Australia	Action Learning - soil water, water quality and coping with change
WRIGLEY	Tim	Food Production	25	Australia	Can a Ramsar wetland be actively used for sewage treatment and support of sustainable livelihoods?
YANG	Zhifeng	E-Flows	26	China	Challenges in the Application of environmental flows in IWRM in China