



Abstracts

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THE DRAINAGE NUTRIENT INTERVENTION PROGRAM: A CASE STUDY IN DRAINAGE IMPROVEMENT

ADKINS Peter

Swan River Trust

Session - A2F

The Swan River Trusts' Drainage Nutrient Intervention Program (DNIP) was established in 2003 in response to algal blooms and fish deaths in the Swan and Canning rivers. The Program implements onground nutrient intervention works in drains and tributaries of priority nutrient enriched catchments in the Swan Canning river system. The DNIP trials different structural nutrient intervention approaches in these priority catchments to determine their effectiveness at improving water quality. Projects provide enhancement of ecological and social values in the areas where they are constructed. The Program works follow a model of engaging key stakeholders from the beginning of the planning process through to implementation and concludes with handover of the site. During this period, the nutrient intervention works are intensively monitored to determine their efficacy, how they can be managed to improve their performance and to add to the understanding of stormwater treatment structures in Western Australia. Since 2003, the DNIP has implemented and monitored nutrient intervention works at a number of sites in urban and rural catchments, with works including constructed wetlands, compensation basin restoration projects and the use of nutrient absorbent materials. This paper will outline the achievements of the program and provide details of outcomes and learning's from specific projects.

INNOVATIVE STRATEGY IN PARTICIPATORY WATER MANAGEMENT- A CASE OF BULK WATER ALLOCATION FROM SRI LANKA

AHEEYAR Mohamed

HK/ Agrarain Research and Training Institute

Session - A2E

Mahaweli river is the longest river in Sri Lanka covering largest irrigation extent of the country. The river basin is divided into number of sub systems for administrative and management purpose. Mahaweli-H is the oldest system of the basin and scarcity of water is high compared to rest of the areas in the basin. The irrigation agency implemented various efforts to mobilize farmers for the system management to meet the challenge of water scarcity in line with the government policy of participatory irrigation management but failed to meet anticipated goals. The concept of Bulk Water Allocation (BWA) was introduced in the system-H to find out a methodology to solve the problem of allocating water for crop production and increase the farmer participation in the context of multi purpose river basin. The paper discusses the concept, implementation methodology and its impacts on managing water scarcity. The approach and methodology adopted in Mahaweli H area via assured water supply and comprehensive devolution policy with appropriate institutional arrangements is a good learning experience for rest of the river basins, which are experiencing water allocation and maintenance problems under the participatory irrigation while having suitable infrastructure to practice BWA.

INSTITUTIONAL CONFLICTS IN SHARING WATER WITH IRRIGATION AND URBAN USERS

AHEEYAR Mohamed

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HK/ Agrarian Research and Training Institute

Session – Poster (Hard & Electronic)

Anuradhapura is one of the fast growing cities in Sri Lanka, but availability of treated water was only for 46 % of the population for 8-12 hours per day. A new water supply scheme was implemented in 2002-2005, but much delayed due to paucity of raw water. Although the line agencies agreed to augment an existing irrigation reservoir in a neighbouring village, the storage and reserving of the allocated water in a irrigation reservoir for drinking purpose when there is a shortage for irrigation created a conflict. The farmers were convinced by some external interested parties that implementation of the water supply project would lead to loss of their farming activities or have to face frequent crop failures due to water shortages in the aftermath of sharing their water. Farmers filed a case against the project in the Supreme Court with the backing of interested groups. The paper discusses the institutional, social and legal background of the case and the causative factors that created the conflicts of sharing

water. The case study highlights that issues in water allocation among different water-use groups can be best resolved if stakeholder consultation is considered as an important strategy. Allocation rules imposed by a state agency are less effective than an agreed set of rules reached after negotiation with all of the water user groups, as their competing demands can only be settled by consensus.

GROUNDWATER-SURFACE WATER INTERACTIONS ALONG THE **BRUNSWICK RIVER. WESTERN AUSTRALIA**

ANNAN Katrina

Bureau of Meteorology

Session - C3E

Traditionally groundwater and surface water have been managed as separate water resources. However, in many regions, they are hydraulically connected and the abstraction from one can influence the other. There is an increasing body of knowledge recognising the significant implications of groundwater-surface water connection and an increasing number of methods developing to assess this connection but still a lack of recognition in many water management plans. Too often groundwater and surface water are dealt with separately, which can cause many water management issues, including the over allocation of water. With more than 67% of Western Australia's drinking water relying upon groundwater, establishing the link between groundwater and surface water in supply catchments is highly necessary. This paper summarises work that was done to investigate groundwater-surface water interactions along the Brunswick River, Western Australia, and a look at how the information has been digested since. Recent dam construction projects for the lower reaches have been placed on hold due to further environmental flow requirement knowledge being necessary. This paper also highlights the need for reliable, extensive and easily available groundwater and surface water data - a challenge the Bureau of Meteorology is endeavouring to achieve through their Water Information role.

CLIMATE CHANGE AND WATERSHED DEGRADATION: COMMUNITY IMPACT AND ADAPTATION

BANSUAN Abdula

Allah Valley Landscape Development Alliance

Session - B3C

The Philippines is one of many countries identified as highly vulnerable to the brunt of climate change. Frequent occurrence of big typhoons has been observed with crushing damage often reaching billions of pesos annually. Meanwhile, there is a growing concern over the pattern of typhoon belt moving southward. Mindanao Island has been hit in recent years by unexpected typhoons and torrential rains. This paper explains and finds that the adverse effects of climate change can be exacerbated by the declining condition of critical watersheds. Large forestlands in the Allah River watershed are converted in traditional agricultural land use sans soil and water conservation techniques. Heavy rains pouring in those areas mobilize enormous silts and bring floods to rivers causing public infrastructures and communities downstream to suffer. Lives and health of many poor people living near riverbanks are often at risk, and as rivers modify courses their farming livelihoods are destroyed. In response, communities and local governments developed concerted efforts in preparedness and adaptation. Among the strategies implemented are riparian zone management, solid waste management, sustainable biodynamic farming and water transport. These initiatives also involve other sectors such as academe, business, civic and women in order to share responsibilities and increase public awareness.

TEMPORAL AND SPATIAL GROUNDWATER CONTRIBUTIONS TO THE SOUTHERN RIVER (WA) BASED ON MODHMS MODELLING

BARR Anthony, BARRON Olga

CSIRO Land and Water

Session - C3E

The Southern River catchment is one of the fastest urbanising areas of Perth. The catchment is located on the south-east margin of the Perth metropolitan area and has a low-lying flat landscape where surface water - groundwater interactions dominate the hydrology and influence environmental flows. The Southern River flows north through the centre of the catchment and has tributaries some of which arise in the nearby hills and some which are anthropogenic drainage systems. The current land use consists of urban areas near the outflow of the Southern River and in the higher areas in the east close to the hills, a large lake in the central part of the catchment, with the remaining area a mixture of wetlands and pastoral lands. The soil type varies from sandy-clay (Guildford Formation) in the east to Bassendean Sands in the west. The Mediterranean climate creates large winter flows whilst summer flows are intermittent. There are differing temporal patterns in groundwater discharge to the rivers in different parts of the catchment. In the north, close to the outflow, there is continuous groundwater discharge that exhibits relatively small seasonal variations. In the west in the low relief Bassendean Sands, groundwater discharge occurs for a short period of late winter to early spring when the watertable levels intercept the base of the channel system. Analysis of the model hydrological parameters and annual modelled groundwater discharge showed the temporal distribution of discharge depends on the incision of the channel into the landscape relative to the minimum watertable level whilst the quantity of discharge depends on the hydraulic gradient and the maximum watertable level.

REJUVENATION OF A CANAL INTO A NATURAL RIVER - A CASE STUDY: KALLANG RIVER ALONG BISHAN PARK

BAUR Tobias

Atelier Dreiseitl

Session - A2F

Integrating a natural resource like a river into a densely populated Singapore has been a constant challenge faced by the municipal leaders and the government. The plan by the Public Utility Board (PUB), Singapore's water agency, was to leverage on the ABC Waters program to achieve the Active, Beautiful, and Clean waterways throughout the city. The program aims to bring people closer to the water, fostering a sense of ownership; creating beautiful attractions and transforming engineered drains and canals into efficient streams and rivers. The ultimate goal was to harness innovative technology to improve the overall water quality of the island. The redevelopment of Bishan Park provided a pilot opportunity to transform the existing Kallang River along Bishan Park into a natural river with the use of soil bioengineering. An experimental test area was used as replacement for a 70m stretch of a major storm drain in Bishan Park feeding the Kallang River and providing real-time data for soil bio-engineering as a viable alternative to a concrete canal drain system. The implementation of the soil bio-engineering treatment for river rejuvenation requires an understanding of the design and construction process, especially of the

soil condition and plant selection. Currently, studies of soil bioengineering in Southeast Asia are limited and can only provide an informative basis for the resilience of the treatments used. Further testing and monitoring would have to be done to determine how it would react to high stress area or severe storm events. Unlike the hard engineering solutions, the evolving nature of the test bed clearly demonstrates that soil bio-engineering is a dynamic design approach subject to the vagaries of natural process which require a unique approach to design and long term maintenance.

LAKE ILLAWARRA: BACK FROM THE MURKY BRINK

BAXTER Cassy

Lake Illawarra Authority

Session - C3D

Lake Illawarra is a coastal lake which has been subjected to accelerated sedimentation, water pollution and ecosystem destruction since settlement over 180 years ago. In 1988 the Lake Illawarra Authority (LIA) was formed under state government legislation to act as a governing body

The freshwater fishes of the Southwest Coast Drainage Division of Australia are depauperate yet highly endemic. These fauna continue to be severely impacted by habitat alterations that have led to considerable population declines. In particular, secondary salinisation has recently been identified as a major cause of these range reductions of these species. Despite these declines, the role that fresh groundwater intrusions have on maintaining critical refuge habitats is poorly understood. Using two case studies from the Swan–Canning catchment and the Blackwood River, this presentation discusses how salinisation has led to range contractions of the freshwater fish fauna and concomitant inland expansions of estuarine species. It then presents findings from the long-term (five year) study into the relationships between freshwater fish movement patterns, habitat usage and prevailing environmental variables in the Blackwood River (the largest by discharge in the region). The study reveals clear relationships between surface and groundwater flow and ecology of freshwater fishes in this system and demonstrates that fresh groundwater intrusion plays a crucial role in maintaining threatened freshwater fish populations. Management implications are outlined in terms of setting ecologically sustainable levels of groundwater extractions from the south-west in light of continuing rainfall reductions due to climate change.

to restore and manage the lake. The LIA has worked to incorporate scientific research with management and engineering techniques to significantly improve the quality and value of the lake in terms of both ecological and social benefits. The major thrust of the Authority has been toward achieving water quality improvements. Significant amongst major works have been improvements to the lake entrance which have taken some 10 years to complete. These works resulted in not only improvements in water clarity and reduced algal blooms but has also resulted in noticeable increases in aquatic species such as prawns within the lake. The LIA has also utilised artificial wetlands in order to minimise nutrient and sediment loads entering into the lake through storm water discharges. A variety of rehabilitation works have also been undertaken to improve the area of habitat for local faunal species as well as to achieve bank stabilisation and erosion control. The LIA has been working in the past with research organisations such as the University of Wollongong to increase the knowledge about the chemical, physical and biological processes within the lake. Work has included a nutrient dynamic study which has been a key document in management decisions within the lake.

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GROUNDWATER INTRUSION MAINTAINS ENDEMIC FRESHWATER FISHES IN SOUTH-WESTERN AUSTRALIA

BEATTY Stephen, MORGAN David

Centre for Fish and Fisheries Research. Murdoch University

Session - C3E

LOCAL WATER QUALITY IMPROVEMENT PLANS

BESCH Debbie

Swan River Trust

Session – Poster (Hard & Electronic)

The Swan River Trust (Trust) through the Healthy Rivers Action Plan aims to maximise the reduction of nutrients and other contaminants entering the Swan and Canning rivers by directing funding to catchments that contribute the greatest amount of nutrients or other contaminants to the rivers The Australian Government under the Coastal Catchments Initiative supports the development of Water Quality Improvement Plans (WQIPs) at a regional level and has funded this approach for the Swan and Canning river system. Using this framework, the Healthy Rivers Action Plan has extended this approach at a local level to the eight priority catchments not meeting the nutrient targets for the Swan and Canning river system. To develop the local WQIPs the Trust has been working with key stakeholders to identify current ecological condition, environmental values and develop a set of management strategies including the use of water sensitive urban 👘 design to reach the targets required. The Healthy Rivers Action Plan aims to reduce nutrient inputs by 30 % by 2015. The Trust has committed more than \$1 million during the next five years to fund community groups and local government to develop and implement local WQIPs. Five of the 🧬 eight WQIPs have been completed and the Trust is working to implement onground works to protect the environmental health and community benefit of the Swan and Canning rivers by improving water quality

ECONOMIC AND SOCIAL ASPECTS OF PROTECTING ENVIRONMENTAL VALUES OF WATERWAYS IN THE GBR

BINNEY Jim¹, CLOUSTON Beth², BENNETT John², MOULTON Dane²

Marsden Jacob Associates¹, QLD Department of Environment and Resource Management^a

Session – Poster (Hard)

The Australian National Water Quality Management Strategy details a water guality 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, two key policy approaches are being adopted to protect and maintain water quality: formal scheduling for environmental values (i.e. waterway values and uses) and water quality objectives (i.e. water quality targets) by the Department of Environment and Resource Management; and the establishment and funding of Water Quality Improvement Plans (WQIPs) under the Australian Government's Coastal Catchments Initiative. But what are the economic and social benefits, costs and implications of establishing and achieving water quality objectives? What are the social and economic impediments to achieving the objectives and what policies or suites of policies are needed? This poster summarises the findings from a socio-economic assessment of five WQIPs developed in the Great Barrier Reef. It outlines how the socio-economic assessment has been integrated into broader water quality policy, planning and regulation in Queensland and how economic and social science analysis can assist in designing and developing effective and efficient water quality actions.

LINKING FLOW AND ECOLOGY: MAKING BETTER ENVIRONMENTAL WATER ALLOCATION DECISIONS IN TASMANIA

BOBBI Christopher, HARDIE Scott, UYTENDAAL Adam

Department of Primary Industries, Parks, Water and Environment

Session - D1E

The natural flow regime (and its intrinsic variability) is widely recognised as being important for riverine ecosystems. The Tasmanian Environmental Flows Framework (TEFF) has recently been developed in recognition of the need to preserve critical aspects of the flow regime, most importantly the variability, of unregulated rivers, and the connectivity through space and time of rivers, floodplains and groundwater systems. However, this framework recognises that there is often limited understanding of the links between flow and ecological patterns and processes, especially those in Tasmanian river systems. The TEFlows Project was undertaken to gather information in this area for riverine and estuarine ecosystems in Tasmania. This 2-year study was conducted in catchments in the east of the State which have two distinct flow types: (1) a high degree of flow variability and (2) a much more predictable pattern of flow. The project had a holistic approach and comprised several distinct, but interconnected, studies investigating links between flow regimes and: geomorphic and substrate characteristics, riverine vegetation, and aquatic macroinvertebrates. Aspects of organic material inputs, aquatic food web structure and productivity were also examined. This paper provides an overview of the findings and discusses what they mean for environmental flows assessments.

NEW SOURCE OF WATER FOR THE INDUSTRY: FROM REUSE TO SEAWATER DESALINATION

BONNELYE Veronique

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Session - B3D

In the last 10 years, desalination installed capacity has been multiplied by 10, with large Drinking water treatment plants reaching capacities in the range of 200 to 500 m³day⁻¹. This period is also dominated by a technology evolution from thermal processes (mainly in the Middle East) to reverse osmosis membrane applications (Europe and North Africa, USA, and Australia over the last 4 years). Reverse osmosis is not a new technology: Developed in the late 60s, it has been applied as concentration technology In the production process (mainly in diary and beverage industry). In relation to water scarcity, water cost increase, environmental impact reduction and to face more stringent regulation, desalination by reverse osmosis finds now its place for reuse applications. In the last decade, this process has been proposed for the polishing of mining leaching water or for waste water reuse in several applications. Desalination is also used to

create a new source of fresh water from brackish or seawater. This paper will present two case studies of desalination technology applied in petrochemistry industry for reuse, and as new source of fresh water from the sea in mining industry.

SOCIAL AND ECONOMIC CONSEQUENCES OF GLOBAL POST 2010 BIODIVERSITY POLICIES

BRAAT Leon

Alterra, Wageningen University

Session – A1

Having failed to achieve the CBD 2010 biodiversity target and aware of the necessity to move biodiversity as the necessary condition for ecosystem services to the top of the global political agenda, policy makers around the world are now developing ambitious post 2010 targets and strategies . The survival and prosperity of billions of people are at stake. A major challenge is to keep the ecosystems involved in providing adequate water to humans in top condition, and make their social and economic value undisputable. The role of biodiversity as an essential condition for well functioning ecosystems, and thereby for human benefits is complex and not widely understood yet. Conservation was too long founded in moral and ethical convictions, which lost out in day-to-day trade offs to short term social and economic survival priorities. In the next few decades, a few billion more people will become dependent on the globe's ecosystems for basic necessities as food and water, while biodiversity is degrading fast, the oceans are becoming cemeteries and climate change will alter the distribution of energy and water. Will the post 2010 world learn from its dismal past?

MANAGEMENT OF A LARGE INTERNATIONAL RIVER BASIN - THE DANUBE

BRICELJ Mitia

International Commission for the Protection of the Danube River

Session - C2B

The Danube river basin shared by 19 countries is the most international river catchment in the world. Despite great ecological, political, and cultural diversity a functioning legal basis for the cooperation in the field of environment and water in the Danube River Basin exists - the Danube River Protection Convention signed in 1994.

The ICPDR has established a number of products and tools which support sustainable water management and development. The Danube River Basin Management Plan (DRBMP) was adopted in 2009 and it is a comprehensive plan required by the EU Water Framework Directive for achieving a good water status. The ICPDR Action Programme for Sustainable Flood Protection in the Danube River Basin (2004) created a key framework for flood prevention, protection and mitigation leading to adoption of detailed flood action plans in 17 sub-basins of the Danube catchment in 2009.

The ICPDR was and is still faced with the following institutional challenges: (1) achieving cooperation among countries with differing social and economic circumstances; (2) maintaining country commitment to the ICPDR; (3) maintaining and managing the ICPDR Secretariat to meet the needs of the countries; and (4) esponding to new challenges - need of dialogue with the navigation, hydropower and agriculture sectors; adaptation to climate change.

CASE STUDY - MURRAY DRAINAGE AND WATER MANAGEMENT PLAN

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Session - B2C

The Murray area of WA presents significant water resource management challenges in relation to urban development. It also presents a significant opportunity to properly align land and water planning using the Better Urban Water Management (WAPC,2008)(BUWM) framework so that future land and water planning decisions for the area can be better informed on water resource management issues. The Murray Drainage and Water Management Plan (Murray DWMP) provides district level guidance on water management issues incorporating technical information from several background studies (including floodplain, groundwater, nutrient

and ecological water requirements studies). Lessons learnt during the preparation of several previous DWMPs led to a review of the key objectives and underpinning strategies that have formed the basis of the DWMPs and the development of a detailed communications plan which included the appointment of a steering committee, technical working groups for each of the technical studies and substantial stakeholder consultation throughout, including regular news updates to the numerous interested landowners and developers. This paper presents an overview of the Murray DWMP preparation and some of its key outcomes as well as a review of the communications plan outlining key successes and issues encountered during the project.

MOVEMENT PATTERNS AND FLOW REQUIREMENTS OF FIVE FISH SPECIES FROM THE CLARENCERIVER. AUSTRALIA

BUTLER Gavin¹, BRODERICK Tony², MACKAY Brad¹, REINFELDS Ivards³, ROWLAND Stuart¹

Department of Industry and Investment NSW¹, Northern Rivers Catchment Management Authority², NSW Office of Water³

Session - C2F

Understanding river discharge requirements of fishes is essential when establishing environmental flow regimes for freshwater river systems. Two hundred individuals from three catadromous (Australian bass, Macquaria novemaculeata; freshwater mullet, Myxus petardi; and sea mullet, Mugil cephalus) and two potadromous (eel-tailed catfish, Tandanus tandanus; eastern freshwater cod. Maccullochella ikei) fish species were implanted with acoustic tags and monitored using an acoustic telemetry array in the largely unregulated coastal Clarence River catchment, Australia. The array extended over 600km of river from the lower estuary into numerous upper freshwater tributaries. Distinct seasonal migrations were undertaken by catadromous fishes, with a number of individuals travelling up to 300 km downstream to the estuary, before undertaking return upstream migrations some months later. Large-scale upstream and downstream movements were also recorded within potadromous species. Generally, the larger-scale migrations and movements of all five species were triggered by increases in river discharge, but not in all cases. Movements upstream and downstream were often impeded by instream barriers, with fish using increases in discharge to passage over or around waterfalls and a man-made weir. This study highlights the importance of river discharge in the life-history of freshwater fishes and provides information to improve management of Australia's coastal river systems

LEARNING TO ADDRESS COMPLEX CHALLENGES: LESSONS FROM AUSTRALIA AND EUROPE

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Session - C3F

Recent world experience has increased awareness of the risks and consequences of water use decisions and the need for a new approach to decision-making that places greater emphasis on the involvement of local communities and communities of interest. Dealing with complexity, uncertainty and risk emerges as a shared need and responsibility for government and communities, highlighting the importance of mutual learning and shared knowledge. Local knowledge and effective long-term policy-stakeholder-research partnerships can support social learning and a more adaptive and resilient approach. This paper compares two projects aimed at addressing these challenges and opportunities. The first project, Northern Australia Irrigation Futures (NAIF), commenced in 2004 and was part of the Australian Cooperative Research Centre for Irrigation Futures (CRC IF) System Harmonisation program to develop new knowledge, tools and processes to support debate and decisionmaking about irrigation in northern Australia. The second project, the European Urban Knowledge Network (EUKN), started in 2004 as a way of facilitating access to information about experiences (cases), research and policy documents of urban policy related issues in Europe. In this paper we draw from these very different experiences some common lessons for harmonising irrigation systems and similar complex challenges.

Ipswich City sits at the heart of the Western Growth Corridor of South-east Queensland. With the fastest growing population in Queensland, Ipswich faces the challenge of matching urban development with meeting its vision for improved water quality and enhanced biodiversity of the City's waterways. The primary waterway in Ipswich, the Bremer River, is the most degraded estuary system in SEQ, with the highest levels of nutrient and sediment loads in the region. Its legacy as a conveyor belt for industrial effluent, woollen mill discharge and abattoir off-cuts is matched today by the continual input of pollutants from un-mitigated urban development and rural run-off. Ipswich City Council is faced not with protecting a pristine waterway, but with balancing the economic and social demands of urban development with the community desires for healthy waterways. Council's greatest capacity to improve waterway health is through the use of planning mechanisms, strategic plans and community partnerships. Reducing the quantity of pollutants transported by urban stormwater, protecting riparian corridor vegetation and engaging the community are the critical weapons in Council's armoury to achieve a win-win outcome for development and waterways

A key theme of the Murray Darling Basin's Native Fish Strategy is the establishment of demonstration reaches. Demonstration reaches are sections of river where multiple management actions are implemented to improve aquatic and riparian habitat, and support the rehabilititaion of native fish populations. Demonstration reaches are based on the principle that it is more effective to apply multiple rather than single interventions (e.g. pest fish management, riparian protection/rehabilitation and provision for fish passage), and recognise the need for monitoring and evaluation, whilst engaging and empowering local communities in aquatic habitat rehabilitation.

INVESTIGATING NUTRIENT THRESHOLDS FOR MACROPHYTE OR ALGAL DOMINANCE IN RIVERS AND ESTUARIES

Environmental Science - Murdoch University¹, Marine and Freshwater Research Laboratory – Murdoch University², Department of Environment and Conservation WA³

Recent literature suggests that the initial concept of two contrasting ecological regimes (macrophyte or phytoplankton-dominated) in nutrient-enriched waterbodies should be extended, based on observations that such systems may be dominated by free-floating plants, submerged charophytes, submerged angiosperms, green algae or cyanobacteria at different points along a gradient of eutrophication. The implications of this for management and restoration are that different levels or thresholds of a controlling variable (such as nutrients) may be necessary to cause a shift in dominance depending on the characteristics of the dominant taxa. This paper explores the drivers for dominance of different plant communities in the Canning River, Vasse River and Vasse-Wonnerup Estuary based on long term datasets and experimental mesocosms. The research focuses on potential thresholds (particularly total phosphorus concentrations 🧑 and N:P ratios), that might explain the efficacy of nutrient reduction measures, the likelihood of catastrophic loss of macrophytes from the wetlands or guide restoration of macrophytes in currently phytoplanktondominated systems.

DEVELOPMENT AND WATERWAYS - CAN THEY BOTH BE WINNERS?

CAVANAGH Kaye, BOWLING Tari, KILGOUR Jane, PRASAD Monishaa

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Ipswich City Council

Session - A3A

DEMONSTRATING A DIFFERENCE

CHALLEN Stephanie

DEEDI (Fisheries Queensland)

Session - A2B

CHAMBERS Jane¹, NOVAK Peter¹, WILSON Celeste², CLARKE Alan³, PAICE Robyn¹

Session - B3B

DEVELOPING A WETLAND MANAGEMENT PLAN FOR YANGA NATIONAL PARK

CHILDS Paul

NSW Department of Environment, Climate Change and Water

Session - B3A

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An Ecological Risk Assessment was undertaken to identify the Key Ecological Values of Yanga National Park floodplain and the potential threats to each of the values. The methodology broadly followed the approach outlined in the Australian Standard for Risk Management (AS/ NZS 4360). Risk and hazard matrices were adapted from ecological risk analysis frameworks previously used in other areas of Australia. The Key Ecological Values were identified as: River Red Gum *Eucalyptus* camaldulensis communities; Black Box E. largiflorens woodlands; Tall Spike Rush *Eleocharis sphacelata* wetlands; Egrets, and; Southern Bell Frogs Litoria raniformis. The values were representatives of the entire floodplain ecosystem and not individual species. The results showed that a majority of the potential threats were directly or indirectly associated with water management issues. The key outcomes of the Ecological Risk Assessment are: (a) The DECCW must participate in the development of the Water Sharing Plan for the Lower Murrumbidgee in order to safeguard biodiversity conservation for the Lower-Murrumbidgee Floodplain; (b) A Wetland Management Plan must be developed to achieve positive ecological outcomes: (c) Research is required to determine the likelihood and consequence of specific threats to certain values, and; (d) Threats are to be prioritised and actions identified to minimise risk.

PADDOCK TO REEF PROGRAM - MEASURING PROGRESS TOWARDS THE REEF PLAN GOALS AND TARGETS

CHINN Chris

Queensland Department of the Premier and Cabinet

Session - A2C

The long-term goal of the Reef Water Quality Protection Plan is to ensure that the quality of water entering the Great Barrier Reef from adjacent catchments has no detrimental impact on its health and resilience. The objective of the Paddock to Reef Program is to measure and report on the progress towards the Reef Plan goals and targets. The Paddock to Reef Program represents an investment by the Australian and Queensland Governments in excess of \$40 million over four years. Implementation of the program is a collaborative effort between over 20 organisations including governments, key industry partners, research organisations, regional NRM bodies and individuals. The framework for the design involves monitoring and modelling a range of attributes at a range of scales including management practices, water quality at the paddock, sub catchment, catchment levels and in adjacent marine areas. The Reporting Framework for the program is driven by the Reef Plan goals and targets. A 2008–09 baseline report of management practice adoption, water quality and ecosystem health will be released in 2010. The subsequent annual Reef Plan water quality reports will report on progress towards the Reef Plan goals and targets from the paddock to reef.

ANALYSIS ON SCOURING CHARACTERISTICS BY SUBMERGED FLOATING STRUCTURES IN RIVERS

CHOI Heung Sik, LEE Chang Hun

Sangji University

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Session – Poster (Hard & Electronic)

Scouring characteristics by submerged floating structures which affect the river bed sedimentation are analyzed in this study. The criteria of initiation of motion, tunnel scouring, and lee-wake scouring related to the location of submerged floating structure are suggested by the relative location. hs/D of the distance between the center of structure and river bed with the diameter of structure. The critical hs/D which begins scouring is 0.89 and the corresponding relative location, hs/H of the distance between the center of structure and river bed with water depth is 0.64. The regression equations of the relative scouring depth, dd/D are analyzed with the functions of Reynolds, Shields, Froude numbers, and hs/D. The dimensionless numbers of Reynolds, Froude, and hs/D have relatively greater scouring effect than Shields number. The regression equations of dd/D are suggested with the functions of the dimensionless parameters and additional parameter, hs/D which showthe different

scouring phenomena related to the location of submerged structure. Also, the regression equations of dd/D are provided with the functions of the dimensionless parameter of hs/D and Revnolds. Shields, and Froude numbers.

THE IMPACT OF BLACK SWAN GRAZING ON THE SEAGRASS HALOPHILA OVALIS IN THE LOWER SWAN RIVER ESTUARY.

CHONEY Gary, MCMAHON Kathryn, LAVERY Paul

Edith Cowan University

Session - Poster (Hard & Electronic)

Herbivory on seagrasses is generally considered to be minor in many temperate regions of the world. However, this generalisation overlooks grazing by waterfowl in estuaries. This study investigated the significance of grazing by black swans in a temperate, estuarine seagrass ecosystem and the strategies seagrasses employ to cope with grazing. This study experimentally tested the ability of seagrasses to increase sexual reproduction following grazing, a strategy that has been suggested as one seagrasses might use to cope with grazing, but which has not been experimentally tested. The Black Swan feeds on estuarine seagrasses in south-west Australia, where they can consume 23% of daily production. Seasonal assessments were undertaken of swan grazing activity and seagrass growth characteristics to assess the ability of seagrasses to cope with grazing at different times of the year. The results show swan abundance increased from 53 in Spring to 89 in Summer; while seagrass branching frequencies increased in grazed areas. The changes in seagrass growth characteristics over these seasons will be compared with swan grazing pressure to assess the impact of swan grazing on seagrass. The results of this study will improve our understanding of plant-grazer interactions in temperate seagrass ecosystems and contribute to the information needs of temperate estuarine system managers.

DISPERSAL, CONNECTIVITY AND INVASION IN REGULATED RIVERS: THE MOVEMENT DYNAMICSIOF RIVERINE WEEDS

CHONG Caroline, BROADHURST Linda

CSIRO

Session - A3F

The movement dynamics of riverine plants is difficult to predict and is not well understood, particularly in heavily regulated systems. Results are presented of a study that identifies the patterns of dispersal and connectivity among invasive weed populations in the Ramsar-listed Barmah Forest and tributaries on the River Murray floodplain, Victoria, Australia. The prevailing flow regime, regulatory infrastructure and unique hydrogeomorphological characters can together influence the tempo and directionality of dispersal among river habitats. Clonal and seed offspring may both contribute to the movement of individuals, but occur at different spatial scales. Demographic studies, molecular genotyping and novel network analyses were used as complementary research approaches to determine the implications of reproduction and dispersal for spatial connectivity among streams, using a model, recently introduced aggressive weed species. Seed propagation was identified as the major dispersal unit. Genetic clustering is consistent with multidirectional range expansion and natural flood patterns in the Barmah Forest, and suggests maintained risk of gene flow among streams. Genetic connectivity among localities indicates long-distance dispersal (tens of kilometres). These findings are considered in the context of improving the detection and management of movement dynamics in prominent riverine plant species in the Murray-Darling River Basin.

IMPERVIOUSNESS IMPACTS ON URBAN CREEKS: RESTORATION PROCESSES

CHOWDHURY Rezaul¹, GARDNER Ted¹⁸², GARDINER Richard²

CSIRO Land and Water¹, QLD Department of Environment and Resource Management²

Session - C4F

Urban creeks experience significant hydrological, geomorphologic and water quality impacts which degrade their ecological health. Restoration of urban creeks involves the restoration of a pre-development flow regime and source control of urban runoff. These can be achieved by: (1) providing 'pervious barrier" across the hydraulic pathway; and (2) ensuring

"retention and loss" of some of the urban runoff. Stormwater harvesting has been identified as a potential solution in this regard. In this study, we have estimated urbanisation (defined by the degree of catchment imperviousness), impacts on creek hydrology and water guality, and delineated the role of stormwater harvesting in restoration of predevelopment flow conditions. Two gauged catchments located in South East Queensland (Australia) have been considered for analysis. These are: (1) Tingalpa Creek, a 2800 ha forested catchment on the eastern edge of Brisbane (1% imperviousness); and (2) Stable Swamp Creek, a 440 ha traditional urban catchment at Sunnybank, a Brisbane suburb (42% imperviousness). The former was calibrated using the US EPA SWMM model for flow simulation and the latter was used for continuous water quality monitoring. The number of low flow events at Tingalpa (defined as less than 5% of daily mean flow) were found to increase significantly once the fraction of impervious area exceeded 10% - this supports previous research (in Victoria) that stream ecosystem health degrades beyond 10% of imperviousness. The smaller ARI peak flow events (1 month to 6 month ARI) were found to increase rapidly with increase in % imperviousness. Response of the 1 year to 5 year ARI peak flow events to increased imperviousness was much more muted. The 95th percentile peak flow value was found to increase from 1.2 m³.sec⁻¹ (pre-development regime) to 5.5 m³.sec⁻¹ at 40% imperviousness. In terms of urban runoff quality, the turbidity and electrical conductivity (a measure of dissolved ions) at the Stable Swamp Creek were observed to increase and decrease with storm events respectively. Dissolved oxygen concentration increased from 2 mg.L^{-1} (low flow condition) to 6 mg.L^{-1} (during storm events) and then dropped after events, whereas pH fluctuated within the optimal range from 6.5 to 8.5. Both electrical conductivity and dissolved oxygen were found to be statistically correlated with runoff pH value. Different options (water sensitive urban design (WSUD), rainwater harvesting and stormwater harvesting) of urban runoff management and their roles in urban creek restoration processes will be discussed. While stormwater harvesting provides beneficial response to urban creek hydrology, a number of challenges will be outlined.

SWAN AND HELENA RIVERS MANAGEMENT FRAMEWORK

CIRCOSTA Roberta, VOLOBUEVA Yulia, CAMPBELL Sue, HARDY Rhonda, RAKELA Naomi FMRC

Session – Poster (Hard & Electronic)

The Swan River traverses the Perth metropolitan area and is an economic, cultural, environmental and recreational asset as well as one of Australia's most iconic river systems attracting national and international visitors to Perth. Ironically the desire to be on. in. adjacent to or in view of the river threatens to permanently damage this fragile ecosystem. To address this issue the EMRC in partnership with its member Councils and other stakeholders have developed the Swan and Helena River Management Framework (SHRMF) which is arguably "a best practice approach" for river planning and a blueprint for other riverine regions. The framework uses a stakeholder partnership approach and identifies roles, responsibilities and actions to guide the ongoing management of the eastern reaches of the Swan River and its major tributary, the Helena River. The framework is underpinned by the guiding principles of: social benefits, environmental values, cultural and natural heritage, indigenous values, design, development, planning and management. Since the development of the SHRMF, a number of actions have been completed including the Trails Project; Heritage Audit and Statement of Significance; Regional Recreational Path Development Plan and Best Management Practices for Shore Stabilisation. The SHRMF identifies that the river system should be respected and managed in a coordinated manner to ensure its conservation for future generations and enhance its economical and cultural values.

ASSESSING ENVIRONMENTAL FLOW INDUCED CHANGES IN THE SHOALHAVEN RIVER - OPTIMISING THE OUTCOMES

COLLINS Emma¹, FOY Sarah¹, CHURCH Tony¹, VERHOEVEN Mirella¹, KOTLASH Amanda², PAULL Tony²

Sinclair Knight Merz Pty Ltd1, Sydney Catchment Authority2

Session - B3A

New environmental flow rules are being implemented by Sydney Catchment Authority for the Shoalhaven River, NSW to address river health issues downstream of Tallowa Dam. The Shoalhaven River is one of the major systems that service both the Sydney Metropolitan and

Fortescue Metals Group (FMG) is developing a major new mining hub in the Hamersley Ranges north of Tom Price in the Pilbara Region of Western Australia. The Solomon Project consists of an above water table Brockman iron ore deposit (Firetails) with associated Detritals and a significant below water table Channel Iron Deposit (Kings CID). The Kings CID is effectively an infilled palaeodrainage system that is now a buried regional groundwater aquifer system. The CID requires dewatering ahead of mining to ensure safe mining conditions during operation. The dewatering discharge from the Kings CID will be used to meet Ore Processing Facilities water supply demands, provide dust suppression water and provide for maintenance of fringing Groundwater Dependent Ecosystems (pools). As part of the Royalties For Regions Pilbara Water Opportunities Project, it is proposed to pipe excess dewatering discharge approximately 100km to supplement the Millstream Aquifer. The Millstream aquifer provides water to the West Pilbara Water Supply Scheme supplying Dampier, Karratha and Roebourne. This presentation will show how FMG is balancing the following water challenges: (1) Efficient onsite water management including dealing with excess water; (2) Providing security of supply for coastal demand centres; and (3) Creating positive sustainable environmental outcomes during and after mining

Shoalhaven drinking water supplies. In order to assess the effectiveness of any environmental-flow induced changes, a robust monitoring program has been adopted to examine the response of the river to the new environmental flow regime. The program includes monitoring of thermal impacts, pool stratification, general water quality, iron bacteria cover, periphyton and macroinvertebrates. The study area extends from Tallowa Dam to the tidal interface at Burrier, NSW. Data collected as part of the monitoring activities has been analysed to test hypotheses relating to the effectiveness of release water from Tallowa Dam in improving downstream health to the tidal limit. This presentation provides an overview of the findings of the monitoring program to date.

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WATER MANAGEMENT FOR THE SOLOMON PROJECT

COLMAN Ron

Fortescue Metals Group Ltd

Session - B3D

EFFECT OF POLITICAL NEGLECT ON URBAN PEOPLE'S ACCESS TO WATER

CORDERY Ian. ASGHAR Kamran

University of New South Wales

Session - C2D

Accessibility to safe water is essential to life. Developing countries are reluctant to install or upgrade piped water supplies as this is regarded as prohibitively expensive. A survey of 545 water users and water vendors in Quetta, Pakistan revealed the water supply to be totally inadequate and the cost of the inadequate supply to consumers to be very high, high enough that if supervision and management were competent the revenue would be more than sufficient to construct and operate a safe, reliable supply system. Less than half households have a piped water connection, which usually does not supply their needs. The charge for a connection is Rs125/month (less than AUD2) but many do not pay and the supply authority has insufficient funds to operate, let alone upgrade the system. Vendors (road tankers) supply much of the water at prices of between Rs1 and Rs3 per 10 litres. The total amount paid to all retail water suppliers is more than enough to fund a first class system supplying every household. The current total water delivery rate from pipes and vendors is about 15 litres/person/day, barely above survival needs. With population growing more than 10% pa and no prospects for new supply sources, a crisis is rapidly approaching.

THE SWAN CANNING RESEARCH AND INNOVATION PROGRAM (SCRIP)

COSGROVE Jeff

Swan River Trust

Session - A3D

The Healthy Rivers Action Plan (2007 - 2013) provides a comprehensive, catchment to coast approach to improve water quality in the Swan Canning river system. A key component of this plan is the Swan Canning Research and Innovation Program (SCRIP); recognising that our knowledge of the system and how the system responds to stressors is an important guide for management. The SCRIP will address critical knowledge gaps and establish collaborative partnerships with key stakeholders. In addition, SCRIP seeks to: (1) encourage and expand the capacity to conduct highquality and innovative research in the Swan Canning river system; (2) develop strong collaborative ties between the Swan River Trust and leading research agencies; (3) expand the capacity for Swan Canning research projects to be nationally competitive, (e.g. Australian Research Council (ARC) Linkage and Discovery); and (4) support research excellence by students, individuals and teams. To date, 17 projects have been funded for a total of \$316,678 under this scheme - supporting research teams working on topics ranging from 'Optimising the development and use of strategic communication to influence user behaviour in the Swan Canning river system' to 'Ecotoxicological And Bioaccumulation Investigations Of Claisebrook Cove'

COMMUNITY ENGAGEMENT IN THE COORONG. LOWER LAKES AND MURRAY MOUTH REGION. SA

CUNNINGHAM Gemma

Department for Environment and Heritage

Session - A2E

Engaging with the community has been a cornerstone of the Federal and South Australian Government's efforts to secure a healthy and sustainable future for the Coorong, Lower Lakes and Murray Mouth (CLLMM) region. With its internationally-recognised wetlands and diverse mix of communities, cultures and industries, the region has been critically impacted by prolonged drought across the Murray-Darling Basin, record low inflows and over-allocation of water upstream. This presentation will explain how it became clear that working with the local community would becrucial to the success-or otherwise-of the region's future management. To respond to this need, a specialist Community Engagement team was established within the SA Department for Environment and Heritage's CLLMM Projects unit. Critical to the engagement process has been establishing a strong working relationship with Ngarrindjeri people - the Traditional Owners of the region - culminating in the Kungun Ngarrindjeri Yunnan Agreement (KNYA), a framework for consultation and negotiation with the Ngarrindjeri Regional Authority. The presentation details the community engagement work undertaken as part of the long-term planning process, including consulting the community on the draft plan, the establishment of community reference and focus groups, targeted community information and publications, socio-economic assessment, field visits and community meetings, and the creation of the Lakes Hub at Milang.

NSW RIVERS ENVIRONMENTAL RESTORATION PROGRAM -**IMPROVING E-WATER MANAGEMENT IN NSW**

D'ARCY Clare

NSW Department of Environment, Climate Change and Water

Session - C3C

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The NSW Rivers Environmental Restoration Program (RERP) is a \$180 million program funded by the NSW and Australian Governments. It focuses on the five most important wetlands of the NSW in the Murray-Darling Basin for bird breeding and bird species diversity considered tobe at risk of collapse without adequate e-water being provided. The condition of these wetlands continues to deteriorate due to prolonged drought and water resource development. Future climate change predictions generally indicate a further decline in the extent and frequency of large inundation events. Effective environmental water management is essential for maintaining wetland ecosystem function, and dependent industry such as grazing. RERP investment has equipped water managers with more

environmental water, better relationships, knowledge and planning tools and more flexible infrastructure to manage ecosystems to arrest their decline. The program has provided strategic investment to maximise ecological outcome from medium to low flow events and has benefited from a multi-disciplined team with good working relationships. The stepchange investment has provided a permanent improvement to our wetland knowledge and management benchmarks. A key priority is to ensure the knowledge gained is transferred to change for the better future-decision making regarding environmental water, and ultimately, to the enhanced condition of wetland environments.

INTEGRATING SCIENCE AND RESTORATION: COMMUNITY STEWARDSHIP IN THE LAKE SIMCOE WATERSHED

DAVIES Philip, KEMP Brian

Lake Simcoe Region Conservation Authority

Session - C3F

Using an integrated watershed management model, the Lake Simcoe Region Conservation Authority (LSRCA) provides environmental restoration services to the watershed community through the Landowner Environmental Assistance Program (LEAP). Scientific research and monitoring conducted by LSRCA are used to target restoration opportunities within sub-watersheds that are under stress due to urban development, agricultural practices, or misuse of source water. Project grants and technical assistance are supported financially by the watershed municipalities, with extension services delivered through on-site visits and workshops. Municipal funding is leveraged with grants secured from all levels of government, external agencies and foundations. Prioritization of project delivery is undertaken with local stakeholder committees that include landowners, public agencies, and the private sector. Since 1990, implementation of urban and rural LEAP projects that incorporate best management practices and innovative solutions have contributed to an 18mT decrease in phosphorus entering the lake. Recently, both the Federal and Provincial governments have established new financial and legislative instruments to address environmental challenges in the watershed. Partnerships are inherent and critical to program success. Through this locally-driven, long-established, and adaptive program, LSRCA has delivered measurable results efficiently and effectively leading to internationally recognized project success, including the 2009 Thiess Riverprize

RIVERS IN SOUTHWESTERN AUSTRALIA: IMPACTS OF CLIMATE CHANGE AND METHODS FOR OPTIMISING RESTORATION

DAVIES Peter

The University of Western Australia

Session - C4A

Globally, southwestern Australia was one of the first regions to experience quantifiable climate change with a significant reduction in streamflow and an associated increase in temperature. In this region, a 20% reduction in rainfall over the past 40 years has resulted in almost a 40% lowering of streamflow. Climate change induced seasonal shifts in streamflow may have an impact on reproductive triggers for native fish migration and the predicted reduction in winter flows would minimise pool flushing which are important habitats for fish. Drying will further increase fragmentation of aquatic communities and more extreme events may expose fauna to conditions not historically experienced. Changes to freshwater systems due to increased temperature are often neglected although they may substantially impact on aquatic fauna. The current and predicted water temperatures in southwestern Australia often exceed the thermal tolerances of aquatic fauna, particularly in more cleared catchments. The endemic Gondwanic fauna, characteristic of southwestern Australia, are typically cold stenotherms and intolerant of elevated temperatures. River restoration activities in this region therefore should focus on producing a suitable biophysical envelope within species' thermal tolerances. Riparian replanting can reduce water temperature and mapping at a catchment scale is a useful tool to spatially prioritise these restoration activities.

RIVER RESTORATION IN GLOBAL BIODIVERSITY HOTSPOTS UNDERGOING CLIMATE CHANGE

DAVIES Peter

The University of Western Australia

Session - D1A

Most global biodiversity hotspots are geographically constrained, limiting movement of species as a response to climate change. Southwestern Australia, as a biodiversity hotspot with increased temperature and reduced rainfall serves an example of issues associated with river restoration. In this hotspot, a 20% reduction in rainfall has resulted in almost a 40% change in streamflow. However, ecosystem changes due to increased temperature are often neglected and may substantially impact on aquatic fauna. The current and predicted water temperatures in southwestern Australia often exceed the thermal tolerances of aquatic fauna. Gondwanic fauna, characteristic of southwestern Australia, are typically cold stepotherms and therefore intolerant of elevated temperatures. Therefore, river restoration has to produce a suitable biophysical envelope within the species' thermal tolerances. Riparian replanting can reduce water temperature and mapping at a catchment scale is a useful tool to spatially prioritise restoration activities. A 10% increase in riparian cover can reduce water temperatures by up to 10°C. Restoration techniques using water temperature as a guide to focus activities is considered applicable to other global biodiversity hotspots where geography constrains species' movement and the present biophysical condition is the desired restoration endpoint.

COMMUNITY OF PRACTICE FOR ENVIRONMENTAL WATER MANAGERS

DAVIS Richard¹, SPEERS Andrew², HINCHLIFFE Anne²

National Water Commission¹, Australian Water Association²

Session - C4D

The National Water Commission's 2007 Assessment of progress under the National Water Initiative reported that "too often environmental managers lack clear identity, authority and sufficient financial and technical capacity [to carry out their roles] and [that] independent audits of environmental outcomes are not yet occurring. Environmental water management arrangements deserve renewed attention." Similar findings were made in the 2009 Review. In response, the NWC has established a Community of Practice (CoP) for environmental water managers the intention of which is to provide a means of enhancing environmental water managers' capacities by creating means for them to communicate, collectively problem-solve, share concepts and ideas and to unlock tacit knowledge. CoPs are "...groups of people who share a concern, a set of problems or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an on-going basis" (Wenger et al 2002). This paper will detail the design of a CoP that meets the needs of environmental water managers, and the progress to date including the development of an interactive website and the results from self-organized regional workshops of environmental water managers.

GROUNDWATER DEPENDENT ECOSYSTEMS - HOW WELL ARE THEY ACCOUNTED FOR IN WATER PLANS

DAVIS Richard¹, EVANS Nick²

National Water Commission¹, Sinclair Knight Merz²

Session - A2A

Some of Australia's iconic aquatic ecosystems depend totally or nearly totally on groundwater. These include some of the rivers of northern Australia, the mound springs of central Australia and the wetlands of the coastal plain of south-western Western Australia. Other ecosystems, while less iconic, rely for at least part of the time on a supply of groundwater. Hatton and Evans (1998) and Clifton and Evans (2001) recognize six canonical types of groundwater dependent ecosystems (GDEs) - terrestrial vegetation, wetlands, river base flow systems, aquifer and cave ecosystems, terrestrial fauna, and estuarine and near shore marine systems. Under the 2004 National Water Initiative agreement, jurisdictions are required to achieve environmental and other public benefit outcomes by providing water for the environment in their water allocation plans. The extent to which provisions are made to provide groundwater to support GDEs varies greatly. Some nationally iconic GDEs are clearly

The stock of the European eel (Anguilla anguilla L.) has severely declined, since the 1960s fishing yield gradually decreased to almost below 15% of historic levels. Recruitment levels have even declined more drastically in the last 30 years to just a few percent of historic levels. In 2007 the European Union established a restoration plan (the "Eel Regulation", EU 2007). Each EU Member State has developed a management plan. aiming at a uniform restoration of the stock by implementing protective measures (related to fishing, water management, migration barriers, etc), and monitoring of stock and fisheries. Throughout their lifecycles, eel are hindered from freely moving through river systems by a range of obstructions (dams, sluices, pumping stations, dykes, hydropower stations). Furthermore, pumping stations may cause significant mortality among silver eels when migrating downstream towards the ocean. In the paper we present an overview of the role of barriers with regards to the decline of eel and discuss some (engineering) solutions to improve eel migration from glass eel to silver eel in the Netherlands

Regional acidification of surface waters is occurring in the Western Australian Wheatbelt that is strongly coupled with dryland salinity and acidity carried by rising groundwater. Almost half a million hectares of lowlying landscapes on the Wheatbelt contain shallow saline groundwater expected to be acidic (pH<4.5). Discharge of this to waterways and lakes results in impacts in addition to those caused by increased salt concentrations and flooding. We report on the influence of acidic saline groundwater discharge on surface water chemistry investigated through 7 years of annual base-flow water quality snapshots and lake surveys. Over 300 km of major floodways and tributaries in the Avon Basin have been found to exhibit base-flow acidity (pH< 4.5) along with numerous lakes in late drying phase. The acidic waters create conditions similar to those associated with coastal acid sulfate soils, although contain high concentrations of aluminium and a wider range of trace elements (e.g. Pb, Cu, Ni, Zn, Ce, La). Discharge of acidity from groundwater drains used to manage dryland salinity accounts for some acidification, however there is geochemical and mineralogical evidence of acidification due to regional groundwater discharge. Groundwater discharge is expected to continue in the Wheatbelt, despite climate change, and may drive expansion in baseflow and drying phase acidification. Practical treatment options have been developed to enable farmers to treat acidic groundwater drainage, however alternative options of containment may be required to manage broader scale acidification

recognized in water plans and specific provisions are made to protect them. In other cases, where GDEs are of local or regional importance, there are provisions in water plans to manage groundwater at levels which will maintain some ecosystems. However, there are some types of GDEs, such as aquifer and cave systems and estuarine and near-shore systems, which are seldom recognized in water plans. This presentation will examine the reasons why GDEs have not always been incorporated in water plans; these reasons include lack of recognition of GDEs, lack of scientific information about links between groundwater and ecosystem requirements, the high cost of achieving environmental protection and the limited number of integrated groundwater-surface water plans.

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BARRIERS AND THE RECOVERY OF EUROPEAN EEL

DE GRAAF Martin. WINTER Hendri Volken

IMARES Wageningen UR

Session - A2D

GROUNDWATER DRIVEN ACIDITY IN WATERWAYS OF THE WESTERN AUSTRALIAN WHEATBELT

DEGENS Brad, MUIRDEN Peter, ALLEN Michael, KELLY Bernard

Department of Water WA

Session - C3E

DAMS TO SUPPLEMENT WATER IN WATER STRESS RIVERS-SRILANKAN EXPERIENCE

DHEERA Kumudinee, GURUGE Thanura

Irrigation Department

Session - B4B

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Construction of new dams took place at a minimal level during the last decade compared to the previous era, in Sri Lanka. This was due to exhaustion of technically feasible sites for dams. However, about 6 large dams constructed during the last decade were mainly to augment the small reservoirs or barrages in downstream areas, which could not fulfil the irrigation water requirements of the benefitted areas. Reservoirs thus formed were able to improve the efficiency of the irrigation systems, which in turn contributed to improving the living condition of the rural farmers. Many environmental and social conditions were considered when planning these dams. The affected communities were given priority in reaping the benefits of the project. Structural measures to issue environmental flows to the river also were provided. Ground water recharge took place in the newly benefitted areas. Al these contributed to enhancing the environmental conditions which support sustaining of rivers. Catchment areas in the dry zone where flash floods occurred during the monsoon rains in the past, now have been changed due to vegetation. Hence the controlled issues from the reservoirs have converted most of the dry rivers to perennial rivers. The aim of this paper is to discuss the benefits achieved by those recently constructed dams in Sri Lanka.

AN ASSESSMENT OF 7 'SOFT' ENGINEERED RIVERBANK STABILISATION TECHNIQUES

DIXON Nicola¹, HARRIS Kate²

Parramatta Park Trust¹, Harris Environmental Consulting²

Session - C4F

Treating riverbank slumping in a modified urban environment commonly involves hard engineering. Parramatta Park Trust is currently undertaking a trial that evaluates the effectiveness and practicality of seven different 'soft' engineering river bank stabilisation techniques, some of which have not been previously utilised. The installations were funded through a Federal Envirofund grant. The trial site is located on a stretch of the upper Parramatta River, a highly modified environment within a densely populated catchment, where riverbank erosion is extensive. Land with important heritage, recreational and ecological values was being lost permanently due to bank slumping. Past attempts to stabilise the banks with hard engineering have failed as the limited life cycle of those structures ends. All stakeholders were interested in a solution which would apply ecological principles and practices to achieve long-term riverbank stabilisation in a cost effective manner, while enhancing habitat, improving aesthetics and ultimately providing a model to extend soft technology erosion control further up and downstream. The trial evaluates the success of the various techniques employed based on: the recapture of lost bank profile, prevention of further erosion, riparian plant establishment and resistance to carp and waterfowl attack, and ease and cost of installation and maintenance. This paper describes the soft engineering techniques used, the methodology for monitoring each treatment and evaluates the advantages and disadvantages of each treatment.

STRENGTHENING SCIENTIFIC RESEARCH AND MANAGEMENT THROUGH ON-GROUND COMMUNITY INVOLVEMENT

DOBBS Rebecca¹, COSSART Robert²

The University of Western Australia¹, Department of Water WA²

Session – C3F

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Good water management requires government planning and scientific research to be complemented by community involvement, with the National Water Initiative (NWI) highlighting the need for increased community capacity. In the Kimberley region of Western Australia, the vast geographical area and diverse socio-economic population represents a significant challenge to government agencies and research institutions in realising this goal. With these challenges, the Department of Water and The University of Western Australia developed, trialled, and are currently implementing an on-ground waterways education program for the Kimberley. Extensive consultation and flexibility was necessary to develop a program applicable to stakeholder (particularly indigenous) needs

rather than implementing a program that may have provided little onground applicability or relevance. The program engages the community in discussions regarding management of their local waterways providing an important vehicle for them to interact with local researchers and government agencies. Recognition of both contemporary and traditional water knowledge has allowed for a range of different objectives to be achieved i.e. research, language and cultural outcomes enhancing the uptake and potential longevity of the program. This collaborative approach provides a template for future initiatives, strengthening community engagement and therefore research and management in the Kimberley.

THE COMMONWEALTH AS WATER HOLDER: A BASIN-WIDE APPROACH TO ENVIRONMENTAL WATERING

DOCKER Benjamin, ROBINSON Jan, MILNES Gavle

Department of the Environment, Water, Heritage and the Arts

Session - B3A

 ${\it AustralianGovernment} reforms have created the position of Common wealth$ Environmental Water Holder. The Commonwealth is holding and managing water entitlements throughout the Murray-Darling Basin. Entitlements are acquired through the Government's Water for the Future initiative and are managed for the purposes of protecting and restoring environmental assets such as wetlands and streams. The flexibility offered by this approach is an important complement to rules-based or planned environmental water. However, decisions need to be made about using this held environmental water for competing environmental outcomes where ecological opportunity costs may be significant. To address this, the Commonwealth Environmental Water Holder is working cooperatively with Basin states to identify watering options, evaluate these against a set of criteria and seek advice from a scientific advisory committee. A long-term framework has been developed to guide the approach and a range of decision-support tools are being evaluated. As at March 2010, approximately 80 gigalitres of environmental water had been delivered across 28 floodplain and wetland sites. Preliminary outcomes are positive, including improved tree health, decreasing salinity and benefits to threatened species. However, the program is at a very early stage and in the coming years, the Commonwealth's environmental water holdings will grow substantially. This will provide an increased range of watering options and a much greater capacity to protect or restore environmental assets and improve overall ecosystem health.

ROLE OF HIGH FREQUENCY WATER QUALITY ANALYSIS IN CONFIRMING CATCHMENT HYDROLOGY INTERPRETATION

DONN Mike, BARRON Olga, BARR Anthony, POLLOCK Daniel CSIRO Land and Water

Session – C4F

Nutrient transfers from urban and peri-urban streams and drains to the Swan-Canning Estuary, Western Australia has led to the growth toxic algal blooms, low oxygen levels, fish kills and a loss of biodiversity. High frequency water quality analysis has seen increasing use in determining temporal variability in nutrient transfers to better inform land and water management practices mainly in agricultural catchments. The Southern River catchment is the third highest contributor of nitrogen and phosphorus to the Swan-Canning Estuary delivering an average of 21.3 t of total nitrogen and 2.21 t of total phosphorus annually. In-situ high frequency water quality measurements at three sites within the catchment aim to provide an understanding of the temporal variability in phosphorus transfers and assist in the understanding of the catchment hydrology. Differences in rainfall patterns between years were shown to influence the seasonal variation in phosphorus concentrations and export from the catchment. An early start to the winter wet season resulted in greater phosphorus export compared to a later start to the wet season due to changes in flow contribution from the different monitored subcatchments. Changes in phosphorus concentration measured in one sub-catchment also support a change in seasonal change in hydrology resulting from the surface expression of the groundwater table. Therefore a reduction in rainfall due to climate change may potentially reduce phosphorus exports from this catchment.

SECURINGENVIRONMENTAL WATER IN AGRICULTURAL CATCHMENTS **OF SOUTH-WEST WESTERN AUSTRALIA**

DONOHUE Robert, GREEN Adam

Department of Water WA

Session - C3C

Rivers in the south-west of Western Australia support both healthy and degraded ecosystems that are under increasing pressure from water abstraction, decreasing flow due to climate change and loss of in-stream and riparian habitat. Irrigated agricultural, the largest user of water in the region, is a self-supply supply industry which depends on storage of winter flows in on-stream farm dams. When setting allocation limits on surface water use, the Department of Water aims to secure water for the environment, irrigated agriculture, and other water-dependent industries. In 2010 the department will set allocation limits based on estimates of a river's ecologically sustainable yield. The yields were based on environmental flow studies carried out between 2005 and 2009. The number of studies was relatively small with the yield figures subject to sample error and uncertainty. Therefore it was important that the risk of overestimating sustainable yields was recognised by decision-makers to avoid over allocating water when setting allocation limits. This paper describes how the results of environmental flow studies were used to set sustainable limits on the interception of river flow by farm dams. It also describes how the risk of over allocation due to sample error was considered in setting allocation limits.

CLIMATE CHANGE ADAPTATION IN WEST AUSTRALIAN WETLANDS AND WATERWAYS

D'SOUZA Frances¹, CHAMBERS Jane², COOTE Michael³

Department of Water WA¹, Murdoch University², Department of Environment and Conservation WA³

Session - B3C

The large geographic range of Western Australia (14° to 35° south) places it in a number of climate zones from Mediterranean in the southwest across the dry interior, to the summer wet and winter dry in the north. There is a huge diversity of wetlands and waterways across this landscape and while predictions of climate change suggest all of the state is likely to get warmer, predicted changes in rainfall are more variable. Major impacts include terrestrialisation of groundwater-fed wetlands, extended salt water intrusion into rivers, temperature impacts on fauna in biodiversity hotspots and changes in seasonality of flow in a landscape already under multiple stressors (eg water abstraction and other human impacts). Climate change adaptation depends on our understanding of these changes across the state. NCCARF (WA node of the National Climate Change Adaptation Research Facility for Water Resources and Freshwater Biodiversity), Department of Water and Department of Environment and Conservation facilitated a symposium and workshop on climate change in wetlands and waterways in WA in July 2010. This paper synthesises the research being undertaken and presents the agreed direction and priorities in research, management and policy in response to the impact on these ecosystems.

SALTMARSH REHABILITATION WITH THE REMOVAL OF MANGROVES AT PORT BOTANY

DWIGHT Steve

Department of the Environment, Water, Heritage and the Arts

Session - Poster (Electronic)

There has been a growing concern that sea level rise as a result of climate change will impact on coastal wetlands. This includes the encroachment of mangroves into areas previously supporting saltmarsh. The focus of this paper is an estuary rehabilitation project that will test the hypothesis that removing mangroves will assist in the establishment and rehabilitation of saltmarsh. The project involves the creation of saltmarsh as compensation for an area that has been lost due to a port expansion project. This saltmarsh creation is part of an estuary rehabilitation project resulting from the expansion of Port Botany near the city of Sydney. The total cost of the port expansion project is \$1 billion with \$8 million allocated to the estuary rehabilitation project. The large budget for this project on a relatively small site has allowed for the implementation of rigorous scientific assessment procedures to ensure ecological success. The goals of this project are to increase the available saltmarsh habitat

The NZ Landcare Trust has been managing a community-based catchment management project in the Aorere River catchment, Tasman, New Zealand. There have been concerns raised by the aquaculture industry farming shellfish in the near shore coastal environment adjacent to the Aorere River discharge due to high faecal coliform levels in the river. A combination of social and biophysical research has been conducted to enhance farmers' understanding of land and water management issues. Dairy farmers have responded to community criticisms by enhancing the implementation of on-farm best management practices to minimise the runoff of faecally contaminated water to the river. As a consequence of improving farming practices shellfish harvesting closures have reduced dramatically. The project has focused on 'farmers as leaders' so that landowners in the river catchment have a strong influence on both planning and implementing outcomes. The Aorere farmers are now working with another farmerled catchment management group in the Rai River, Marlborough. The aim is for the Rai River farmers to implement successful approaches to catchment management from their Aorere River neighbours. The project has developed considerable profile in New Zealand as a potential model for enhancing the management of intensively farmed dairying catchments for water quality improvement.

Hydro Tasmania Consulting¹, Technical Advice on Water², Freshwater Systems³

through the removal of mangroves and to create and maintain new saltmarsh habitat. This is in the context of an overall project objective of expanding the existing habitat for migratory shorebirds.

FARMERS AS 'MOVERS AND SHAKERS' IN COMMUNITY-LED RIVER MANAGEMENT

EDGAR Nick

NZ Landcare Trust

Session - C3F

MONITORING THE EFFECT OF BASSLINK DOWNSTREAM OF THE GORDON POWER STATION

EGERRUP Marie¹, McCAUSLAND Malcolm¹, KOEHNKEN Lois², DAVIES Peter³, WILD Anita¹, HOWMAN Alison¹

Session - D1E

The Gordon Power Station discharges to the Gordon River which flows through the Tasmanian Wilderness World Heritage Area. Tasmania's connection via the Basslink cable to the Australian National Electricity Market (NEM) in 2006 was expected to change the operating regime of the Gordon Power Station. These predicted changes included increased hydro peaking and longer periods with no discharge potentially resulting in faster bank erosion and reductions in in-stream habitat. To mitigate against these potential impacts, a ramp down rule and an environmental flow were established, and a monitoring program was designed to compare pre-Basslink conditions with post-Basslink conditions. Triggers were developed for geomorphological, riparian vegetation, macroinvertebrate, algae and fish variables with the purpose of detecting change in environmental condition. Post-Basslink assessment has shown that changes have occurred for all disciplines except fish. Some negative changes were determined to be a result of Basslink related effects, while others were drought related and some positive changes for macroinvertebrates were believed to be caused by the environmental flow. The data and information gained from the monitoring program have significantly increased understanding of the processes and impacts on the Gordon River, and will continue to assist in refining monitoring and mitigation measures.

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BUILDING A SCIENCE-MANAGEMENT COLLABORATION FOR LARGE-SCALE MONITORING OF ENVIRONMENTAL FLOWS

EN CHEE Yung¹, WEBB Angus², STEWARDSON Michael², SCHREIBER Sabine³, SHARPE Andrew⁴, JENSZ Michael³

School of Botany - The University of Melbourne¹, eWater Cooperative Research Centre & The University of Melbourne², Department of Sustainabilty and Environment³, Sinclair Knight Merz⁴

Session - C4D

Striking the balance between water for consumptive uses and water for restoring our degraded freshwater environments is difficult and contentious. Effective environmental flow management is integral to public support for wise-use policy and monitoring is critical to demonstrating its ecological benefits in our dynamic, diverse and inherently variable riverine ecosystems. Victoria has developed a large-scale, model-based environmental flows monitoring and assessment program to address this. Implementing such a program involving multiple partners with differing priorities, expectations and responsibilities was a considerable challenge. This presentation provides a frank, real-world account of the challenges in building ascience-management collaboration. We explain the mistakes made during this process, the corrective actions taken, and present a critical analysis of the lessons learned. In our experience, partnership-building is aided by: explicit recognition of the importance of engagement, establishing the partnership as early as possible, a strong, shared vision that is frequently reiterated, acknowledging the different needs of individual partners, and providing opportunities and channels for knowledge exchange among partners. We hope that our account of the complexities and lessons learned might both encourage and ease the process for others attempting a similar enterprise.

CARP REMOVAL AT RIVER MURRAY LOCK AND WEIR FISHWAYS

ERDMANN Brenton, RISHWORTH Jim

SA Water

Session - A3E

The River Murray is a highly regulated river, starting with the major dams at Hume and Dartmouth on its headwaters, a series of Lock and Weirs and mid river storages along its length and culminating in the River Murray Barrages at its mouth to the Southern Ocean. The construction of these structures has meant that there has been a physical barrier for the migration of fish along the length of the River which has contributed to the major decline in native fish stocks. When completed in 2012, the \$55m Sea to Hume fishway program will allow the passage of fish from the sea to Hume Dam and will remove this obstacle. Another factor that has contributed to the decline of native fish stocks is the proliferation of European carp. The slow flowing waterway and the large expanses of floodplain inundated during high flows has proved to be an ideal breeding ground for carp. Innovative research and design by river operations staff has led to the development of a cage that can be installed in the exit channel of these fishways to separate European carp from native fish. These cages have proven to be highly effective, each capable of removing several tonnes of carp per day. This paper looks at the evolution and operation of the carp separation cages.

BREATH OF LIFE: ARTIFICALLY OXYGENATION THE UPPER SWAN **RIVER ESTUARY**

EVANS Sarah, ROBB Malcolm

Department of Water WA

Session - C3D

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The Department of Water and the Swan River Trust has been successfully utilising artificial oxygenation as a remediation tool in the Canning River since 1998, to increase dissolved oxygen concentrations and reduce availability of dissolved nitrogen and phosphorus. In response to the increased frequency of low oxygen events in the Swan River estuary, a study was commissioned to assess the feasibility of long-term, large-scale ⁶oxygenation in the upper reaches. Artificial oxygenation is most frequently utilised in deep freshwater reservoirs in the Northern hemisphere, so its application to a shallow, warm and saline estuary provides many technical challenges. An oxygenation plant, using the BOC Turbolox technology, has been operating in response to low oxygen conditions since February 2009, with promising initial results. The plant draws water from above the sediment, supersaturates it with oxygen and returns it to the bottom waters via a series of diffusers. The tide distributes the entrained oxygen over the range of the tidal excursion. Preliminary results suggest that the plant is able to increase water column dissolved oxygen over a range of 3 km. The impact of the plant upon sediment dynamics and benthic fauna will be the focus of environmental monitoring over the second and third season

ANN METHOD PERFORMANCE IN RIVER POLLUTION MODELING WITH OUALITY PARAMETERS

FARAHMAND Aliraza, GOLKAR Foroogh

IAU-Fars Science and Research Branch

Session – Poster (Electronic)

In this research ANN method efficiency in EC and TDS pollution modeling in Kor River with quality parameters (pH, Hco3, Cl-, So4, anion summation, cation summation, Ca, Mg, SAR and Na) is investigated. Also the importance of these quality parameters in EC and TDS prediction are studied. Data used in this study were collected at the Chamriz station. Before predicting the pollution, the best ANN model structure was determined. The results showed that this model was able to predict EC and TDS with high accuracy and correlation. By determining each quality parameter's importance in river pollution, unimportant elements can be eliminated. Thus ANN method with a few quality parameters can be used to predict river pollution.

RESILIENT COMMUNITIES. RESILIENT ECOSYSTEMS: LEARNING ABOUT INTEGRATED CATCHMENT MANAGEMENT IN NEW ZEALAND

FENEMOR Andrew¹, YOUNG Roger², PHILLIPS Chris¹, HARMSWORTH Garth¹, GILLESPIE Paul², BASHER Les¹, DAVIES-COLLEY Rob³, DYMOND John¹, ALLEN Will⁴, SMITH Roh⁵

Landcare Research NZ Ltd¹, Cawthron Institute², NIWA³, LearningForSustainability.net⁴, Tasman District Council⁵

Session - C3C

We present three linked conceptual models for Integrated Catchment Management (ICM) developed from a 10 year inter-disciplinary, multistakeholder research programme carried out in the Motueka River catchment in New Zealand. The research aimed to provide processes, tools, methods, models and insights for regional councils, catchment groups and sector groups to tackle the complex challenges of managing cumulative effects of land, water and coastal uses. Through this research ICM is seen as having two pillars: biophysical knowledge and social process, with both the prerequisite and the outcome being "resilient communities, resilient ecosystems, together". Our research focussed on five ICM research themes: (1)Allocation of Scarce Water Resources among Competing Land & Instream Uses; (2) Managing land uses in harmony with freshwater resources; (3) Managing Land and Freshwater Resources to Protect and Manage Marine Resources: (4) Integrative tools and processes for managing Cumulative Effects; and (5) Building Human Capital and Facilitating Community Action. The research has demonstrated the value of voluntary landowner actions to improve water quality, marine impacts associated with catchment outflows, integrated catchment modelling for designing futures, dialogue processes to cultivate catchment action, and how cultural measures of river health based on indigenous Maori views of stewardship ('kaitiakitanga') can be incorporated into resource management

PROVIDING WATER FOR ECOSYSTEMS IN UNREGULATED AREAS -HOW WELL ARE WE DOING

FINN Wilf

National Water Commission

Session - A2A

The National Water Commission will shortly publish its first Australian Environmental Water Report (AEWR). The report will provide a summary of environmental water management arrangements around Australia, with separate summaries for each jurisdiction that include: A summary of the statutory framework for environmental water (responsible ministers, environmental water managers, relevant institutions, etc); jurisdiction specific terminology; the objectives and outcomes for the environmental water regime; the instruments used for defining environmental water; and the monitoring and reporting arrangements for environmental water management. While government programs to purchase entitlement based environmental water management in regulated systems have received widespread attention in the past few years, the AEWR will reflect the primacy of water planning to achieve environmental objectives and outcomes. The report will describe the different mechanisms for environmental water management in different hydrological systems. Most water systems outside the Murray Darling basin are unregulated and the AEWR will provide details of environmental water management in these systems

CO-MANAGEMENT ARRANGEMENTS FOR THE WAIKATO RIVER - A WAIKATO-TAINUI PERSPECTIVE

FLAVELL Donna

Waikato-Tainui Te Kauhanganui Inc

Session - C4B

The Waikato River is New Zealand's longest, spanning over 425 km. It is of significant national economic importance. However, with economic gain often comes environmental loss and much like many rivers globally, the health and wellbeing of the Waikato River has become severely compromised since 1840. In 2009, Waikato-Tainui and the New Zealand government finalised what is to be one of the first legislated Co-management Settlements under the Treaty of Waitangi grievance process. Importantly, it is about "the restoration and protection of the health and wellbeing of the Waikato River for present and future generations". This ensures full participation by Waikato-Tainui in decisionmaking over the River and its natural resources. It will be argued that this has, and will continue to culminate in better integrated management of the River and address the past ad hoc approaches to its management. Ultimately, the Settlement has provided a stronger voice for the Waikato River. This presentation provides the background to a 139-year old fight by Waikato-Tainui to protect their ancestral River (Tuupuna Awa) and restore their traditional rights and interests. It highlights some of the major mechanisms under the Settlement including a minimum contribution by the government of \$210 million to the river's clean up. And, we examine the overall benefit that greater participation by the River's kaitiaki (guardians) can have in working towards a healthier river for all.

UNDERSTANDING HARDY INLET - A PERMANENTLY OPEN ESTUARY UNDER STRESS.

FORBES Vanessa

Department of Water

Session - B3B

Eutrophication affects many Western Australian estuaries with symptoms of unfavourable growth of aquatic vegetation, phytoplankton blooms and even the occurrence of harmful algal blooms. This presentation examines the current condition of Hardy Inlet, a permanently open estuary, situated in the typically Mediterranean climate of the south-west of Western Australia. A long-term dataset (+10 years) on Inlet water quality including salinity, dissolved oxygen, nutrients and phytoplankton data, together with investigations on the condition of sediments and submerged aquatic vegetation are considered. Salt wedge effects (i.e. salinity and oxygen stratification) due to the permanent opening of the Inlet, and high nutrients from the heavily cleared and agricultural catchment (each coupled to rainfall and river flow) are the main drivers of Inlet condition. Ruppia megacarpa, the dominant macrophyte in the shallow basin of the Inlet is potentially an important buffer between nutrient inputs and unfavourable phytoplankton blooms. In the deeper channels stratification can be permanent and light conditions unfavourable for macrophyte growth. These channels are depositional areas for fine organic rich sediments which release nutrients under anoxic conditions and favour phytoplankton blooms, particularly dinoflagellates which are less dependent on light. Dinoflagellate blooms and outbreaks of Lyngbya aestuaria, a cyanobacterium, are becoming more frequent and show that the Hardy Inlet is under stress.

of Water WA²

Phreatophytic plant communities are typically complex and dynamic, and consequently, their management is inherently difficult. We attempted to 'simplify' groundwater-dependent Banksia woodland dynamics on the Swan Coastal Plain, Western Australia, by classifying vegetation ecohydrological states as defined by the association between vegetation composition and hydrological habitat. The classification was based on the understanding that the vulnerability of vegetation to hydrological change can be predicted from the historical dynamics of plant composition and distribution relative to the hydrological sources that maintain them. We used Classification and Regression Tree (CART) analysis of historical floristic and hydrological datasets to create rules that define the hydrological boundaries of the different ecohydrological states. By relating groundwater contour and soil (categories relating to water retention) maps to the ecohydrological state classification rules. the distribution of the states at a given point in time were mapped. The risk of impact to phreatophytic vegetation from groundwater drawdown was determined by comparing groundwater scenario modelling to the hydrological boundaries of the different ecohydrological states. Using this approach, and in water resource planning situations where the dynamics of vegetation relative to hydrological change are known, the risk of unacceptable loss of hydrological habitat can be assessed at the landscape scale.

FISH HEALTH IN CLAISEBROOK COVE

Black Bream are an important ecological, recreational and commercial icon of the Swan River, Western Australia. Sediments in the estuary adjacent to Claisebrook Cove have been identified as having elevated pesticide, metal and PAH concentrations compared to other sites in the estuary. The health status of fish captured in Claisebrook Cove was evaluated using a suite of physiological indices and biochemical markers including general indicators of fish health (liver somatic index - LSI, condition factor, gonadosomatic index – GSI) and biomarkers of exposure to contamination (PAH metabolites, serum sorbitol dehydrogenase sSDH, EROD, oxidative DNA damage). Relative to Black Bream captured in Burswood Lake (a reference site), Black Bream captured in Claisebrook Cove had higher hepatic detoxification activity indicating recent or ongoing exposure to organic contaminants. Fish in Claisebrook Cove had higher

COMMUNICATING A WATERSHED MESSAGE - SOCIAL MARKETING AND SOCIAL MEDIA

FRANZ DELFAU Karen

Watershed Strategies

Session - D1C

Addressing watershed, water supply and sustainability challenges require new ways of communicating with and engaging communities. Traditional advertising and information-based campaigns focused on raising environmental awareness do not produce the necessary quantifiable onthe-ground results, and many studies have shown it to have no impact at all. Just because individuals or communities know they should engage in an environmentally-responsible behaviour, does not mean that they take action. This presentation introduces Community-Based Social Marketing (CBSM) for sustainable behavior change, which is a quantifiable way to measure and influence behaviour change to promote sustainability. CBSM is a data-driven approach that identifies barriers and benefits to specific behaviours before implementing and evaluating an intervention. In addition, emerging social media approaches will be explored, including Twitter, Facebook, Ning and the use of collaborative Wikis for communicating complex messages related to environmental sustainability in a way that can produce commitments and results. Examples from the author's professional experience working with nonprofits and as a consultant in both San Diego, CA and Brisbane, QLD will be provided.

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MODELLING OF VEGETATION ECOHYDROLOGICAL STATES FOR GROUNDWATER PLANNING AND RISK ASSESSMENT

FROEND Ray¹, SOMMER Bea¹, PATON Andrew², HUNTLEY Brenden²

Centre for Ecosystem Management - Edith Cowan University¹, Department

Session - Poster (Hard)

GAGNON Monique

Curtin University

Session - A3D

levels of biliary PAH metabolites, providing evidence of recent exposure to PAH contamination. Fish captured in Claisebrook Cove had higher sSDH concentrations than those captured in the reference site but this was not elevated above that measured in hatchery reared fish. Similarly, there was no difference in oxidative DNA damage between the two fish populations. In addition, Black Bream captured in Claisebrook Cove had higher LSI and male fish had lower GSI relative to fish captured in Burswood Lake. Along with biochemical markers of fish health, physiological indicators suggest that the health of the Claisebrook Cove fish was generally compromised. These results demonstrate that the fish captured in Claisebrook Cove were exposed to a source of organic contamination, and were assimilating these contaminants. This suite of biochemical and physiological indicators constitutes a rigorous method of assessment of localised populations in the Swan River and other urban estuaries and demonstrates the ability of these biomarkers to detect differences between such populations.

CHANGING CHARACTER: THE RAMSAR CONVENTION ON WETLANDS AND CLIMATE CHANGE IN THE MURRAY-DARLING BASIN, AUSTRALIA

GARDNER Alex¹, PITTOCK Jamie², FINLAYSON Max¹, McKAY Clare¹

The University of Western Australia¹, Australian National University²

Session - B3C

The Ramsar Convention on Wetlands was established to conserve the world's diminishing wetlands on the assumption of a stationary hydrology, which is now threatened by climate change. We examine how the Australian Commonwealth Government is using the provisions within the Convention to deal with the degradation of six Ramsar-listed wetlands in the Murray-Darling Basin in Australia. The ecological character of the wetlands is changing, primarily due to the manner in which the rivers have been managed and excessive extraction of water for human consumption. Climate change is expected to exacerbate this situation. We outline breaches in the Government's obligations under the Convention. The Environment Protection and Biodiversity Conservation Act 1999 (Cth) and the Water Act 2007 (Cth), which are based in part on supporting the implementation of the Convention, are undermined by a lack of adherence to the Convention. Gaps and inconsistencies are also identified in the Convention for managing the impacts of climate change on wetlands

PATTERNS IN THE MICROBIAL COMMUNITY STRUCTURE OF THE SWAN RIVER ESTUARY, WESTERN AUSTRALIA

GEDARIA Alice, HIPSEY Matthew

School of Earth and Environment – The University of Western Australia

Session - B3B

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The interactions between various microbial populations in an estuarine system are complex and vary in response to numerous physical, chemical and biological properties. The aim of this study was to explore the relationships between the microbial communities in the Swan River Estuary over a range of space and time scales and how they relate to various physical and chemical properties of the water. The abundance of various microbial populations such as pico- and nano-phytoplankton, bacteria, virus-like particles and phytoplankton were measured along the Swan River fortnightly for 12 months using flow cytometric and microscopic analysis. Many of the measured groups have not previously been explored in a temperate estuary. The spatial and temporal patterns of various microbial populations showed considerable variations over a seasonal scale. The relationship of each microbial group in relation to various physico-chemical parameters measured showed strong correlations, particularly to salinity and nutrients. Through a better understanding on the interactions between microbial populations and their distribution across the estuary during different seasons, we have been able to gain insights into the key controls of nutrient cycling processes within the water column

GIROUD Marnie Swan River Trust Session - C3A

See SWAN RIVER TRUST

THE SWAN CANNING RIVER GUARDIANS - A CARING COMMUNITY

GIROUD Marnie Swan River Trust

Session - Poster (Hard)

The River Guardians program enables the Perth community to be an important part of applying solutions to complex river protection issues in the Swan Canning Riverpark. It provides members with free learning opportunities and activities, and is underpinned by recognised social science, environmental education and behaviour change principles. Independent research has demonstrated the effective uptake of more river-friendly behaviours that help to improve water quality in the Swan Canning Catchment, as a result of this program. Since June 2008, more than 700 members have joined the program which provides: handson river protection and restoration projects; river science and history activities and presentations; indigenous cultural events; networking opportunities with river restorers; and training focused on river issues. River Guardian members can also become Dolphin Watch volunteers - a new program being delivered in partnership with the Swan River Trust, Murdoch and Curtin Universities. It is the first river-based community project monitoring dolphin behaviour in Western Australia. Since the project's launch in April 2009, 123 reports have been received. Dolphin Watch connects people to the rivers and gives them a unique opportunity to make a useful contribution to new scientific data.

RESERVOIR AND FLOOD ROUTING IN MOLLASADRA DAM WITH HEC_ HMS MODEL

GOLKAR Foroogh, FARAHMAND, Alireza

IAU-Fars Science and Research Branch

Session – Poster (Electronic)

Reservoir routing in Mollasadra dam (structured on Kor river, Fars province, Iran) with HEC_HMS model is investigated in this paper. Due to biotechnical methods in river management, appropriate river bed determination for planting is important. So flood peak estimation before and after a dam starting operations can be the first step in a river bed study. Flood peak estimation before the dam started in different return periods gained from hydrometry stations data is presented. Also flood peak after dam starting probed with HEC_HMS Model. The results show that floods reduced from 25-200 year return period to 2-14 year return period due to reservoir effects.

IMPROVING FOOD SECURITY THROUGH BETTER WATER MANAGEMENT - COMMUNITY COLLECTIVE ACTION IN ADOPTING WATER SAVING TECHNOLOGIES

GOUD Vinod¹, GUJJA Biksham²

ICRISAT^{1,}, WWF International²

Session - C3F

Rice is a staple food for millions of households in the world, particularly in developing countries. It is the main cereal for the majority of the population in India. The demand for rice is growing with the ever-increasing population. Rice is grown in flooding conditions. More than 70 percent of the country's ground and surface water is being used for agriculture, and out of this, 70 percent is allocated to rice cultivation alone. Hence, it is the largest irrigation water guzzling crop occupying the command areas of all rivers, tanks, ponds and also bore wells tapping the ground water. This made water increasingly the single biggest constraint to producing more rice to meet increasing demand for food and supporting livelihoods. With inevitable growth of demand for human and industrial needs, water available for agriculture will become scarcer in future. Hence, India needs to invest on improving its water productivity, and any capacity to produce more rice with less water will be an important contribution to sustainable water and food security. System of Rice Intensification, known as SRI, is

one such method that saves water considerably and vet produces more rice. SRI method is introduced in two water stressed villages falling in the Godavari River basin in southern India during the post rainy season in 2007-08 with 50 farmers. Through field demonstrations and capacity building coupled with handholding support, small and marginal rice farmers were helped to adopt SRI. The success in saving 30-40% of water made other rice farmers motivated in the next year and by 2009 about 300 farmers came forward to adopt SRI. Comparative studies between SRI and non SRI farmers showed that the conventional rice cultivation used 60 to 70 times irrigation, where as SRI rice fields needed only 30 to 40 times only. Rice fields grown under SRI method showed great resilience to unprecedented drought conditions in the 2009 rainy season and yet yielded well compared to the conventional rice fields, establishing its potential for better management of irrigation water in the Godavari River basin. Today all the farmers in these two villages are aware of the benefits and skills of adopting SRI practices. The success story of these villages is being emulated by many villages in the Warangal district of Andhra Pradesh state in southern India with policy makers and district authority's impressive involvement motivated by this success.

VALIDATION OF SATELLITE-BASED OPERATIONAL FLOOD MONITORING ON THE LOWER-BALONNE FLOODPLAIN, QLD

GOUWELEEUW Ben¹, TICEHURST Catherine¹, LERAT Julien¹, THEW Peter²

CSIRO Land and Water¹, CSIRO ICT Centre²

Session - C4E

The potential of remote sensing technology to monitor the dynamics of hydrological events lies in its ability to map surface water. For flood events, remote sensing imagery needs to be available sufficiently frequently to capture subsequent inundation stages. Optical sensors such as MODIS allow open water mapping with a combination of moderately high spatial and temporal resolution (250m-1km, twice daily), but are affected by cloud cover. Passive microwave observations are available at comparable temporal resolution, but coarse spatial resolution (5-70km), where the smaller footprints corresponds with the higher frequency bands, which are also affected by precipitating clouds. A novel operational technique to monitor flood extent combines MODIS reflectance and AMSR-E passive microwave imagery to optimize the advantages of both sensor technologies. Flood extent is subsequently combined with a Digital Elevation Model (DEM) to obtain total flood water volume. The flood extent and volume product is operationally available for the lower-Balonne floodplain in Southern Queensland, Australia. While the floodplain is dry for most of the year, major flooding occurs regularly, on average once every 2 years. For validation purposes, two moderate flood events coinciding with the MODIS and AMSR-E sensor lifetime are evaluated.

PADFLOW - A NEW APPROACH TO IDENTIFYING AN ENVIRONMENTAL FLOW REGIME

GREEN Adam, DONOHUE Robert

Department of Water WA

Session – Poster (Hard)

A range of approaches have been used in Australia to estimate the environmental flow (EF) requirements of rivers. The methods used in Australia (and elsewhere) over the past two decades are essentially habitat approaches that identify flows that achieve a minimum water depth in important aquatic and riparian habitats. These threshold flows are then used to 'construct' an EF regime. The natural variation in river flow between seasons and across years is responsible for the evolution of the observed ecological state and maintaining the evolutionary and future adaptive capacity of river ecology. While approaches such as the building block method determine EF regimes with seasonal variation, they have essentially ignored the importance of flow variation across years. The Department of Water identified the need to create an EF regime that incorporated the variation across years and developed the 'proportional abstraction of daily flows' (PADFLOW) method. The PADFLOW method 'constructs' an EF regime which mimics a rivers natural flow regime by removing a proportion of daily flow from an existing flow record with reference to a range of known ecologically important flows. This poster demonstrates how the department has used the PADFLOW method to construct an EF regime for rivers in south-west Western Australia and ultimately determine an ecologically sustainable yield.

MANAGING IMPACTS OF DROUGHT ON SOUTH AUSTRALIA'S FRESHWATER FISH HALL Arkellah

HALL Joel

The Streamflow Quality Affecting Rivers and Estuaries (SQUARE) model was applied to the Nambeelup Brook catchment in the south-west of Western Australia. SQUARE is a lumped semi-distributed process-based rainfall-runoff and nutrient model. Model inputs include rainfall, soil phosphorus retention index, leaf area index, deep-rooted vegetation, fertilisation rates and nutrient point sources. The Nambeelup Brook catchment is located on the Swan Coastal Plain, approximately 50 km south of Perth. Land uses are predominantly beef and dairy grazing, with some lifestyle blocks, remnant native vegetation and forestry. Calibration was undertaken over an 18 year period from 1990 to 2008, using daily flow data and fortnightly nutrient data. The model achieved Nash-Sutcliffe efficiencies of 0.86, 0.95 and 0.97 for daily, monthly and annual flows respectively. Daily nutrient load efficiencies of 0.78 for total phosphorus, 0.83 for soluble phosphorus, 0.67 for total nitrogen, 0.51 for nitrate and 0.42 for ammonia were achieved. Modelled winter median concentrations were within 10 percent of the observed values. The calibrated model was used to determine subcatchment loads, load contributions from the different land uses, catchment hot-spots and the effect of land use and climate changes on flow and nutrient load delivery to the receiving water body (the Peel Inlet).

HOSJA Was³ University of Tasmania¹, University of Maryland², Department of Water **W/A**3

Department for Environment and Heritage

Session - Poster (Hard)

Over allocation of water resources across the Murray Darling Basin (MDB) has anthropogenically exacerbated over eight years of drought in South Australia. Subsequent record low inflows have resulted in a dramatic decline in the condition of aquatic ecosystems, placing significant stress on native freshwater fish populations. In response, during 2008 a South Australian 'Drought Action Plan' (DAP) for threatened small-bodied native freshwater fish was initiated. The DAP is focused on monitoring, conserving and re-establishing these species along the Lower River Murray wetlands and in particular the Coorong, Lower Lakes and Murray Mouth region. Five species were identified as having undergone significant declines and thus are a high priority for protection: Murray hardyhead (Craterocephalus fluviatilis); southern pygmy perch (Nannoperca australis); Yarra pygmy perch (*Nannoperca obscura*); river blackfish (*Gadopsis marmoratus*); and southern purple-spotted gudgeon (Mogurnda adspersa). Actions under the DAP have included active management of wild and captive populations (for later re-introduction) and the identification of surrogate refuge sites. Future conservation and management programs throughout the basin should adopt whole-of-basin values including protecting population structure and restoring critical habitat for high priority native freshwater fish species. This presentation aims to provide background to the DAP, describe progress to date and highlight the importance of environmental water requirements of aquatic biota alongside other consumptive users of water, particularly in the Coorong, Lower Lakes and Murray Mouth region.

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CALIBRATION AND APPLICATION OF A COMPLEX RAINFALL-RUNOFF AND NUTRIENT MODEL

Department of Water

Session - Poster (Hard & Electronic)

WHAT TRIGGERS FISH-KILLING DINOFLAGELLATE BLOOMS OF KARLODINIUM VENEFICUM IN THE SWAN-CANNING RIVER SYSTEM? HALLEGRAEFF Gustaaf¹, MOONEY Ben¹, EVANS Kate¹, PLACE Allen²,

Session - A3D

Fish killing blooms of the dinoflagellate Karlodinium veneficum have occurred at various times in the Swan River (2003, 2010), Beaufort Estuary (1998) and Murray River (1999). In other years, this species has been present but did not cause blooms nor fish kills. We established that Karlodinium in the Swan Canning populations are genetically uniform and always produce polyketide karlotoxins, reputedly to kill algal prey. At the same time these toxins can kill fish, shellfish and zooplankton, but critically

Karlodinium cells need to lyse for fish kills to occur. Culture studies have shown this dinoflagellate to be tolerant to salinity (15-35 ppt), to prefer warm water (20oC), able to grow phototrophically (0.2–0.8 div.day-1) but also able to feed mixotrophically on cryptomonad prey. While mixotrophic feeding had no significant influence on dinoflagellate growth rates, it markedly increased the length of stationary phase of growth notably under P deficient conditions. These results are being used to add value to interpreting the long-term Swan River water quality and phytoplankton dataset collected by the Department of Water, and define early warning signals for Karlodinium blooms and fish kills in the Swan River.

A FISH-BASED ESTUARINE HEALTH INDEX FOR THE SWAN ESTUARY, W۵

HALLETT Chris

Centre for Fish and Fisheries Research - Murdoch University Session – A3F (Future Water Leaders Award Finalist)

We describe the development of a fish-based, multimetric estuarine health index (EHI) for the Swan Estuary, Western Australia. A suite of fish community characteristics (metrics), including measures of species composition, diversity and abundance, trophic structure and life history function, were selected via a weight of evidence approach, on the basis of their sensitivity to detect interannual change. Reference conditions for each selected metric were established for each region of the Swan Estuary using historical fish assemblage data, and represent a best available standard of biotic integrity against which the current and future health of the estuary may be assessed and compared. Scores for each metric were assigned according to the extent of the metric's deviation from its reference condition. Values for the EHI were calculated from summed metric scores for each main region of the Swan Estuary for each season and year, to identify trends in the recent health of the estuary, and to validate the sensitivity and reliability of the index. The index, which is the first such tool to be developed for Western Australia, will provide managers with a reliable and cost-effective, quantitative method for assessing and communicating the health of the Swan Estuary.

DEMONSTRATION REACHES: ENGAGING WITH THE COMMUNITY

HAMES Fern

Department of Sustainability and Environment

Session - A2B

Demonstration Reaches have been in place throughout the Murray-Darling Basin for three years, and it is important to review the effectiveness of our efforts and share learnings from our experiences. This presentation considers the forms of community engagement that have been used by demonstration reaches across the Basin, and identifies their successes and challenges. The presentation will also make recommendations for achieving more effective community engagement not only in demonstration reaches, but in other environmental projects as well.

SWAN CANNING WATER QUALITY IMPROVEMENT PLAN: DEVELOPMENT AND IMPLEMENTATION

HAMS Alex

Swan River Trust

Session - A2F

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In 2006, the Swan Canning river system was identified as a coastal hotspot for water quality issues as part of the Australian Government's Coastal Catchment Initiative (CCI), an initiative aimed at improving water quality in priority coastal catchments throughout Australia. A major output of the CCI was the development of the Swan Canning Water Quality Improvement Plan (SCWQIP) with the focus of reducing the nutrient contribution entering the Swan Canning river system. The SCWQIP presents a series of findings based on predictive modelling and provides a series of recommendations to address the water quality issues through a "treatment train" approach during a seven year period. Predictive modelling conducted in the development of the SCWQIP indicates a required reduction of total nitrogen loads of 120 tonnes or 49% and total phosphorus loads of 12 tonnes or 46% to meet maximum acceptable limits. The implementation of the SCWQIP during the next seven years will rely on collaboration and investment from Australian, State and local governments to apply key recommendations, as well as involving

community groups and individuals in education and awareness raising programs aimed at instilling behaviour change.

ANALYSIS OF HYDRAULIC CHARACTERISTIC FOR NATURAL RIVERBANK CREATION

HAN Manshin

International Center For Urban Watar Hydroinformatics & Innovation(ICUH)

Session – Poster (Hard & Electronic)

Although impingement area of low revetment requires hydraulic stability in the river, there is not enough reliable data and selection of the appropriate technique. For making a natural river, a technique on the river revetment is applied using robust material such as concrete block, blasting rock. belemnites, broken stones and so on. A recently developed technique using vegetation is actively underway to make an ecological environmental river without flood control evaluation. According to tractive force evaluation, the possibility of adaptation of this technique is applied with a flood control view rather than ecological environmental view. The purpose of this study is to analyse on hydraulic characteristics the application of the developed new technique for ecological function in the low revetment. Korea ecological river's gradient is normally not steep (from 1:2 to 1:5) and the design velocity is of 2~3 m.s⁻¹ because a river does not drop suddenly. The velocity used with the new developed technique in this study is up to 5 m.s⁻¹ considering vegetation area, so it is necessary to verify the gradient according to stability. Therefore, since stability of revetment depends on the slope, indoor open-channel model is set as 20 m length, 2 m width, 1 m height. The 2-dimentional velocity distribution is analysed according to a gradient control device at 1:1, 1:2, 1:3, 1:4 and different discharges.

PLANNING FOR DEMONSTRATION REACHES - KATFISH REACH CASE STUDY

HARPER Mike

Department of Environment and Natural Resources

Session - A2B

The Katfish Reach Project is located on the Katarapko/Eckert Creek anabranch system between Berri and Loxton along the River Murray in South Australia. Between the light bulb going on and the Katfish Reach project getting legs, it took over a year and half and involved the following decisions and actions: Is creating a Demonstration Reach the best marketing decision for the project or would the project be better placed to receive support/funding under a different natural resource program such as River Care. Both agency and community interest in establishing a Demonstration Reach were assessed. A Project Brief was developed which described the site, the Demonstration Reach program, site issues, project benefits, possible stakeholders, a 5 year program (now totally shot to pieces) and possible funding sources. To lock in support and identify roles and responsibilities for the project an MOU was established between the major players which involved agencies, a community group and a business sponsor. The Project Brief was essential in bringing the MOU parties together. In partnership with the Katfish Reach Steering Group the following planning documents have been developed: Implementation Plan (identifies project vision, objectives and proposed actions), Investment Proposal (identifies preferred actions, concept designs and costs), Monitoring and Evaluation Framework (identify intervention, condition and compliance monitoring) and a Communications Strategy.

SUSTAINABILITY PERFORMANCE OF HYDROPOWER COMPANIES

HARTMANN Joera

WWF International

Session - B4B

Hydropower generation is currently the main driver behind the loss of free-flowing rivers. Projects entail a number of complex sustainability challenges, and different investors respond differently to such challenges. More mature companies with a well-developed sense of Corporate Social Responsibility (CSR) may face higher up-front investments, but the reward can be better stakeholder acceptance, and reduced risk of conflicts and delays. This paper explores the underlying incentives for companies to adopt good and best practices, and ways for stakeholders to gauge company performance. It argues that good sustainability performance does not require large expenditures or sophisticated knowledge, only available to large companies from developed countries. Instead, it can be achieved by a combination of two rather basic principles: firstly, avoidance of negative impacts by early-stage screening of projects, and secondly, good project management to ensure that social and environmental mitigation and compensation are performed timely and cost-effectively. Given the rapid global expansion of hydropower, it is critical that the lessons learnt and tools developed to improve project sustainability are easily accessible, incentives to use them are strengthened, and companies commit to systematically adhering to them.

ECOSYSTEM RESTORATION IN WATER-SHORT RIVERS OF THE WESTERN USA

HARVEY Michael, MUSSETTER Robert, FULLERTON William

Tetra Tech Inc.

Session - C3C

Land use changes, mainstem dam construction, off-channel storage, diversions, flood flow regulation, channelization and levees have caused disconnection of floodplains and associated adverse impacts on the populations of endangered native fish species in snowmelt runoffdominated, sand-bed, reaches of four rivers (Rio Grande, Green, Colorado and Pecos Rivers) in the semi-arid western USA. Significantly reduced peak flows (30 to 80 percent) and resulting geomorphic adjustments of the channels (degradation and narrowing) have reduced or eliminated overbank flooding, except during large, infrequent flood events (> 10-year recurrence interval). Ecological restoration requires that the overbank needs of the individual species and their life stages be met through specific, frequently occurring, hydrologic and hydraulic conditions that incorporate hydrologic risk so that some restored habitat will be available in all water type years. Because of the paucity of water, reconnection of the floodplain has generally been accomplished by mechanical intervention, including lowering of bar, floodplain and terrace elevations, breaching of levees, reconnection of cutoff channel segments, raising water-surface elevations with weirs and construction of fish-passage structures to allow fish access to locations where overbank habitat still exists. In each of the rivers, Tetra Tech, Inc. designed projects have successfully achieved the ecological restoration goals.

SUPPLEMENTING WATER SUPPLY TO MARE AUX VACOAS RESERVOIR IN MAURITIUS

HAUMANN Ken

PD Naidoo & Associates

Session - A3E

The Mare Aux Vacoas Reservoir (MAV), with a capacity of 27,63 Mm³, comprises four dams that have, through raising of perimeter walls, become one large reservoir used for the supply of potable water to surrounding towns in mid-west Mauritius. The combined water resources mobilized through the existing feeder canals and the contribution by the surrounding catchment have become insufficient as a result of increasing water demands. During the past few years the reservoir starts depleting from the months of July/August and lasts for 6–7 months until the onset of the next rainy season. It has also been observed that the reservoir remains below the long term average storage as from the months of August/September. Consequently curtailment of certain demands has been necessary to ensure judicial allocation of water resources among users. Therefore there is a need to mobilize additional water resources to the MAV reservoir in order to ensure sustainable supply. To achieve the mobilization of additional water resources to the MAV reservoir, in order to meet current and future demands, it is proposed that a diversion weir on the nearby River du Poste be constructed to capture and divert flood flows into MAV. This paper details the methodology used in the Feasibility Study.

ASSESSING THE EFFECTIVENESS OF AERATION IN REDUCING **EVAPORATION FROM DAMS IN AUSTRALIA**

HELFER Fernanda, ZHANG Hong, LEMCKERT Charles

Griffith University

Session – Poster (Electronic)

This paper aims to assess the effectiveness of air-bubble plume aeration

water will be heated due to sensible heat flux and the aeration system will

All aquatic ecosystems require water to maintain their ecological processes and associated communities of plants and animals. Environmental Water Requirements (EWR) describes the water regime needed to sustain the ecological values of water dependent ecosystems at a low level of risk (ARMCANZ and ANZECC 1996). To identify the EWR for the Coorong. Lower Lakes and Murray Mouth, a comprehensive list of species, assemblages and ecological processes were compiled that occur within the site under the described Ramsar-nominated ecological character. Their flow-related requirements (including water quality, water level, connectivity and return intervals for flooding and barrage flows) was then linked to ecological objectives and outcomes that describe what a healthy and resilient wetland is. Hydraulic and ecosystem response modelling was then used to develop a set of minimum flow targets and flooding requirements that essentially represent an end-of-system flow regime for the River Murray. This EWR establishes the long term targets that environmental water under the draft Basin Plan should ideally be seeking to provide. Additionally, these targets and the underlying information provide for establishing the Limits of Acceptable Change, Management Triggers, future priority research projects and monitoring within the site under the site's long term plan and Ramsar management plan.

Thermal pollution has been an ongoing issue for major dams and regulated rivers in New South Wales. The releases of cool temperature water in the spring – autumn and particularly in the summer period, adversely affect downstream temperatures for many kilometres. The NSW Government has implemented a strategy focussing on capital works and flow management to minimise the occurrence of thermal pollution. This paper addresses the economic benefit cost analysis undertaken to assess expenditure to reduce thermal pollution. Economic costs were based on capital works and implementation of monitoring and flow management. Economic benefits of the thermal pollution strategy were based on dollar values for changes in native fish numbers and species as a result of implementation of the Strategy. Economic values were sourced using benefit transfer ${}^{\bigcirc}$ from choice modelling studies. The outcomes indicated that the thermal pollution strategy was economically feasible and the study supported ongoing funding and implementation of the government strategy.

in reducing evaporation from shallow and deep stratified dams in Australia using modelling. A one-dimensional model was applied to simulate the water temperature and evaporation rates from a farm dam in Queensland under different aeration conditions and two different depths: 6.5 and 13.5 metres. The results showed that aeration can reduce surface temperature and evaporation from both situations (shallow and deep water), but higher effectiveness is expected for deep lakes. This happens because the bottom of a deep lake is colder than the surface during almost the entire year, which is a condition necessary for reducing the surface temperature and, consequently, evaporation, under air-bubble plume aeration conditions. However, the results also showed that the reduction in surface temperature and evaporation will not be significant during hot weather periods (i.e., when the difference between the surface temperature and the air temperature is too high). Under this condition, the cooled surface

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HOW MUCH ENVIRONMENTAL WATER IS ENOUGH FOR THE LOWER MURRAY WETLANDS? PART I

only contribute to increase the heat stored in the water even more.

HIGHAM Jason¹, MULLER Kerri², LESTER Rebecca³, FAIRWEATHER Peter³. HENEKER Theresa⁴

Department for Environment and Heritage¹, Kerry Muller NRM², Flinders University³, Department of Water, Land and Biodiversity Conservation⁴

Session - B3A

VALUING THE ECONOMIC BENEFITS OF REDUCING THERMAL POLLUTION IN NEW SOUTH WALES

HILL Christine

NSW Office of Water

Session - C2E

CATCHMENT MANAGEMENT AND BEHAVIOUR CHANGE

HINDMARSH Rosanna

Ellen Brockman Integrated Catchment Group

Session - C3A

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Behaviour change sounds easy. People want to do the right thing – don't they? Well, individually they may - if it costs them nothing or if it is desirable. Everyone feels that the environment should be better protected but it is "they" who should take care of it - isn't it? How do you change community behaviour? The anti-smoking campaign was successful at changing community behaviour but at enormous cost. Millions of dollars went into media campaigns. The behaviour change that has occurred benefits the individual rather than the community and -yes- there is an economic benefit for the government and thus the community but it is a different story for environmental behaviour change. The environment lobby does not have millions of dollars for public education campaigns; individuals rarely benefit from behaviour change for the sake of the environment. So, any widespread media campaign will rely on individual altruism. Will this be effective long-term or is "doing the right thing" short lived? Individuals only change if there is individual financial benefit or a personal change of conscience. Wider behavioural change in the community will rely on a collective change of conscience. Community groups can achieve this with individual attention.

COUPLED HYDRODYNAMIC-BIOGEOCHEMICAL MODEL OF THE MURRAY LOWER LAKES FOLLOWING DROUGHT

HIPSEY Matthew¹, SALMON Ursula¹, MOSLEY Luke², ALDRIDGE Kane³, **BROOKES** Justin³

The University of Western Australia¹, SA Environmental Protection Agency², University of Adelaide³

Session - D1D

Significant hydro-climatological change in South-Eastern Australia has resulted in a dramatic reduction in flow dynamics of the Lower River Murray and Lower Lakes of South Australia. The reduced flows have led to increased stratification in river pools, reduced flushing, and unprecedented water level decline as evaporative losses are now significantly higher than inflows. The changes in flow regime have led to marked changes in water quality. Seasonal patterns of nutrient and resource delivery have changed, and evapoconcentration of dissolved salts in the lower lakes has altered salinity concentrations and distribution. Acidification of parts of the system due to exposure of acid sulfate soils has created a significant management challenge due to the potential for low pH and dissolved metal release to impact adversely on lake ecology. To support quantification of water quality changes and contribute to management decision-making, a unique high resolution, process-based, 3D coupled hydrodynamic-geochemical-biological modelling system has been developed. The model is used to understand how the lake is responding to changing flows and engineering interventions, and to study the potential effects of seawater entrance into the lake system to mitigate acid sulfate soil risks. The process-based approach has allowed for forecasting in a relatively data-poor environment and has enabled for planning of management responses.

RETROFITTING OUR CITIES FOR SUSTAINABLE URBAN WATER MANAGEMENT

HOBAN Alan

SEQ Healthy Waterways Partnership

Session - A3A

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Whilst water sensitive urban design is now widely supported in principle, and in some jurisdictions in policy, most of its application in Australia to date has been in new, greenfield urban developments. Most of our urban areas were planned and constructed well before the advent of sustainable integrated urban water management, and these areas have a major legacy on the our urban rivers. The challenge of retrofitting existing urban areas with contemporary water management infrastructure is significant. Challenges include identifying relevant water management technologies and urban design solutions, integrating them into various urban form typologies, prioritising and scheduling where works should occur, identifying funding mechanisms and synergies with other construction activities, and setting appropriate targets and implementation scenarios.

The SEQ Healthy Waterways Partnership's Water by Design program has undertaken an investigation into this topic, working with a broad team of urban planners, architects, landscape architects, engineers and urban thinkers. This project builds upon a recent business case prepared by the program which demonstrates a three-fold return on investment for applying water sensitive urban design.

CLIMATE CHANGE IMPACTS ON THE ST. LAWRENCE RIVER (QUEBEC, CANADAI

HUDON Christiane Environment Canada Session - D1A

Growing evidence suggests that the climate of the Great Lakes - St. Lawrence (SLR) region is already changing: winters are getting shorter, annual average temperatures are rising, the duration of lake ice cover is decreasing as air and water temperature rise, and heavy rainstorms are becoming more common. Between 1960 and 2007, the annual water temperature of the SLR rose by 1.3°C (0.027°C.y⁻¹) and its mean annual water level near Montreal declined significantly, coinciding with major shoreline alteration and channel excavation. Low discharge and warm temperature conditions enhance primary productivity and proliferation of exotic species in riparian wetlands. Fish recruitment and survival are markedly affected by the conjunction of adequate water temperature and levels. Under low discharge conditions, human pressure to excavate the navigation channel and encroach on the floodplain and riverbed are intensified, thus compounding the impacts of climate variability on the ecosystem. Climate, hydrology, ecosystem function and human activities thus exemplify complex feedback mechanisms in SLR.

SAVING THE MARGARET RIVER HAIRY MARRON FROM EXTINCTION

HUGH Cameron¹, LAWRENCE Craig¹, DE GRAAF Martin²

Department of Fisheries WA¹, Institute for Marine Sciences and Ecosystem Studies²

Session – Poster (Hard & Electronic)

Marron, Western Australia's largest freshwater crayfish, support a large recreational fishery and aquaculture industry. Due to translocation of this popular species, the distribution of marron in the south-west of Australia has seen many changes since European settlement. In 1996, a separate species of marron, the Margaret River Hairy Marron (Cherax tenuimanus) was recognized. Continued surveys found the population was at risk from the introduced smooth marron (C. caani). During the 1980's smooth marron were introduced to the lower reaches of the Margaret River, and their increased distribution coincided with the decrease in range and abundance of the Margaret River Hairy Marron. Subsequent action by the Department of Fisheries has included setting up a Margaret River Marron Recovery Plan in conjunction with NRM groups, universities and landowners. Field surveys and genetic testing that showed that Hairy marron were decreasing and hybridizing with smooth marron. Department of Fisheries established a captive breeding program using genetically proven pure hairy marron which has to date, resulted in the restocking of over 1200 tagged animals back into the Margaret River. Additionally, over 4000 smooth marron have been removed from hairy marron habitat in a joint project involving Fisheries staff, NRM groups and landowners.

SETTING THE SCENE

HUGHES Rod

Swan River Trust

Session - C3A

See SWAN RIVER TRUST

VALUING RIVERPARK, WESTERN AUSTRALIA

HUGHES Michael¹, SHADBOLT Roxane², CARLSEN Jack¹

Curtin University¹, Swan River Trust²

Session – Poster (Electronic)

This study presents a total economic valuation of the Swan Canning Riverpark. Riverpark is located within the Perth Metropolitan area, Western Australia. It includes the Swan and Canning river systems, tributaries and adjacent public land. Riverpark is a Perth Icon and accounts for much of the City's natural environment. It also functions as a major focus for recreation, events and commercial activities. However, Riverpark's popularity and urban setting places significant stress on its ecological systems, requiring significant resources to mitigate these effects. Riverpark management involves numerous State and local government and community organisations. The foreshore parks and recreational reserves are vested with different land managers, including the Swan River Trust (SRT), 21 local governments, the Department of Environment and Conservation, the Department of Planning and several redevelopment authorities. The river reserve is vested mainly in the SRT. Despite its significance, the value of Riverpark is not well documented. Measurement of Riverpark's contribution to the Western Australian economy can strengthen general understanding and appreciation of the importance of the river system. Measurement of Riverpark use and nonuse values will enable a business case for the appropriate allocation of resources to facilitate the sustainable management of the area.

MAXIMISING THE VALUE OF BIOSOLIDS - CATCHMENT AND WATERWAY RESTORATION

HUMPHRIES Robert¹, LONG Tom¹, WALTON Katrina², ALLEN David³

Water Corporation¹, Chemistry Centre WA², MBS Environmental³

Session - C3D

Most Australian water utilities strive to direct biosolids to beneficial uses. However, the "solutions" to the problems of biosolids utilization are often expensive, inefficient, and unstable because of constantly changing perceptions regarding health and environmental safety. This project has assessed the social, technical and economic feasibility of converting annual pastures in the nutrient-enriched Ellen Brook catchment into perennial-plant based systems by using a slow release fertiliser based on lime-amended biosolids. The initiative is designed to create win-win social, economic and environmental outcomes: (1) Progressively reducing excessive nutrient loads to Ellen Brook, and hence the Swan Estuary; (2) Establishing strong new partnerships with all stakeholders; (3) Facilitating beneficial land use change in the catchment; including re-linking fragmented native vegetation; [4] 'Climate-hardening' of agriculture; (5) Proving the efficacy of a low-phosphorus leaching biosolids-based fertiliser; (6) Reducing biosolids transport distances; and (7) Creating carbon credits and nutrient offsets for the Water Corporation.

ECOLOGICAL WATER REQUIREMENTS FOR URBAN WATER MANAGEMENT

HUNT Kelsey¹, MUIRDEN Peter²

GHD¹, Department of Water WA²

Session – Poster (Hard & Electronic)

This project is the first application of a draft Department of Water state guideline to define EWRs for water dependent ecosystems that may be impacted by proposed urban and industrial development. Ecological water requirements were determined for water dependent ecosystems within an area under consideration for future urban and industrial development in the Murray River region of south-western Australia. Site specific data were collected for selected wetland sites including surface and groundwater hydrology, water quality, topography and ecological data. Surface and groundwater hydrological data were used to calibrate regional and specific wetland hydrological models that were used to identify wetland water regimes. Site specific vegetation data were used to define ecological values and to determine acceptable changes to wetland water regimes. Model data were also used to assess the impact of various climate and development scenarios on the water regimes of these water dependent ecosystems. The outcomes of the project were used as inputs into, and to provide guidance for, drainage management and urban water design for the Murray River region to inform structure planning at the regional scale.

Session - A2B

Anoxia in estuaries is becoming a serious problem worldwide. Australian estuaries are particularly susceptible to anoxia and frequency of these events is predicted to increase in the future with climate change. Anoxia has the potential to increase and reduce N removal efficiency. However, the mechanisms, processes and microorganisms involved remain largely unresolved. Denitrification is an anaerobic process and usually occurs in the sediments where it is coupled to nitrification. However, during an anoxia event conditions in the water column may become more favourable for denitrification, although this has not been demonstrated. Here, we used molecular biology (gPCR and community fingerprinting), activity measures and modelling techniques to investigate the impact of seasonal anoxia on the size and activity of N cycle functional groups in the water column. In the Swan River we found evidence that denitrification occurs in the anoxic bottom waters found under the salt wedge during winter and under areas of high algal biomass during summer. Data waere analysed with multivariate statistics to identify key components of the microbial community responsible for driving anaerobic N cycle pathways. We gained a better understanding of N cycling dynamics in the water column and how the estuarine microorganisms respond to the often dynamic patterns. of anoxia.

The Yellow River descends 4,500 m from the Tibetan plateau, flowing for 5,500 km before emptying into the Bohai Sea. Within its catchment of 800,000 km² live more than one hundred million people. The river has a long history of destructive flooding, and because of its particularly high sediment load, the mouth of the Yellow River has one of the world's most rapidly prograding deltas. The situation changed noticeably beginning in the 1970s. Due to the combined pressures of decreasing runoff and increasing water demand, flows began to decrease, to the extent that in 1997 the lower Yellow River ceased to flow for most of the year, and the Ramsar-listed delta area began to shrink. There were consequent serious social and environmental problems. One response was to assess the need 🧄 for environmental flows that would both restore river health and boost social conditions. Because of the situation of very high water demands. the need to transfer and scour large amounts of sediment, and the need to maintain the values of internationally recognised ecological assets, it 🧖 is inevitable that any feasible environmental flow recommendation for the Lower Yellow River will represent a compromise between competing objectives. This paper reviews past efforts on assessing the environmental flow needs of the lower Yellow River, and explains the differences in the results in terms of different objectives and methodologies adopted by the various studies. The Yellow River Conservancy Commission implemented

THE NATIVE FISH STRATEGY IN THE MURRAY-DARLING BASIN

JACKSON Peter

Consultant

Native fish numbers have declined dramatically across the Basin with experts estimating that current levels are about 10% of those at pre-European settlement levels. A continuing decline is predicted without significant interventions. The Native Fish Strategy (NFS) is a long-term, multijurisdictional plan to bring back native fish populations in the Basin. Its aspirational goal is to bring back native fish populations to 60% of their pre-European levels within 50 years. The NFS provides a template for a coordinated response to the key threats that affect native fish populations in the Basin, which range from flow regulation, habitat degradation, reduced water guality, to alien species such as Carp and artificial barriers to fish movement

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EFFECT OF ANOXIA ON WATER COLUMN N CYCLING

JENKINS Sasha, HIPSEY Matthew, GEDARIA Alice, WAITE Ian, O'DONNELL Tony

The University of Western Australia

Session - A3D

INTEGRATING ENVIRONMENTAL FLOW ASSESSMENTS FOR THE LOWER YELLOW RIVER. CHINA

JIANG Xiaohui¹, GIPPEL Chris², HE Hongmou¹

Yellow River Institute of Hydraulic Research¹, Department of Resource Management & Geography – The University of Melbourne²

Session - D1E

an environmental flow regime for the lower Yellow River in 2002 in an effort to halt environmental and social decline. This has led to significant improvements in various social and ecological health indicators. The environmental flow regime is being managed adaptively, supported by a comprehensive program of environmental monitoring, and also ongoing assessment of environmental flow needs based on refined methodologies. This paper outlines recent progress in this endeavour.

EXPLAINING DECLINING INFLOWS TO GOOGONG RESERVOIR

JORDAN Phillip, LOWE Lisa, LANG Simon

Sinclair Knight Merz

Session - D1D

Googong Dam is an integral part of the ACT and surrounding region's water supply strategy. The last decade has seen a reduction in inflows that are commensurate with reductions in some ACT catchments and greater than in others. The reduction in inflows is causing concern about the longer term water resource available to the ACT. A conceptual rainfall runoff model was used to estimate streamflows at three long term streamflow gauges, which identified statistically significant trends in the differences between modelled and observed streamflows, suggesting that changes in the catchment (other than decreased rainfall) may be contributing to the decreasing inflows. The Watercast modelling framework was used to develop and calibrate a model to predict inflows to Googong Reservoir that explicitly accounts for the changes in groundwater extractions, land use and growing impact of farm dams over preceding decades. A range of modifications were made to Watercast to meet the specific modelling requirements for the Googong catchment. Increasing the sophistication of the rainfall runoff model improved the accuracy of the Watercast estimates of monthly streamflows, particularly during recent years of low inflows, when compared to the simpler model framework that had previously been adopted. The approach adopted in this study, of explicitly considering changes in groundwater extractions, farm dam development and landuse in the model structure, may provide a useful template for other catchments in southern Australia that have experienced more severe declines in inflows than would be expected exclusively from declines in rainfall over the period.

FLOOD LEVEL MITIGATION EFFECT OF THE NAKDONG RIVER **RESTORATION PROJECT**

JUN Kyung Soo, KIM Jin Soo

Department of Civil and Envir. Engineering – Sungkyunkwan University

Session – Poster (Hard & Electronic)

A looped-network unsteady flow model was developed to analyse the flood level mitigation effect of river dredging. The model was applied to the stream reach of the Nakdong River of South Korea in which the Four Rivers Restoration Project is under way. River dredging and construction of multi-functional weirs are the main features of the project. Firstly, historical flood events were simulated for the current stream geometry, and the model was calibrated. Then, they were simulated for the condition that the restoration project be completed. The simulation results show that the maximum flood water level becomes significantly lower for the most part of the reach once the project is completed compared to that for the current stream conditions. The mitigation effect is remarkable for the upstream reach, and it becomes less significant downstream because of the backwater effect of the Nakdong Estuarine Barrier.

CLIMATE CHANGE IMPACTS ON THE HYDROLOGICAL CONNECTIVITY OF FRESHWATER WETLANDS IN THE TULLY-MURRAY

KARIM Fazlul, WALLACE Jim, KINSEY-HENDERSON Anne CSIRO

Session – Poster (Hard)

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The hydrological connectivity between floodplain wetlands and the main catchment streams is a major determinant of the ecological condition of these important floodplain systems. If the climate changes in the future so will river flows and flood frequency, which in turn may affect wetland connectivity and the aquatic biota they support. This paper describes a new technique for quantifying wetland connectivity using hydro-dynamic modeling of the Tully-Murray floodplain in north Queensland. Over bank connectivity during floods was estimated using the 2-D MIKE 21 hydrodynamic model and the between floods connectivity, via the network

of streams and sugar cane drains, was estimated using the 1-D Mike 11 model. The location and size of the wetlands and the extent and size of the stream and drain network were quantified using high resolution laser altimetry (LiDAR) data. The two hydrodynamic models were calibrated against a set of measured flows and water depths in the river and on the floodplain. The calibrated model was then run using current climate and different future climate scenarios and the impact of these on wetland connectivity quantified.

SHARING EXPERIENCE IN MANAGING TRANSBOUNDARY WATERS -REFLECTIONS FROM THE ORANGE-SENOU BASIN COMMISSION

KATAI Othusitse ORASECOM

Session - C2B

The Orange-Sengu River, shared by Botswana, Lesotho, Namibia and South Africa is the third largest in southern Africa, after the Congo and the Zambezi. The river system covers some 1,000,000 km2, and has to just over 14 million inhabitants. The river originates in the highlands of Lesotho and flows westwards to its mouth at Alexander Bay/Oranjemund on the Atlantic Coast of Africa. Lesotho falls entirely within the basin and contributes over 40% of the stream flow from only 5% of the total basin area. but Lesotho is one of the smallest users of water from the basin. South Africa is by far the biggest user of water from the Orange-Senqu River system, and this use drives the economic heartland of southern Africa. As one of the most developed river systems in southern Africa, the Orange- Sengu River already faces extensive water scarcity. This is expected to get more complex with the impact of climate change. This presentation will outline the key challenges faced by the four countries sharing the river system, and share experiences on governance models adopted to improve water resources management to improve water security through transboundary water cooperation. The basin States have adopted both bilateral and multilateral arrangements to manage water resources of the Orange-Sengu.

SEPTIC TANKS IN URBAN AREAS

KELSEY Peta, KRETSCHMER Peter

Department of Water WA

Session – Poster (Hard & Electronic)

This paper discusses historical and future impacts of septic tanks on the Swan and Canning estuaries. In 1994 the Water Corporation commenced an \$800 million Infill Sewerage Program. This program is nearing completion, with about 90% of all Perth properties connected to the deep-sewerage system. The nitrogen and phosphorus loads to the Swan and Canning estuaries due to septic tanks before 1994 and in 2006 were estimated by the Streamflow Quality Affecting Rivers and Estuaries (SQUARE) model. The fraction of total nitrogen and phosphorus loads that are from septic tanks, and the estimated decreases due to the Infill Sewerage Program are discussed. Many areas on the fringes of the Perth metropolitan are now being developed for urban residential land use. Some are large distances from the Water Corporation's reticulated deep-sewerage network. The nitrogen and phosphorus loads to the Swan-Canning estuary from proposed urban development in Ellen Brook catchment were estimated using the SQUARE model for the two cases: 1) connection to deep-sewerage system, and 2) septic tanks in all lots. The results show that any nutrient load reductions form catchment management and remediation would be overwhelmed by the additional nutrient inputs from new developments with traditional septic tanks.

URBAN NUTRIENT INPUTS TO COASTAL CATCHMENTS

KELSEY Peta, KING Lisa, KITSIOS Artemis Department of Water Session - Poster (Hard & Electronic)

Perth and many regional towns in Western Australia are located close to rivers and estuaries, and excess nutrients from urban land uses can promote overabundant plant growth in these naturally oligotrophic systems. The Department of Water undertook a survey of landholders in residential areas of the Swan Coastal Plain to determine nitrogen and phosphorus input rates from fertiliser and pets for residential lots with varying characteristics, in terms of lot size, dwelling age, dwelling type, location and whether occupied by owner or lessee. Information was also sought on

area of lawn and garden, and fertilisation and gardening practices. The survey revealed a large range of nutrient inputs with approximately 64% of the nitrogen and 75% of the phosphorus fertilisation being organic (manures mulches and composts). Pet inputs were estimated to be 9% of the nitrogen and 7% of the phosphorus. The median input rates for all the respondents were 84.1 kg.ha.year⁻¹ for nitrogen and 19.7 kg.ha.year⁻¹ for phosphorus. This paper discusses results of the survey and compares the estimated nutrient inputs in urban areas with those for rural land uses which are likely to be displaced by urban developments.

DEMAND DRIVEN APPROACH FOR SUSTAINABILITY OF RIVER ACTION PLAN- A CASE STUDY ON YAMUNA RIVER

KHAN ANWAR ALL

Department of Urban Development, Govt of Uttarakhand

Session - D1C

The first phase of Yamuna Action Plan was initiated in 1993 by the National River Conversation Directorate of the Ministry of Environment and Forests, Government of India, with financial assistance from the Japan Bank for International Cooperation with an aim to improve the water quality and space environment of river Yamuna. Under this project, there 15 cities were identified across three Indian states. While addressing the pressure of rapid urbanization within the Yamuna River basin during YAP-I (1993-2003), it was realized that as part of holistic planning, stakeholders' involvement and capacity building of the ULBs for efficient implementation and effective O&M of the assets was crucial for the success of the project. Thus, in YAP- II (2004-2009), holistic planning for the cities sewerage systems development, capacity building of the ULBs and public participation and awareness (PP&A) have been the integral components for the sustainability of the project outcomes. The sewerage and drainage master planning for a 30 year time horizon is being carried out for the cities covered under the project with active involvement of stakeholders seeking their demand and requirement. Capacity building of the ULBs encompasses human, technological, organizational and resource capabilities. The concerted efforts involve stakeholder consultation and participation to facilitate sustainability in making the project a success towards pollution prevention and management of the assets created. It is emphasized that if engineering

designs feature the skeleton, then non-engineering components provide the life and body to it. In summary, YAP-II focuses on the need to think beyond the engineering aspects to achieve the intended objectives of infrastructure development and sustainable maintenance. This paper describes how synchronisation of engineering and non-engineering works aims at promoting a common approach to simultaneously meet social, economic, technological, and institutional needs for infrastructure development and sustainability of the intended project outcome. The paper gives brief description of the improved environmental conditions in the cities wherever the demand driven approach has been adopted as compared to the supply driven approach adopted in less effective previous river action plans involving huge investments. The paper will showcase the various tools adopted in participatory river action plan.

ASSESSING ACID SULFATE SOIL CONTAMINATION: A NEW INDICATOR FOR WATERWAYS **KILMINSTER Kieryn** Department of Water WA Session - A2C

The effects of acidification and increased metal mobility associated with disturbed acid sulfate soil (ASS) can result in deteriorated water quality in nearby streams and estuaries. In Western Australia coastal acid sulfate soils are estimated to affect some 16600 km². Although there are policies and processes in place to minimise the disturbance of ASS in the terrestrial environment: from a water resource management perspective it has previously been difficult to identify water resources affected by ASS unless the effect was extreme. During a study of 300 water samples (including estuarine, brackish and freshwater) from the south-west of Western Australia, we have developed an early warning indicator for water affected by oxidised ASS. This indicator requires analysing the water sample for: $\delta 34S$ in precipitated sulfate, [SO42-] and [Cl-]. The $\delta 34S$ of dissolved sulfate provides information on the origin of the sulfur, while the ratio of chloride to sulfate indicates if sulfate is present in excess. The indicator is sensitive to chronic as well as acute impacts on water quality, and this approach is novel and innovative. The concept, theory and possible future applications of this tool within management situations will be discussed.

2007 World Economic Forum (WEF) referred to climate change as the overriding matter we confront. Concerns have been raised about the ways the acceleration of global warming would change future climate and about the consequences resulting from phenomena that may appear. Many climate change studies have predicted extreme high temperatures, increases in heavy rain events and strong typhoon in near future. Currently, climate change scenarios have been used to prepare appropriate plans for these phenomena under climate change. The main purpose of this paper is to suggest and evaluate an operational method of assessing the potential impact of climate change on hydrologic components and water resources at the regional scale. Future runoff was simulated using high resolution RCM(27km×27km) A2 scenario which is operated by Korea Meteorological Administration (KMA) and semi-distribution model, SLURP. The study area was applied to the Han River including nine dams. It was found that runoff characteristics, especially annual distribution, can be changed. The discharge in July tends to be decreased while the runoff can be increased in August and September. The flow duration curve was estimated and compared from observation data and simulated daily runoff data for Paldang-dam to evaluate climate change effect. The analysis of the duration flow curve was shown that the mean of averaged low flow was increased while the averaged wet and normal flow were decreased under climate change scenario.

The objective of this study was to understand the habitat conditions for fish species through monitoring of the ecological environment and building a database in the Geum River Basin in Korea. Twenty-one species (42%) including *Rhodeus uyekii* and *Pseudopungtungia nigra* were found endemic out of the 50 species in 11 families sampled during this study period. The most frequently found one was Zacco platypus (34.3%) followed by Z. koreanus (10.2%) and Coreoleuciscus splendidus (8.4%). For Z. platypus, the dominant fish species in the basin, the favoured habitat conditions were estimated to be 0.1–0.9 m for water depth, 0–0.9 m.s⁻¹ for flow velocity and silt-cobbles for substrate size, respectively. Overall, it was concluded that the Geum river basin has been relatively well protected from the anthropogenic disturbance for the legally protected species including the endemic species studied in this study.

In 2009, the Korean government unveiled a master plan of Four-river restoration project which is proclaimed as "Green New Deal" policy. It is planned to restore waterways by constructing 16 weirs and reservoirs on the country's 4 major rivers:Han, Nakdong, Geum and Yeongsan Rivers, including expansion of a barrage gates and overhaul of agricultural water supply storage dams. Among these 4 major rivers, the water supply and control system of Nakdong River basin will be changed drastically. Dredging deeply the riverbed behind the weirs located upstream may help increase the storage effect, since water often becomes very scarce in Nakdong basin during the dry season. However we are not sure if all the water secured upstream is still plenty enough to maintain the river water 🧖 quality. In order to negate the probable negative effects of the weir on water quality, more water will be required to release from upstream dams and it may hamper the water supply capability in the long run. This paper will highlight the methodology of assessing the impact of weirs and dam structures on ultimate water supply, meeting river water quality objectives from the perspective of multi-reservoir operation.

AN IMPACT ASSESSMENT OF CLIMATE CHANGE ON WATER **RESOURCES IN THE HAN RIVER, SOUTH KOREA**

KIM Byung-Sik¹, KWON Hyun-Han²

Water Resources Division - Korea Institute of Construction Technology¹, Chonbuk National University²

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Session - B3C

ASSESSMENT OF FISH FAUNA AND HABITAT CONDITIONS

KIM Jeongkon, HUR Jun Wook

K-water Institute, Korea Water Resources Corporation

Session - C2F

NAKDONG RIVER RESTORATION PROJECT FROM THE PERSPECTIVE OF SYSTEMS THINKING

KIM Sheung Kown¹, KIM JaeHee²

Div of Engineering Management - Korea Universityl, Divison of Business Administration – Chonbuk National University2

Session - A3E

ESTIMATING THE CURVE NUMBER FROM RIVER STAGE AND ANTECEDENT RAINFALL CONDITION(ARC)

KIM Taegyun¹, PARK Sangwoo², CHAE Soogwon³

Department of Landscape Architecture – Jinju National Univerity¹, Seonam University², Eulji University³

Session – Poster (Hard & Electronic)

The NRCS runoff curve number method is used to estimate the effective rainfall for Hydrologic Design and especially for the real-time flood forecasting system in the South Korea. According to the experience and existing research about flooding forecasting system, the new method to estimate CN would be necessary, since it is very difficult to operate the flood forecasting system using the method which uses the AMC from 5-day antecedent rainfall developed by NRCS. The CN has much effect on the peak discharge and time for the real-time forecasting system and CN is related to the land use and hydrologic soil type that affect infiltration and soil moisture. It could be assumed that the maximum potential retention(S) will be related to the groundwater or groundwater levels and antecedent rainfall condition (ARC); therefore, the relationship between water stage in river and maximum potential retention(S) and ARC would be investigated. In order to derive the relationship, the flooding data of 1990 through 2007 in Sulma Stream and tributaries of Gum River is used, since these data are delicately constructed. Here, the CN is calculated using the total rainfall discharge and the total depth of runoff discharge at the flooding period and then water stage in river and maximum potential retention(S) would be determined.

COMMUNITY INVOLVEMENT IN FRESHWATER ECOLOGY: MUSSEL WATCH WA

KLUNZINGER Michael¹. ROBERT Julie². WALTERS Robyn³

Fish Health Unit – Murdoch University¹, South East Regional Centre for Urban Landcare², Robyn Walters Web Design³

Session – Poster (Hard & Electronic)

Freshwater ecosystems are some of the most endangered on Earth and freshwater organisms, including mussels, are particularly vulnerable. In countries which have been thoroughly surveyed, many freshwater mussel populations are highly imperiled. The freshwater mussel Westralunio carteri was listed as vulnerable on the IUCN Red List of Threatened species as a result of population decline due to salinisation of freshwater habitats. The Department of Environment and Conservation, Western Australia (W.A.), lists the species as Priority 4 (P4), taxa in need of monitoring. Little work has been done to update information on species distribution since the species was first listed in 1999. Public knowledge of freshwater mussels, in particular their life cycle and functional role in the ecosystem, is largely unknown. As a result, researchers at Murdoch University, in partnership with the South East Regional Centre for Urban Landcare (SERCUL) have created a website, developed by Robyn Walters, entitled www.musselwatchwa.com which will educate the public about the value of W. carteri to freshwater ecosystems of south-west W.A. and its unique life cycle (having larval 'glochidia' that are obligate parasites of fish), the importance of their conservation and online surveys to update and map distribution of the species.

PRODUCTIVITY AND RESPIRATION OF PLANKTON COMMUNITIES IN A RIVERINE-FLOODPLAIN SYSTEM

KOBAYASHI Tsuyoshi (Yoshi)

NSW Department of Environment, Climate Change and Water

Session - D1E

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Primary productivity, respiration and structure of plankton communities were measured in river-channels and floodplains during flow and flood pulses in the Macquarie Marshes. The measured ecological processes and patterns were discontinuous on both longitudinal and lateral spatial scales. There was also evidence that planktonic primary productivity was limited by dissolved inorganic nitrogen during flood pulses. Hydrogeomorphological factors seem to be important determinants of the observed ecological discontinuums and the limited planktonic primary productivity in this semi-arid riverine-floodplain system

THE CASPIAN SEA LEVEL AND THEIR FORECAST

KOLCHA Tatvana Ecotera Ltd

Session – Poster (Electronic)

The Caspian sea level periodically changes. In 1930-1970 the lowering of the sea level caused shallowing of the nearshore aquatic area, thus damaging the coastal economy. The 1978–1995 rise of the sea caused an adverse flood of a vast area. The flooded northeastern coast is the location of 19 oil-gas fields developed with 1485 wells. The flood submerged 43 operating oil wells. The problem of the Caspian sea level forecast is topical so far, as all the previous forecasts were found to be unreliable. A factor affecting the sea level is the solar energy delivered through the global system: cosmos - magnetosphere - ionosphere - atmosphere ocean. The new method of prediction of the Caspian sea level also studies the solar activity, as a factor influencing it. This will be useful in proper planning of the coastal economy

CURRENT PRACTISES IN AUSTRALIAN WINERIES FOR WASTEWATER REUSE: THEIR ADVANTAGES AND LIMITATIONS

KUMAR Anu¹, SMITH Lester¹, CORRELL Ray², GROCKE Sonia¹, GONZAGO Debra¹, DOAN Hai¹, KOOKANA Rai¹

CSIRO¹. Rho Environmetrics²

Session - B3D

Winery wastewater improvement for irrigation reuse is a keystone to the industry's environmental sustainability. The practices of irrigation of pastures, woodlots and grapevines with treated winery wastewater and land treatment of winery wastewater are becoming more common as means to treat, dispose or recycle wastewater. We assessed the effects of long-term irrigation with winery wastewater on the surface soil (0-10 cm)properties of selected sites. Salinity, sodicity and available potassium in soils were noted to be elevated in the wastewater treated plots, especially woodlot and pasture sites, in comparison with the control plots. Many wineries are considering the use of treated wastewater to produce a commercial benefit that does not lead to deterioration of soil or crop health. Grasses, root crops and cereals have been trialled by some wineries. Yields can not be expected to exceed those produced on normally fertilised soils, but some economic benefit could come from successful reuse of wastewater. Prior to winery wastewater application to land, one needs to consider several factors, including wastewater characteristics, topographical, hydrological and climatological features of the area, soil chemical and physical properties, cropping plans, crop nutrient requirements and elemental limits and public reaction or sentiment. Aided by such information, improved management systems can be developed to optimise winery wastewater reuse.

TREATED EFFLUENT AS ENVIRONMENTAL FLOWS: CONCERNS AND ISSUES FROM AN AUSTRALIAN PERSPECTIVE

KUMAR Anu, WOODS Marianne, WILLIAMS Mike, SHAREEF Ali, DOAN Hai, KOOKANA Rai

CSIRO

Session - C2F

The Australian environment poses some unique challenges and contrasts. Australia is a land of climate extremes with high summer water temperatures and very seasonal river flows. For many large river systems in Australia, treated effluent is a major component of the flow. In recent years, there is mounting evidence that very low levels of specific contaminants in wastewater, including hormones (from animal husbandry and residue from human hormonal contraception methods) and synthetic chemicals that mimic hormones in their action, can have unpredictable adverse impact on the aquatic organisms including fish and frogs. Discharges from sewage treatment plants (STPs) are increasingly being seen as a potential source of environmental flows in riverine systems. Endocrine disrupting chemicals (EDCs) and other micropollutants (pharmaceuticals) are of particular concern as these are not fully removed by existing treatment technologies, and these have been found to be present in the Australian environment at ecologically relevant concentrations. Currently, we have little understanding of what impact the range of micropollutants such as EDCs present in STPs effluent would have on the aquatic ecosystem.

Therefore, it is compelling to establish that the discharge of treated effluent would not have any undesirable impact on our already fragile aquatic ecosystem. From a sound and sustainable natural resource management and policy perspective, these questions must be answered. A project funded by the National Water Commission and CSIRO is using integrated chemical and biological approaches to develop a better understanding on the long-term health effects of effluent discharges from STPs. Some of the key outcomes of this project will be discussed during this presentation.

HYDROELECTRIC POWER DEVELOPMENTS-A THREAT TO THE EXISTENCE OF RIVER, LIFE AND LIVELIHOOD OF MOUNTAIN

KUMAR Mohinder

Government Post-Graduate College, Chamba HP India

Session – B4B

Dams have had serious impacts on the lives, livelihoods, culture and spiritual existence of indigenous, tribal and illiterate people, and on the physical environmental conditions and biodiversity. As far as the dam related developmental activities in Himachal Himalayas are concerned, they got momentum during 5th five year plan and at present there are more than 400 power projects in five perennial river basins spread over 55.673 km2 geographical area. Every basin is being excessively exploited which has a considerable impact on environment and threatening the lives and livelihood of the mountain inhabitants. The present paper is based on the primary research carried out in Ravi basin of the state. There are more than 50 rivulets in the Ravi catchment which have been earmarked for the planned development. At present, more than 80 power projects are either proposed or generating electricity. Speaking specifically, series of power projects i.e. Shahpur Kandi (125 MW), Thein Dam (600MW), Baira-Suil (198), Chamera-I (540MW) and Chamera-II (300 MW) on Ravi Basin have unintentionally produced weather and climate changes on a larger scale and threatening the existing biodiversity and sources of livelihood by interfering with the ecosystem. These activities started way back in the 1980s with the installation of the Baira Suil Power Project and today it has covered almost a whole basin starting from inter-state border of Jammu & Kashmir and spreading to Punjab and Himachal Pradesh which has engulfed the green cover of the area. More than 100 km of reservoirs and 25 km of dried patches are responsible for tremendous increase in the temperature, untimely and unusual rain in the basin after the installation of power projects. In the present paper the responsibility of hydroelectric power projects for threatening the livelihood will be analysed, which is based on original micro field research carried out in the lower Himalayan Region by using exploratory and descriptive method. To analyse the impacts on climatic conditions and its consequences on ecosystem services and livelihood, metrological data of Ravi basin from 1984 to 2004 have been used and paper will also report the viewpoint of the respondents belonging to different age groups.

'DANCING WITH THE RIVER' IN DELTAIC BENGAL: AN EXPLORATION OF RIVER, LAND AND RIVER ISLANDS

LAHIRI-DUTT Kuntala

Australian National University

Session - C1

How can one interpret the rivers alone without land, the environment and livelihoods of people living in them? How does one think about the fixed categories such as land and water, or vulnerability and security? This presentation throws light on the 'charlands' - little islands formed within the river beds- in the deltaic flats. In Lower Bengal, the charlands are created as part of the ecological processes, but they have been affected by recent construction of dams and barrages on the river. The presentation highlights the case of the Damodar River and shows how a greater attention on land during the colonial times changed the way rivers were seen and treated. These charlands in the lower reaches of the Damodar River in India are prone to frequent floods, shifting river channels and riverbank erosion. They defy such convenient categorisations because an entire village on one of the chars can be wiped out in a few hours during the monsoonal flows. The presentation gives a summary of my research, undertaken jointly with my colleague Dr Gopa Samanta, on the past and present of the charlands, the mental maps of the chouras, the charland inhabitants, and the contingent process of settling in and adjusting to the marginality of the charland environment.

The integration of Indigenous Traditional Ecological Knowledge (TEK) into catchment management and planning is essential for the protection of Northern Australia's Tropical River Systems. The North Australia Indigenous Land and Sea Management Alliance (NAILSMA) has developed a model for Indigenous engagement in water management that is designed around a network of six Indigenous Community Water Facilitators (ICWF). The facilitators work with Traditional Owners to increase community capacity to participate in water management, research and planning processes. The network focuses on catchments earmarked for major economic expansion and water reform across northern Australia. These include the Wenlock, Mitchell, Gregory, Ord and Fitzroy River Catchments. The intention of the model is to establish Aboriginal Reference Groups for increased collegial and collaborative research with management bodies and the wider community for sustainable catchment management. Currently the ICWFN is working with TRaCK researchers to engage Aboriginal Reference Groups in the Mitchell, Daly and Fitzroy catchments allowing TEK to inform research agenda while articulating Indigenous interests in the planning processes. Additionally water facilitators are documenting Indigenous TEK to help inform scientific processes and inform on-ground catchment management. NAILSMA's ICWF model has demonstrated the importance of participatory catchment management planning for policy development across Northern Australia.

LESTER Rebecca¹, FAIRWEATHER Peter¹, HENEKER Theresa², HIGHAM Jason³, MULLER Kerri⁴

0 Flinders Universityl, Department of Water, Land and Biodiversity Conservation2, Department of Environment and Heritage3, Kerri Muller NRM

In a natural river system, the biota will have evolved in response to the hydrology of the river system. However, in determining which components of a flow regime are essential to maintain the ecological character of a wetland, it is important to understand what the essential flow-related

WA NATIVE FISH STRATEGY: FRESHWATER FISH DISTRIBUTION DATABASE AND WEBSITE

LARSEN Renae¹, MELVILLE-SMITH Roy¹, DE GRAAF Martin², LAWRENCE Craig¹

Department of Fisheries WA¹. Institute for Marine Sciences and Ecosystem Studies²

Session - C4F

The WA Native Fish Strategy Department of Fisheries project, resulted in the development of a database and public website which are aimed at promoting a systematic, collaborative and strategic approach to the future management and conservation of freshwater biodiversity in Western Australia. The applications contain valuable distributional information on native and introduced freshwater fish and invertebrate species in Western Australia. The database captures and consolidates all available historical and future freshwater species distributional information and the website serves as an information source for the general public on freshwater fish and invertebrate species distribution. The applications will not only improve data management and accessibility but also facilitate a systematic review of the comprehensive dataset to be carried out. This will enable the data to be used to: focus and prioritise conservation rehabilitation, feral species eradication and native fish restocking efforts on waterbodies and species identified to be at greatest risk; identify critical knowledge gaps (i.e. in terms of regions where freshwater fish research is lacking) and; track changes in the spatial and temporal distribution of native and introduced freshwater species (i.e. the reduction in range of a native species or invasion of feral species to new regions).

STANDING TOGETHER: A PARTICIPARY MODEL FOR INDIGENOUS ENGAGEMENT IN WATER MANAGEMENT PLANNING

LEONARD Sonia¹, WALACE-SMITH Hugh²

Kimberley Land Council¹, Northern Australian Idigenous Land and Sea Management Alliance²

Session - C4B

HOW MUCH ENVIRONMENTAL WATER IS ENOUGH FOR THE LOWER RIVER MURRAY WETLANDS? PART II

Session - B3A

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water requirements of the key biota are, and what volumes of water are needed to meet them. We modelled flow sequences for the River Murray to meet water quality targets set for Lake Alexandrina and the Coorong using hydrological, hydrodynamic and ecosystem response models. Based on this modelling, we developed a set of minimum barrage flow targets that essentially represent an end-of-system flow regime for the River Murray. We have also specified additional flooding requirements for water levels in Lake Alexandrina and flows to the Coorong. Together, these flows constitute an environmental flow requirement for the Coorong, Lower Lakes and Murray Mouth Ramsar site that has the potential to maintain the ecological character of the site in the long term. It is based on explicit links between ecological objectives, hydrological targets and flow regimes to meet these, thus provides a new method for determining environmental flow requirements for large wetland complexes.

GEOGRAPHE CATCHMENT COASTAL ENVIRONMENTS PROJECT

LEWIS Emilv

South West Catchments Council

Session – Poster (Hard & Electronic)

This project takes a landscape-scale approach to protecting the Vasse-Wonnerup and Geographe catchment priority coastal hotspot including the associated Ramsar listed Vasse-Wonnerup Wetlands system, located immediately east and north east of Busselton, extending some 14km. This coastal hotspot is located in the temperate, south-west of Western Australia, within the Swan Coastal Plain biogeographic region and within the Shires of Busselton and Capel. The Vasse-Wonnerup wetland system is also part of an extensive, shallow, nutrient-enriched system known as the Busselton Wetlands. Extensive construction of drainage networks and coastal plain vegetation clearing within the Vasse-Geographe coastal hotspot, for agriculture purposes and to reduce winter flooding of the estuaries, have put significant pressures on the system. Around 96% of the Geographe Bay catchment's original wetlands have been lost or substantially modified as a result. The high level of nutrient from the Vasse and Wonnerup estuaries outflows will influence and potentially impact upon the proposed Ngari Capes Marine Park and Geographe Bay's seagrass communities. The project aims to protect and enhance: a) Geographe Bay including the waterways, wetlands, estuaries and its important seagrass meadows; and b) the Ramsar listed Vasse Wonnerup wetland system. The project will strategically implement key recommendations and management actions from both the "Draft Water Quality Improvement Plan for the Vasse Wonnerup Wetlands and Geographe Bay" (DOW, 2009) and the "Ecological Character Description Vasse Wonnerup Wetlands Ramsar Site South-west Western Australia" (WRM, 2007). Best management practices to be undertaken include invasive pest and weed control, drainage modification, fencing for stock control along waterways, installation of stock crossings and off stream watering points as well as riparian and wetland management. This project is in partnership and cooperation with GeoCatch and their Bay OK program as well as the Department of Environment and Conservation SWCC is also running complementary programs, in partnership with the Government of Western Australia's Fertiliser Action Plan to work with farmers to improve nutrient management on farms in the coastal hotspots.

BIOLOGICAL INDEX APPLICATION IN RIVER HEALTH ASSESSMENT IN GUIJIANG RIVER

LIU Wei

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Pearl River Water Resources Commission

Session – Poster (Hard & Electronic)

The river ecosystem degradation, water pollution and biodiversity decreasing become more serious in China under the pressure of economic development, city expansion and population increasing. How to resolve these problems and keep river health are the challenges both for managers and scientists in China. Indicies and biological indicators including fish, macroinvertebrates, diatoms and macrophytes have proved to be the useful measures in health assessment of ecosystem, and widely applied today. However, biological indicies have seldom been used in China. In the present work, macroinvertebrate and epiphyte diatoms were collected from Guijiang's famous landscape to assess river health. Biological integrity of macroinvertebrates (B-IBI) was composed of seven metrics: total taxa, EPT taxa, Coleoptera %, three dominant taxa, Hydropsychidae (Trichoptera) %, filterfeeders %, and Biotic Index (BI). The ratio scoring method was used to transform the value of each metric into a uniform

score. The results show the measurement accuracy of the health criteria for the B-IBI derived from all sample data was better than that from only reference data. The differences in the water quality of the rivers were reflected by different types of diatom communities and also by the values for some diatom indices, which were calculated using the latest version of the 'Omnidia' database software. The assessment results are not the same between chem-physical parameters and diatom index. Significant relationships were found between IPS and dissolved oxygen. In general, IPS (Specific Pollution Sensitivity Index) gave the best results. Most of the sites were characterised by a greater relative contribution of eutraphent and tolerant ones as well as α -mesosaprobic and polysaprobic diatoms. This study suggests that the structure of benthic diatom communities and diatom indices, especially IPS, can be applied for monitoring rivers in China

MANAGEMENT OF WATER RESOURCES IN MANIK GANGA BASIN WITH COMMUNITY INVOLVEMENT

LIYANAGE Ruwan

National Water Supply and Drinage Board Session - D1C

The average annual rainfall in Sri Lanka exceeds 1500mm per year and hardly anywhere does it fall below 1000mm; in highland areas it is over 5000mm. To suggest, therefore, that Sri Lanka has a water-resource problem might seem difficult to believe; however problems do exist. Rainfall is strongly seasonal and in the drier north western and south eastern parts of the island there are water shortages during the months of June, July and August when low rainfall is combined with high evaporation rates. Severe water shortages during certain periods were observed in the recent past in Manik River Basin and this situation is expected to be aggravated in the foreseeable future due to continuous increase in demand for water associated with poor water management practices. Therefore, a detailed assessment of water resources available in the Manik River basin and a plan for the management of available water resources which involve user community have been completed. The Basin Management committee was established with help of Sri Lanka water partnership and Global Water Partnership to overcome the problem. The problem is being managed by community.

AIRING THE DIRTY LAUNDRY - IMPROVING COOPERATION IN SME ENVIRONMENTAL MANAGEMENT

LOCK Paul¹, BAUDAINS Catherine²

South East Regional Centre for Urban Landcare & Murdoch University¹. Murdoch University²

Session - C2D

Light industrial Small and Medium Enterprises (SMEs) worldwide are an integral part of their local social and economic fabric, making essential contributions to national and global economies, but also representing significant risks to wetlands and waterways. These characteristics have made SMEs increasingly obvious targets for engagement in the sustainability process. How these initiatives are targeted has a significant bearing on their likelihood of success, and in their cost effectiveness. From the macro view considering the suitability of governments, representative bodies, companies or individuals to address specific SME environmental issues, to the micro perspectives on the relevance of conservation psychology in influencing the environmentally sustainable behaviours of individuals' business practices; all have a place in the strategic targeting of initiatives to improve environmental outcomes for wetlands and waterways. This paper examines the use of the System-Individual Blame analysis and the Diffusions of Innovations model (Rogers, 2003) to improve the targeting of cost effective environmental management interventions with light industrial SMEs in Western Australia. The focus on Laggards and Late Adopters using cooperative, individualised and sitespecific environmental auditing is both challenging and intensive, but can invite considerable economic and environmental benefits, and provide pointers for strategic community behaviour change engagement.

FERTILISE WISE - EVIDENCE BASED ENVIRONMENTALLY **RESPONSIBLE FERTILISER ENDORSEMENT**

LOCK Paul, KRUPA Amy

South East Regional Centre for Urban Landcare

Session - Poster (Hard)

Nutrients from household fertiliser are one of the largest contributors of phosphorus and nitrogen to the Swan and Canning Rivers. Currently many fertilisers claim to be 'environmentally friendly' without providing evidence to support their claim, or claim it on a single factor such as low, or no, phosphorus. The Fertilise Wise endorsement program endorses fertiliser products that have undergone a rigorous independent scientific testing process, and fulfil a strict environmental criteria. Fertilisers displaying the Fertilise Wise logo provide consumers with assurance that endorsed products are environmentally responsible, according to the published Fertilise Wise criteria. The seven criteria cover nitrogen and phosphorus limits; labeling for soil type, application rates and plant type; heavy metal, radiological, biological and synthetic levels; and macro and micro nutrient content. The criteria are intentionally strict, setting the bar high to provide a benchmark for change in the WA community, fertiliser industry and government. The South East Regional Centre for Urban Landcare (SERCUL), a not for profit, community NRM organisation based in Perth, launched the program in 2009. The Fertilise Wise endorsement program provides an added behaviour change tool to further extend the information and education campaigns SERCUL have implemented in the Perth community over the past seven years.

PROGRESSIVELY DETAILED SUBWATERSHED SCALE WATER BUDGETS WITHIN THE LAKE SIMCOE BASIN

LONGSTAFF Ben, CUDDY Shelly, GOODYEAR Don, BALDWIN Rob, WALTERS Mike

Lake Simcoe Region Conservation Authority

Session - C3E

Drinking water in the Lake Simcoe basin, Canada, is obtained from municipal and private wells, and surface water intakes. Ensuring sufficient availability of water for current and future drinking water demand is being assessed through a regional scale Source Water Protection program that required preparation of water budgets and water quantity risk assessments to guide the planning process. Building upon a conceptual understanding, water budgets were conducted on a 3 tiered approach, with each tier being more detailed and with greater certainty than the previous. All subwatersheds were required to undergo a conceptual water budget and Tier 1 water budget and stress assessment. Only the subwatersheds identified as being potentially stressed, progressed to a significantly more advanced and detailed assessments (Tier 2 and 3). The Tier 2 and 3 assessments focused on better quantifying the availability of water for water supply (in relation to other permitted and ecological requirements) and the consumptive demand. Within the Lake Simcoe Basin, 8 out the 18 subwatersheds were identified as being potentially stressed in the Tier 1 water budget. However, after the more detailed Tier 2 water budgets, this was reduced to only 7 subwatersheds. This presentation will provide an overview of the water budgeting approach, methods applied and results within the Lake Simcoe basin.

TOO MUCH AND TOO LITTLE WATER: MANAGING WATER OUANTITY WITHIN THE LAKE SIMCOE||BASIN

LONGSTAFF Ben, GOODYEAR Don, BALDWIN Rob, CUDDY Shelly, HOGENBRIK Tom, WALTERS Mike

Lake Simcoe Region Conservation Authority

Session – Poster (Hard & Electronic)

Current and future management of water quantity within Lake Simcoe basin, Canada, must take into account the dichotomous situation of both too little and too much water. Surface water and groundwater is diminishing in some subwatersheds due to increased extraction, loss of recharge and climate change. Quantifying current and future supplies of water for all the competing demands is being undertaken by a series of progressively detailed water budgets. Water budgets have identified 7 watersheds as either currently stressed or at risk of being stressed due factors such as increased population. In contrast, evidence points to increased frequency

Working in waterway management in Australia can be stressful and depressing given the scale of problems many of our rivers, wetlands, creeks and billabongs are experiencing. The state of our waterways reflects our society's relationship with them, and we are now discovering the costs of failing to understand the short and long term impacts some of our activities have had on our natural 'communities'. However, while many of the problems our waterways are experiencing are as a result of human actions, it is only through the ongoing efforts of people that problems are going to be solved. Our waterways need enthusiastic, skilled and creative people, and this paper will argue that there is a need in Australia to reinvigorate and value the people who are working in waterway management as 'natural assets'. This presentation will contend that government and non-government organisations alike, need to allocate resources (money, time, skills) into supporting people to undertake the often difficult, confrontational and emotionally complex work that is waterway management. The disciplines of positive psychology, knowledge management and real-life experience will be drawn upon to outline the ways in which we can value, support and celebrate the individuals and communities who are important natural assets in waterway management.

In 2007, the Victorian Government reduced minimum passing flows and removed access to the use of a bulk Environmental Water Reserve volume for environmental flows in the Yarra River. This action was undertaken to reduce the risk of Melbourne's water supply being subject to further restrictions prior to water supply system augmentations being implemented. As the designated Environmental Water Reserve Manager, Melbourne Water's responsibility is to minimise environmental risk to our waterways. As the Yarra River enters the third year under this arrangement, three key concepts have been fundamental in the short-term management of the Yarra River – 'prioritise, protect and prove'. Prioritise aquatic values to ensure survival and enable recovery when the current low flow conditions change. Protect flow events to meet priority ecological objectives. Prove that protected flow events meet the ecological objectives. This approach highlights the importance of actively planning and developing a representative monitoring program to capture environmental response. In addition collaboration with stakeholders is important to ensure maximum environmental outcomes are achieved in times of limited resource availability. This paper will describe the challenges and successes that extended drought poses for all environmental water managers by focussing on these three key concepts.

of isolated, periodic flooding across the watershed, with three events in excess of the 1:100 year frequency in the past 4 years; this increased frequency likely due to climate change. Flood management is based on forecasting location and extent, and issuing flood warning bulletins to key agencies. An integrated watershed management approach is being used to reduce water quantity stress. This multi-organization program includes initiatives such as a water reuse strategy, storm water management plan and permitting water takings. This presentation will provide an overview of the role Lake Simcoe Region Conservation Authority, winner of the 2010 Thiess RiverPrize, plays in managing water quantity within the Lake Simcoe basin

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VALUING PEOPLE AS 'NATURAL ASSETS' IN WATERWAY MANAGEMENT

LOVETT Siwan

Australian River Restoration Centre

Session - A2E

PRIORITISE. PROTECT AND PROVE - A YARRA RIVER CASE STUDY

LUCAS Anna, HUGHES Christine

Melbourne Water

Session - D1E

ENVIRONMENTAL WATER PLANNING AND MANAGEMENT IN WESTERN AUSTRALIA: WHERE WE'VE BEEN AND WHERE TO NEXT

LYNNE Fiona

Department of Water WA

Session - A2A

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Since the adoption of its Environmental Water Provisions policy in 2000, environmental water planning and management in Western Australia has been guided by the broad concept maintaining water regimes and consequently, ecological values of water dependent ecosystems, at a "low level of risk". With a rapidly growing economy, increasing population and a significant decline in rainfall, especially in the south west of the state, managing to a generic "low levels of risk" has become increasingly difficult. Water resources are under increasing competition and there are requirements arising from both State and Commonwealth level water reform for better definition and formalisation of environmental water objectives as well as accountability for them. Improved definition of environmental water objectives is vital but difficult. We also have to match our definitions to the range of water systems in Western Australia. Our systems are dominated by groundwater and the interactions between groundwater and dependent ecosystems vary across the landscape and over time. Our surface water is typically multiple, small, ephemeral streams and again there is considerable diversity across the landscape and over time. We do have large regulated systems, but typically with only one or two storages. This presentation will provide an overview of our planning and management approach and the directions we are taking to improve that approach.

ECONOMIC CONSIDERATIONS IN MODELLING THE MURRAY DARLING BASIN

MALLAWAARARCHCHI Thilak, CHAMBERS Sarahs

School of Economics – The University of Queensalnd

Session - D1D

The rivers of the Murray Darling Basin have low and highly variable inflows, which provide water to some of Australia's most important irrigation areas, wetlands, and rural towns. However there is widespread recognition that some of the Basin's water resources are over-allocated, which requires greater understanding of the tradeoffs between these different water uses. Since 2005 the Risk and Sustainable Management Group (RSMG) at The University of Queensland, Australia has been developing an economic model of the Murray Darling Basin in Australia that explicitly examines the optimal allocation of water for irrigation, environmental flows and potable urban water supplies in alternative states of nature (normal years, drought years and wet years). This paper will illustrate the benefits of a state-contingent approach to risk and uncertainty for water modelling. It will provide a number of key findings from the efforts of the last 5 years in economic research and development which include: how producers shift production systems in response to climatic variability; the value of interbasin transfers from the Snowy River; how and where water should be taken from to meet environmental objectives; examining differences in managing conjunctive water resources either from the national or regional view point; and other key findings.

USING ACOUSTICS TO CHARACTERISE AQUATIC ENVIRONMENTS

MARKHAM Andrew

Hydrobiology

Session - C4E

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The application of acoustic technology for characterising the ecology and hydrodynamics of the aquatic environment has developed rapidly in recent years and presents exciting new opportunities for environmental investigators and researchers. Hydroacoustics is used for the nondestructive assessment of fish populations (size, distribution and abundance), submerged aquatic vegetation, bottom/sediment classification and bathymetry in marine and freshwater environments and developed from the use of sonar on marine vessels in the 1950s. Similarly, Acoustic Doppler Current Profilers are used to measure the physical characteristics of water, including flow volumes, current structures suspended sediments, bed load and waves in a variety of aquatic environments. Both these applications of acoustic technology can and have been applied to a variety of studies including port and

dredging studies, monitoring of sediment plumes, and river and estuarine hydrodynamics, The combined measurement of the ecology and physics of aquatic environments is a powerful tool for research and environmental management. This paper explores the potential application of this technology, and gives examples of its use on case studies worldwide

REAL-TIME MODELLING OF THE WILYABRUP BROOK TO MAINTAIN ECOLOGICAL WATER REQUIREMENTS

MARILLIER Ben, SHAKYA Deepak, HALL Joel

Department of Water WA

Session - Poster (Hard)

A hydrological model was developed for Wilyabrup Brook, an 80km² catchment located in Western Australia's south west. The model used was the Streamflow Quality Affecting Rivers and Estuaries model (SQUARE), which accurately conceptualises the surface water hydrology of the catchment. SQUARE is capable of flow predictions at daily time-step, using rainfall data collected at local telemetered stations over the previous 24 hours. The model forms the basis for real-time flow predictions provided in a desktop front-end. The application can supply catchment managers with up-to-date predictions of streamflow, that can be used to ensure that ecological water requirements in the Wilyabrup Brook are maintained despite agricultural water extractions to off-stream storages. The project has successfully trialled provision of real-time streamflow data in a south west catchment. The intent is to provide this information through a web interface, that can be accessed by landholders and catchment managers, and used to determine extraction limits for off-stream storage.

DO WE VALUE RIVERS IN THE PHILIPPINES? STUDY ON RIVER MANAGEMENT IN CATANDUANES ISLAND (LUZON)

MASAGCA Jimmy¹, MASAGCA Manrico², TRIBIANA Estrella³, TORIO Sonia³

Pacific Island Institute for Pedagogy, Technology, Arts & Sciences¹, De La Salle University Manila². Catanduanes State Colleges³

Session - B4C

In carrying out this qualitative inquiry, the ethnographic technique having the property of conversation or "pakikipagkwentuhan" was used, which is a naturally-occurring process of sharing and telling stories among individuals. On policy reviews, there is no law in the Philippines that comprehensively covers the management of water quality. There are regulations, but these are embodied in separate Presidential Decrees (PDs). The participants expressed that existing industries in their towns have lacking wastewater treatment provisions or facilities and do not comply with water quality and pollution control regulations. Their views lead us to believe that rivers of the island increasingly become polluted due to non-compliance and eventually exposing the residents to the effects of pollutants from domestic and industrial activities. On river governance, the participants reveal the lack of transparency, minimal community participation and to some extent lack of accountabilities in the disbursement of river funds. Respondents claimed that corrupt higher officials and politicians are allegedly involved in sizeable kickbacks for dredging and other river programs. Environmental staffs of the province were not spared the negative views by having unfavourable image as depicted by the participants for the lack of political will to implement specific provisions on monitoring river water quality embodied in several decrees on environment, i.e. PDs 1151, 1152, 1856 and 984. It was suggested that several policy responses on the values of ecosystem services and stronger collaborative approach on river water management may become even more important with the phenomenon of climate change.

TOGETHERWITHCOMMUNITIESMOVINGTOWARDSENVIRONMENTAL SUSTAINABILITY

MASUD Shafaq, KHAN Najam ul Huda

Pakistan Wetlands Programme

Session – D1C

The Wetlands of Pakistan present a mosaic of rich biodiversity and diverse geographic regions. Wetlands of the northern alpine have been found to be pristine environments with an alleviation range of 3000-5000 m above sea level. Wetlands of central Indus signify trans-boundary regions along the mighty Indus River which is the food bowl (basket) of Pakistan, coastal region support Pakistan's mangrove forests, shrimp breeding and ideal sites for marine turtle nesting, Salt Range provides a unique environment for salt tolerant species, scrub forest, Punjab urial and critically endangered white headed duck. The Pakistan Wetlands Programme has endeavoured to protect and conserve the globally significant biodiversity of these wetlands. The community is the key force behind all these interventions of sustainable management. The Daran community, an impoverished community in the southern region of Pakistan, demonstrates an example of one of the many on-ground projects introduced by the programme. The community is made up of local fishermen and small business holders. The community has been motivated to participate in protecting marine turtle nesting sites in the Makran coast in exchange of a primary and secondary level school enhanced by the Pakistan Wetlands Programme. Another successful initiative is the solar-wind hybrid systems which have been introduced to the poor rural communities in the Makran Coastal Wetlands Complex as an alternative energy source, it has so far benefited 75 households in the targeted area and have replaced kerosene lamp use. Impact stories about what the people have to say and how their lives have changed for the better with this small yet critical intervention will

RIVERPARK MANAGEMENT

MATHER Chris

be highlighted.

Swan River Trust Session - C3A

See SWAN RIVER TRUST.

WILD RIVERS IN THE KIMBERLEY REGION, WESTERN AUSTRALIA: A COOPERATIVE, STAKEHOLDER DRIVEN APPROACH

MA77FIIAlisa

Department of Water WA

Session - Poster (Hard)

Wild Rivers are unique, rare examples of waterways where biological and hydrological processes continue without significant disturbance. Thirty-three of Western Australia's forty-eight Wild Rivers are located in the Kimberley - concentrated mostly in the northern Kimberley. These waterways and their catchments remain generally undisturbed due to their isolation, rugged topography or land tenure. In the Kimberley region, the Western Australian Department of Water is using a collaborative, stakeholder driven approach to manage a number of the region's Wild Rivers. The approach requires strong engagement with planning processes, such as the Commonwealth government's assessment of the Kimberley for National Heritage listing, the Department of Water's Kimberley Regional Water Plan, the Department of Environment and Conservation's Science and Conservation Strategy, establishment of Indigenous Protected Areas, and the Northern Australian Water Future Assessment of ecological assets across the Kimberley. The Department of Water is supporting land managers to address pressures, such as feral animals, weeds, wild fire and tourism on river values in key catchments. The department is also engaging external researchers to increase our understanding of how wild rivers function, their values and threats to their condition

MANAGEMENT OF URBAN WATERWAYS AS LOCAL GOVERNMENT ASSETS- A CASE STUDY FROM THE HILLS SHIRE. NSW.

MCINTYRE Emma¹, MEAKER Tim²

Eco Logical Australia¹, The Hills Shire Council² Session – Poster (Electronic)

Eco Logical Australia was engaged by The Hills Shire Council to develop an asset management system for urban waterways in The Hills Local Government Area. The project was carried out in 2 stages. Stage One involved desktop identification and assessment of all urban waterways in the LGA whilst Stage Two required a more detailed field assessment of urban waterways in Council's ownership to collect relevant information for asset management purposes. The overriding challenge throughout the project was to assess urban waterways within the context of local government asset management. Other key challenges included inaccurate mapping of waterways in the Local Government Area, establishing a methodology for breaking up waterways into effective management units, identification

and agreement on a set of geomorphic, ecological and social indicators of waterways health and development and application of an effective scoring methodology for use within Council's newly acquired asset management system. This paper will discuss each of these challenges and how Council and Eco Logical Australia worked together to overcome them and generate a high quality product for The Hills Shire Council.

TURBIDITY MAPPING IN QUEENSLAND AND DEVELOPMENT OF A TURBIDITY ASSESSMENT TOOL

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McNEIL Vivienne, RAYMOND Myriam

Queensland Department of Environment and Resource Management

Session – Poster (Electronic)

Turbidityandassociatedsuspendedsedimentaresignificantenvironmental management issues. As turbidity values in freshwater relate to landscape features and instream conditions it is more meaningful to derive local targets with consideration to these attributes at the same scale. Turbidity characteristics have been classified and mapped, using extensive water quality data from Queensland streams. Twenty zones were defined, based on clusters of sites with similar turbidity characteristics, geology and rainfall distribution. For each zone, flow-related turbidity ranges were defined using combined data from representative sites. Bounds were based on percentiles of turbidity within narrow flow increments. A further correction for catchment area (significant above 10,000 km²) was applied. A turbidity assessment tool based on the modelled ranges is under development, for classification of turbidity at sites with regards to region, flow, and catchment area. The tool will assist in the development of realistic turbidity targets, and may be extended to predict ecological responses. Current regional ranges are based on existing "background" conditions. Further development of the tool will include modelling to reflect pre-development ranges and future climatic or other impacts. The methodology developed may be applied to other parameters such as total suspended solids.

INTER-BASIN MOVEMENT OF WATER - SRI LANKAN EXPERIENCE

MEDIWAKA SUSANTHA

Irrigation Department

Session - D1B

Out of 103 rivers in the country, rivers run across the wet zone which receives average rainfall of 2500 mm annually to replenish them sufficiently to flow as perennial rivers. Out of the balance, rivers run across the dry zone which receives annual average of 660 mm and hence runs dry during certain months. There are some rivers which run the upper reach in the wet-zone while the middle and lower reaches run through dry zone. Most of the rivers have been regulated either by dams or barrages to supply about 750,000 ha of irrigated agriculture. Interbasin diversion was imminent to supply water to more than 350,000 ha of irrigated agriculture. Inter basin diversion was imminent to augment the water shortage river basins and hence it was a practice from the ancient times to divert water from the water abundance rivers to others. Transbasin canals having a length of more than 150km constructed in 2nd AD to move water from one basin to another which is still operating is a classic example for this. This practice was accepted without any conflict until the 1990's and if one studies the water diversion and conveyance system in the country, the complicated nature of water movement can be observed. However due to increasing demand for water for urban and industrial sector, communities in certain river basins started objecting to water transfers out of their river basins and in some instances administrative boundaries within the same river basin have become divided. The water resources planners had to compensate the losers, to get the consent of the community at these instances. This paper aims to discuss some case studies where WR planners had to work out alternate planning proposals for river diversion for moving water where it is needed.

MONTOYA Juan Luis¹, DEL MARCO Andrew², STEELE Jesse³, WILSON Kim¹, SUMMERS Robert⁴, POND Bob⁵

Peel-Harvey Catchment Counci¹, Ironbark Environmental², Nemont Boddington Gold³, Department of Agriculture and Food WA⁴, Department of Water⁵

Session – Poster (Electronic)

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Fencing and revegetation of the tributaries in the Peel-Harvey catchment have been key parts of a multipronged nutrient -reduction strategy over 20 years, and have been widely embraced by landowners as sensible things to do. Over 450 of the 3100 kilometres of waterways and drains in the catchment have been fenced, covering both sandy and clayey sub-catchments. Despite the multiple benefits, recent research work by Steele & Summers in the catchment has suggested that simply fencing and revegetating tributaries in sandy catchments may not deliver the nutrient reduction that was expected, and that more thought needs to ao into designing these riparian works. The research raises interesting questions for the catchment community and Government, and provides a timely message as more significant biofilter projects are planned on the catchment's middle order streams. The paper uses this research and a number of case studies to demonstrate how the community has worked with Government and researchers, and how it may address the technical and socio-political challenges of the future.

WATER LEVEL IMPACTS OF DESIGN STORM SURGES ON THE LOWER MURRAY RIVER

MORILLO Sebastian¹, ROMERO Jose¹, RODGERS Simon²

GHD Pty Ltd¹, Department of Water WA² Session - B3B

A hydrodynamic model of the Peel-Harvey Estuary was developed to estimate design peak storm surge levels within the waterbody and provide a time-varying water level input for a riverine flood model of the Murray River, Western Australia. The estuary is shallow (~2 m) and typically unstratified, so a vertically averaged two-dimensional hydrodynamic model (MIKE 21 HD FM) was used to simulate storm surge. The storm surges applied were based on the long-term record at Fremantle tidal station. The wind data from Mandurah climate stations and flow data for the major riverine inflows were incorporated into the model. A range of scenarios was simulated, including an assessment of the possible impact of mean sea level rise based on IPCC (2007) estimates. Hourly predicted tides, superimposed with storm surge and mean sea level rise variations served as input to the open boundaries of the two narrow ocean entrances. The recorded water level information in the Peel Harvey Estuary for December 2005 was used to calibrate the model. The design storm surge scenarios coincident with the highest astronomical tide generally displayed an attenuation of 0.2–0.3 metre in the peak and a phase lag of 3-4 hours between the levels in the ocean and the estuary.

IMPACTS OF DROUGHT AND OVERUSE OF WATER RESOURCES ON THE WATER OUALITY OF THE LOWER LAKES

MOSLEY Luke¹, CORKHILL Emily¹, HENEKER Theresa²

Environment Protection Authority SA¹, Department of Water, Land and Biodiversity Conservation SA³

Session – Poster (Hard & Electronic)

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The Lower Lakes of the Murray River in South Australia have received record low inflows since mid-1995 due to a severe drought and overuse of water resources in the Murray-Darling basin. The aim of the paper is to describe the impact of the drought on the water quality of these lakes. Twenty eight years (1980-2010) of water quality data from a long term monitoring station (Milang) were analysed. Large changes to water quality have occurred in the Lower Lakes during the current drought. Significant (p<0.01 to p<0.05) increases in salinity, total nitrogen, pH and chlorophyll a were noted during the drought, while turbidity, total phosphorus and soluble nutrients decreased. These changes were attributed to decreases in source inputs to the lakes, evapoconcentration, and enhanced primary production. Localised acidification events have also occurred in several locations due to exposure and rewetting of acid sulfate soils. Many of the water quality changes in the Lower Lakes during the drought have

exceeded guidelines for protection of aguatic ecosystem health. Improved water management is required in the Murray-Darling basin to reduce the severity of droughts at the end of the river system.

WATER SENSITIVE URBAN DESIGN: A TOOL FOR RESTORATIVE DESIGN AND CATCHMENT REPAIR

MOURITZ Mike

HASSELL

Session - A3A

WSUD has been around as a concept for 20 years. It has grown and it is now time for it to become main stream and for the focus to shift towards catchment repair and restoring the urban landscape. This paper will outline the origins of WSUD and present its potential to be become the foundation of a restorative approach to urban landscape and waterways management. The paper will provide case studies and examples, illustrating the importance of integrated design, policy incentives and vision.

LEADING THE COMMUNITY TO AN IMPROVED UNDERSTANDING OF ENVIRONMENTAL WATERING

MURPHY Lauren

Mallee Catchment Management Authority

Session - B2C

Improving the community's understanding of the important balance between environmental health and horticultural productivity is paramount to future implementation of environmental actions. Irrigation began in the small community of Sunraysia, on the Victorian side of the Murray River, more than a century ago. The perception of irrigated horticulture as the priority user of river water had remained largely unchallenged in the court of community opinion until 2006, when an environmental watering program triggered controversy in the community. This became the catalyst for significantly revamping the way local irrigators, and the community as a whole, regarded environmental water allocation. Now, four years on from that initial environmental watering campaign, resolute community opposition to environmental watering has given way to an improved understanding of the need for the environment to receive an equitable share of available water. The move from rejection to understanding of environmental watering represents a powerful shift in local irrigators' attitudes. It is a major change that has taken several years to achieve. This paper charts the course of community opinion on environmental watering in Sunraysia, citing media coverage to illustrate community views and explain the various factors responsible for this shift in public opinion.

CHALLENGES FOR ECOSYSTEM RESTORATION IN THE SAN JOAOUIN RIVER, USA

MUSSETTER Robert, HARVEY Michael, FULLERTON William Tetra Tech Inc.

Session - C3C

A legal settlement between an environmental coalition and water users forms the basis for an agreement to provide flows (305.000 ML in dry and 685,000 ML in wet years) to restore 240 km of the San Joaquin River downstream of Friant Dam and to re-establish extirpated anadromous Chinook salmon to the river. However, there are also significant geomorphic, hydraulic, sediment transport and water temperature challenges to restoration of the river and provision of suitable habitat for all life stages for the reintroduced fish Not the least of the challenges is the spatial compression of the required habitats because there is no fish passage above Friant Dam to historic spawning and rearing habitats. Restoration components that are being addressed include: development of appropriate annual hydrographs; reconnection of discontinuous channel segments and pits, the legacy of sand and gravel mining that affect sediment continuity and water temperature; absence of upstream sediment supply for replenishment of spawning gravels; historic diversion of flood flows into bypasses and elimination of floodplains for juvenile rearing; and, adult and juvenile fish passage at diversion and flow-control structures. Costs for river and habitat restoration and successful reintroduction of a self-sustaining fishery are estimated to be about \$800M

CLIMATE ADAPTATION STRATEGIES - STUDY OF GREAT RIVER GANGES IN SUNDERBANS

NANDY Supriyo

Society For Park Street Rejuvenation-Kolkata

Session - B3C

The obliteration of Lohachara Island, in the Indian part of Sundarbans where the Ganges and the Brahmaputra rivers empty into the Bay of Bengal, marks the moment when one of the most apocalyptic predictions of climate scientists has started coming true. Refugees from the vanished Lohachara Island and the disappearing Ghoramara Island have fled to Sagar, but this island has already lost 7,500 acres of land to the sea. The Paper evaluates how Sundarbans is experiencing the effects of climate change over the last three decades and how the people are evolving adaptation strategies to counter this threat. Increasing melting of Himalayan ice might have decreased the salinity at the mouth of the Ganges River, at the western end of this deltaic complex. At the same time, salinity has increased on the eastern sector, where the connections to the meltwater sources have become extinct due to heavy siltation of the Bidyadhari Channel. "EduXchange Initiative" an IT-enabled Climate initiative to improve environment education in schools to create a motivated force of students, who through technological advancements are aware of and concerned about the environment and its associated problems. This is a unique programme for creating awareness and understanding on climate change.

ACIDIFICATION AS A RESULT OF SEVERE DROUGHT CONDITIONS AND OVER ALLOCATION IN THE MURRAY-DARLING BASIN: A CASE STUDY OF MONITORING AND MANAGEMENT OF CURRENCY CREEK.

NATT Ashley¹, BARNETT Liz², MOSLEY Luke¹, CORKHILL Emily¹

Environment Protection Authority SA¹, Department of Environment and Heritage SA²

Session - D1D

The current drought conditions, over allocation and river regulation in the Murray-Darling Basin has led to record low flows into the terminal lakes of Lake Alexandrina and Lakes Albert and the adjoining tributaries. The resulting water-level decline exposed large areas of marginal, subaqueous sulfidic soils (acid sulfate soils) to air, initiating the formation of sulfuric materials. Currency Creek, a small tributary that flows into Lake Alexandrina, dried completely during the 2008-09 summer with over 1,000 ha of soils exposed. Subsequent rewetting of Currency Creek in autumn mobilised acid and metals causing major water quality changes, most notably a rapid decline in alkalinity, elevated metal levels and a drop in pH well below acceptable ANZECC guidelines. In response to the risk of large-scale acidification, temporary regulators were constructed across Goolwa Channel near Clayton and Currency Creek, and water was pumped from Lake Alexandrina to raise water levels in the weir pool. Acidified areas of Currency Creek were also treated with ultrafine limestone. The combination of these management actions led to improvements in alkalinity and pH. An adaptive water quality monitoring program is continuing to observe the changes in alkalinity, pH and metals as water levels decline again during the 2009-10 summer.

LIFE AT THE EDGE OF A PRECIPICE: CAN OTTERS AND DAMS CO-EXIST?

NAWAB Asghar

World Wide Fund for Nature - India

Session - B4B

Infrastructural developments in many ways have altered river morphology consequently affecting its ecological assemblages and characteristics. It is generally believed that dams affect otter populations due to the reduction of water flow downstream, denying access to prey and den sites. Between 2001 and 2004 an ecological study was conducted in Corbett Tiger Reserve, India to assess the impacts of making of dams on resident Otter populations. Perennial water bodies were searched for Otter presence, and wherever located, habitat and disturbance variables were guantified within 100 m × 15 m belt. Similar plots were laid systematically at 500 m to quantify habitat availability. Based on logistic regression, microhabitat variables such as water current, water depth, water quality and prey were identified to determine Otter occurrence in undisturbed river sites (classification accuracy = 98.12%). Intensive use areas were

The Algueva dam, in Portugal's Alentejo region, created the largest manmade reservoir in Europe when it filled in 2002. The Argyle dam, in the Kimberley region of north-western Australia, created the largest man-made reservoir on the Australian continent when it filled in the early 1970s. And the similarities don't end there. Both reservoirs were created after decades of discussion, argument and planning. Both were the subject of national and regional development agendas. Both received significant infrastructure funding from national governments. Both are focused on the provision of water for irrigated agriculture. Both are yet to be fully implemented and are currently undergoing government sponsored expansion. And both developments were, and continue to be, contentious. Community attitudes have changed markedly in the decades since the Alqueva and Argyle dams were conceived. In each case, the initial vision was one of large scale irrigated agriculture. However, community attitudes, values and activities have changed. Potential impacts on downstream ecosystems and communities, challenges of the distance to markets, alternative opportunities for water use (such as tourism), the social challenges of creating or expanding irrigation areas, and greater community and government awareness of the impact of irrigation developments around the world have highlighted the need for new thinking about both schemes. This paper compares the history of the Alqueva and Argyle dams projects, highlights some of the key issues which need to be considered in establishing new visions for these developments and draws out opportunities for shared learning. Our aim is not to focus on the question of whether large dams are good or bad. Rather, we aim to focus on the role of central governments supporting large scale water infrastructure for developments. To do this, we highlight some of the key similarities and differences, and make some commentary on what might be learnt from this.

THE LONDON RIVERS ACTION PLAN - RESTORING CITY RIVERS

The Thames Rivers Restoration Trust helped form a partnership to produce the first London Rivers Action Plan (LRAP) for the Thames and its urban tributaries. The plan is now driving river restoration projects across urban London. The LRAP website provides a central updateable resource of ongoing projects and opportunities; it enables all interested parties including local government, developers, NGOs and community groups to examine options for river restoration across the city and help make them happen. LRAP will help deliver the Mayor's London Plan targets of 15km of river restored by 2015 and 25km by 2020. Through an on-line database, anyone can track progress with any projects and help set up new ones. Since LRAP was published in January 2009, there have been over 8,000 hits exploring the restoration opportunities on the webite and 58 new projects have been registered. LRAP also has a section on 'Adapting to Climate Change', so that we restore for the climate of the future and not that of the past. In February 2010, LRAP won the UK Royal Town Planning Institute prize for climate change planning. LRAP is an example for many other cities which have been damaged by the same human impacts as the Thames.

delineated from the presence of dens; through high levels of sprainting and grooming sites. The dam with steep shore lines, deep water and absence of escape cover was found unsuitable for Otters. The conservation of Otter is concomitantly linked to the conservation and restoration needs of the freshwater ecosystems. The study emphasizes this relationship and forms a model resource for similar studies elsewhere.

CHANGING COMMUNITY VALUES ABOUT WATER: THE LARGE DAMS ALQUEVA (PORTUGAL) AND ARGYLE (AUSTRALIA)

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NETO Susana¹, CAMKIN Jeff²

Technical University of Lisbon¹, The University of Western Australia²

Session - D1C

OATES Robert¹, WEBB Dave²

Thames Rivers Restoration Trust (UK)¹, Environment Agency for England and Wales²

Session - C4F

ROBUST REAL-TIME EVENT DETECTION FOR ONLINE WASTEWATER MONITORING DATA

O'HALLORAN Roger¹, TOSCAS Peter¹, WINNEL Melissa¹, ZHAO Huijun²

CSIRO¹, Griffith University²

Session - A2F

As part of the South East Queensland Water Quality Research Alliance, we are developing online sensor systems to reliably collect data from raw sewage and treated effluent. The data must be evaluated in real-time to identify events that could compromise the wastewater treatment plant and subsequently the Potable Recycled Water system. This presents a considerable challenge, as the data typically has very large fluctuations, and there are also major effects due to natural events such as tropical storms causing catchment overflow. We present here the results of two alternative approaches that can detect significant events despite the complex and changeable background. The first method employs a Robust Time-delaying Multivariate Filter for real-time establishment of a reference baseline. It employs a non-parametric filtering approach that aims to estimate the true signal and is robust to single outliers or small patches of outlying input data. The methodology is designed to work with simultaneous inputs from several sensors, and requires development of an accurate mathematical model of the system. However, these conditions do not always apply in practice, so we have also developed a univariate strategy using a running median reference baseline with event bridging for estimating the reference baseline and detecting events.

EVALUATING THE IMPACT OF AN EDUCATION PROGRAM FOR SCHOOL STUDENTS: THE RIBBONS OF BLUE STORY

OLIVE Richard¹, PRABAWA Kelsie², MITCHELL Jen³, PETROW Angela⁴

Department of Environment and Conservation WA¹, Ecochange Consulting², Department of Water WA³, Swan River Trust⁴

Session – Poster (Hard & Electronic)

Ribbons of Blue / Waterwatch WA is an environmental education network that has been working with schools in Western Australia for 20 years. Over that time the program has worked with around 160,000 students, 6000 teachers, 230 community groups and monitored water quality at over 700 sites in metropolitan and regional areas. The innovative participatory evaluation methodology 'Performance Story Reporting' has recently been conducted. This method was developed for natural resource management to capture a range of outcomes and this is one of the first instances of its application to environmental education. Data were gathered by a variety of methods including a teacher survey, student focus groups and semistructured interviews with teachers. A panel of experts reviewed these data, and made statements on the extent to which the program has achieved its desired outcomes. Those statements included that Ribbons of Blue has been successful in enabling students to develop knowledge of their local catchments and waterways; and, values related to environmental responsibility. Teachers described a number of critical success factors, including the importance of hands-on learning in the local environment, and the empowerment that comes from students believing they are able to make a positive difference through their actions.

CORPORATE WATER RISK AND WATER POLICY

ORR Stuart

WWF INternational

Session - A2E

Water is fundamental to life, and one of the most basic of human rights. However, social and cultural dimensions are juxtaposed with its use in various production processes, which imposes an economic value of water. It is this duality, together with the need for water to support all ecological processes, in which business risks begin to emerge. Risk is of course relative, and affects companies in different ways, depending upon their reliance on water (including in their value chains), their brand profile, location of operations, customer relationships, if their products/ services are a luxury or necessity. Water is rising rapidly up the corporate agenda due to increasing water stress internationally, investor perceptions and public awareness. Multinational corporates have begun to assess the risks and uncertainties they face throughout their supply chains in producing and marketing their goods and services. The CEO Water Mandate and World Economic Forum (WEF) processes (amongst others) are already distilling these debates. One of the most complex issues is the engagement of corporates with public water policy. This paper explores a range of risk profiles and activities of the private sector, and assesses response strategies from measurement to public policy engagement.

TRANSFERING FROM LAKES TO RIVER BASIN MANAGEMENT: DRIM DIALOG

PANOVSKI Dejan

Ministry of Environment

Session – A4

The Drin River watershed has its origin in the Lake Ohrid - Lake Prespa ecosystem in Albania, Macedonia, and Greece. The average annual flow near the mouth of the Drin at the Adriatic Sea is about 340 m3/s; but there are strong seasonal variations, with highest flows in the fall and spring, and lowest flows in summer. The total catchment area of the Drin is 15,540 km². The Prespa-Ohrid-Shkoder lakes region of the Balkan Peninsula has been widely acknowledged as an ecological area of global significance, and the Drin River links the lakes, wetlands and other aquatic habitats throughout this region together into a single ecosystem. In the Drin River watershed, water quality problems are linked directly to water quantity. Water levels are managed throughout much of the system and decisions about hydropower production, irrigation water withdrawal, use of the channel bed for gravel mining, and domestic water use and sanitation have a direct bearing on both pollution export and biodiversity conservation. Major economic activities for the area are agriculture, forestry, hydropower generation and mining for gravel. The institutional framework for this region is fragile and it is important to have a water balance and develop a rational basis for water allocation decisions which bears in mind the declining biodiversity and threatened fisheries.

PRACTICAL MANAGEMENT OF ENVIRONMENTAL WATER: CASE STUDIES OF TWO ICONIC GROUNDWATER BASED SYSTEMS -GNANGARA AQUIFER AND WETLANDS (NORTH OF PERTH) AND MILLSTREAM AQUIFER ON THE FORTESCUE RIVER(PILBARA)

PATON Andrew, BRAIMBRIDGE Mike

Department of Water WA

Session - A2A

Some two thirds of Western Australia's water for consumptive use comes from groundwater. The Gnangara Mound to the north of Perth provides water into Perth's urban water supply system and water for market gardens and industrial use. The Millstream aquifer in the Pilbara provides water to the iron ore ports and regional towns of the West Pilbara. Both the Gnangara Mound and the Millstream aquifer support important water dependent ecosystems. There are over 600 wetlands on the Gnangara Mound which are vital to support flora and fauna in an area that receives very little rainfall over the summer. Likewise, the permanent Fortescue River pools in and below the Millstream Chichester National Park are fed by the Millstream aquifer and are critical refugia in an arid environment as well has having considerable significance for Traditional Owners. The Department of Water manages groundwater abstraction from both of these systems. This management is underpinned by some excellent science and relatively long-term data sets but even with this, the complexity of the groundwater-surface water interactions and climate change and variability presents some significant challenges. This presentation will highlight the practical approach to planning and management to deliver environmental objectives for both of these high use groundwater systems.

VERTICAL MIXING PROCESSES IN THE UPPER SWAN RIVER ESTUARY

PATTIARATCHI Charitha¹, HOLTERMAN Peter²

The University of Western Australia¹, University of Rostock² Session - A3D

Circulation in estuaries is widely accepted in the literature to be dominated, in varying proportions, by tidal range, freshwater discharge and gravitational circulation. In the shallow upper reaches of the Swan

River due to the presence of the salt wedge, vertical stratification is a persistent feature especially during periods of low freshwater discharge. Here, vertical mixing occurs due to (1) generation of turbulence at the sea bed; [2] shear generated at the density interface; and, [3] wind effects at the surface. However, quantification of the relative importance of these processes can only be made through the use of numerical models which require validation data under different hydrodynamic conditions. As part of this project, we are applying a high resolution hydrodynamic model: GETM (General Estuarine Turbulence Model) to the Swan River. Although hydrodynamic data (water levels, currents, temperature/salinity distributions) are available from sections of the river at different times, a coherent dataset has been lacking particularly covering the period close to the winter solstice when the water levels and the tidal range are at a maximum. Thus three Acoustic Doppler Current Profilers (ADCPs) were deployed in the river during May/June 2009 to collect velocity and tidal data along the upper reaches. In addition, data on vertical mixing rates do not exist for the upper Swan River and a series of dye experiments to define the vertical mixing rates in the upper Swan was undertaken in November 2009. The dye was injected into the higher salinity bottom layer and was monitored using a CTD equipped with a fluorometer optimised to detect the dye. The experiment yielded values of 0.5 to 2.0 $m^2 s^{\mbox{--}1}$ for the horizontal mixing coefficient which is lower than values recorded in the literature in other estuarine systems (e.g. Geyer et al. 2008). In this presentation details of the dye experiment and how it is being used in the numerical

COOPERATIVE AND INTEGRATED RIVER BASIN MANAGEMENT IS IMPERATIVE TO SOLVE TRANSBOUNADRY WATER PROBLEM

PAUL Reba

Bangladesh Water Partnership

model will be presented.

Session - D1F

The Southwest Region of Bangladesh is very much dependent on Gorai River – the main offtake of the Ganges (a transboundary river having 1.5 km length and 75 m breadth and is shared by Bangladesh, India, Nepal and China)-theonly source of fresh water supply to the region. But the unilateral withdrawal of water from the Ganges by India, has reduced the flow in Gorai drastically which has caused significant economic, environmental and ecological damage in the southwestern part of Bangladesh including World Heritage "The Sundarbans". This reduced flow is also threatening water security of Dhaka city (central part of Bangladesh) for over 12 million people and its fastest growing population. Though a treaty called 'Ganges Treaty' was made between India and Bangladesh in 1977 and 1996, it could not be effective due to mistrust existing between two countries and lack of adequate information sharing of water. However, there is a solution to overcome these but this is not being realized by the four countries. The Ganges could be augmented by Saptakoshi River flowing through Nepal (Himalayan region) and solve the water problems of India and Bangladesh and Nepal can earn lot of money through export of cheap hydropower to neighboring countries India, Bangladesh and Bhutan which face severe power crisis (including Nepal even) and boom their economy. River basin management in the Ganges is therefore of utmost importance in South Asia through multilateral cooperation among four countries Nepal and China.

OUANTIFYING AND MANAGING DISSOLVED ORGANIC MATTER-DERIVED NUTRIENTS IN AGRO-URBAN COASTAL CATCHMENTS

PETRONE Kevin¹, FELLMAN Jason², HOOD Eran³, DONN Michael¹, **GRIERSON** Pauline²

CSIRO¹, University of Western Australia², University of Alaska³

Session - A3D

We used PARAFAC modelling of excitation-emission fluorescence spectroscopy and biodegradation incubations to examine how DOC concentration and character influence bioavailable DOC (BDOC) in surface waters of urban and agricultural catchments in summer (low flow), winter (high flow) and spring (flow recession). Overall, DOC concentrations (2 to 140 mg.L-1) that varied widely across catchments were negatively related to labile fluorescence components and positively related to humic-like fluorescence. Percent BDOC change during incubations (2 to 57%) was also highly variable and negatively related to DOC:DON and humic-like fluorescence, but positively related to protein-like fluorescence and indices of DOM lability and freshness (FI and $\beta:\alpha$). Urban and agricultural land-use

The input of wood into the Daly River in tropical northern Australia provides habitat complexity that is likely to have a major influence on aquatic biodiversity and river geomorphology. Wood recruitment to the river from the riparian forests occurs sporadically during flood events in the wet season. Surveys in 2008 and 2009 of the aggregated river wood formations (AWR) found densities of 37 – 78 pieces. km⁻¹ with five distinct types of ARW identified. After large wet season flows in 2008/2009 between 46 – 51% of ARW had moved. Distribution of wood age classes indicated continual recruitment and slow turnover of wood within the river. Fish species richness was higher in river reaches with a high proportion of wood, but there was no significant effect of wood on the total abundance of fish. The importance of wood as habitat appeared to vary for different species and ages of fish. Wood was also a significant habitat feature that influenced fish community composition. This study demonstrates the dynamic nature and complex characteristics of in-stream wood and its importance as fish habitat. This highlights the need to consider in-stream wood in the development of relevant flow-habitat-ecology relationships.

THE ART OF PROTEST - LEARNINGS FROM TRAVESTON CROSSING DAM, QLD

Session - D1C

The announcement in April 2006 to dam the Mary River at Traveston Crossing came as a shock to the residents of the Mary Valley. However the response that followed was fast, efficient and highly effective. A massive groundswell of resistance arose from one end of the Mary to the other, and from many other quarters as well. It was apparent to all who knew the Mary that the plan would lead to economic, environmental and social disaster for the entire bioregion. The community was mobilized by a desire to protect the river, its endangered species, the farmlands and lifestyle of the valley. From its beginnings, the campaign to save the Mary River has been characterised by creativity. While the Mary Council of Mayors commissioned a report from expert scientists on alternatives to the proposed dam, the everyday people of the district tapped in to their considerable talents in song-writing, cartooning, visual art, photography, poster and banner design. An amazing range of talents in rhetoric, web design and campaign organization came about over the course of three and a half years. The rejection of the Traveston Crossing Dam proposal represents one of the very few projects rejected outright under the federal Environmental Protection and Biodiversity Conservation Act.

IS THE PRICE RIGHT: CAN AGRICULTURAL VALUE APPROXIMATE 🥥 ENVIRONMENTAL WATER VALUE? PILZ David The Freshwater Trust

In 1993, The Freshwater Trust (TFT) began purchasing and leasing water rights from irrigators and rededicating the rights as temporary or permanent environmental flows to support endangered fish in the

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was not associated with a consistent DOM character or degradability in streams. Rather, fluorescence characteristics and BDOC variability were likely driven by contrasting hydrologic pathways that differ in catchments and change seasonally with flow. Overall, higher BDOC and labile fluorescence components were found at low DOC concentrations. Despite low percent BDOC for humic-rich DOM, total BDOC (as mg.L-1) was still significant due to elevated DOC concentrations from terrestrial sources. Our findings suggest that fluorescence characteristics can be used to predict BDOC in human dominated catchments to better understand the flow of carbon and nutrients in aquatic foodwebs for improved monitoring and management of coastal ecosystems.

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DYNAMICS OF AGGREGATED RIVER WOOD AND IMPORTANCE AS FISH HABITAT

PETTIT Neil¹, WARFE Danielle², PUSEY Bradley³, KENNARD Mark³

The University of Western Australia¹, Charles Darwin University², Griffith University³

Session - A2D

PICKERSGILL Glenda, BISSETT Zela

Save the Mary River Coordinating Group Inc

Session - B4C

Northwestern U.S. TFT compensates landowners using "market-based" valuations linked to land and agricultural value. Unlike countries with active water markets, water trading in the Northwestern U.S. remains limited. This paper discusses the evolution of valuation methods for water rights in the absence of an active market. Methods include comparing irrigated and unirrigated land price differential, agricultural production replacement value, and an economic model that determines contribution to net revenue from water input. In the 17 years since TFT began purchasing water, the price has remained low compared to other regions of the U.S. and other countries with active water markets. At the same time, success purchasing rights for environmental flows has been limited. This raises two questions. First, might agriculture-based valuations undervalue water and, if so, has this reduced participation of irrigators who perceive the price paid to be too low? This paper concludes by analyzing whether valuation based on potential ecological benefit would provide more accurate valuation, higher price, and result in greater rrigator participation.

CAN'T SEE THE WATER FOR THE CARBON: THE THREAT TO RIVERS FROM CLIMATE CHANGEPOLICIES

PITTOCK Jamie

Australian National University

Session - D1A

The world faces an enormous challenge to mitigate dangerous climate change, and our governments are adopting policies to reduce greenhouse gas emission and sequester carbon. However, there are few free lunches in environmental management, and many of the technologies favoured by our governments will significantly increase water consumption and threaten rivers. Drawing on research in developed and developing countries that looked at on ground programs in seven countries, national policies in nine jurisdictions, and three treaty regimes, major conflicts and synergies are identified between climate change mitigation and conserving rivers. The paper concludes with key recommendations for more sophisticated, integrated and adaptive policy development to minimize perverse impacts and optimize conservation of our climate and rivers.

INVESTING IN THE MARDOOWARRA, RIVER OF LIFE (FITZROY RIVER) W۵

POELINA Anne

Madjulla Incorporated

Session - B4C

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Mardoowarra, River of Life is a 15 minute film produced and directed by traditional owners to showcase the Fitzroy River (WA) for its culture, conservation and landscape assets. As traditional owners we are known as Yimarrdoowarra. The Mardoowarra continues to sustain Yimarrdoowarra livelihood and is central to our cultural heritage, beliefs, values and continuing lived experiences. The Mardoowarra provides a refuge that harbours many different species of fish, waterbirds, plants and other animals, including threatened plants and animal and species only found in the Kimberley. The Mardoowarra gives rise to permanent water holes known to be important fish habitat areas, a stronghold for several nationally and internationally threatened species. The area is remote and relatively undisturbed with high biodiversity. Scientists and conservationists agree the Mardoowarra estuaries and floodplains are a threatened cultural heritage and ecosystem because of changing river flows and feral animals, unmanaged access from visitors and the new threats of mining along the Fitzroy River. This film provides justification for sound water governance, integrated land and water management validated through an insider worldview of Yimarrdoowarra, that the Mardoowarra is the River of Life, and needs serious investment and protection for current and future generations of the world.

A DECISION-SUPPORT TOOL FOR PREDICTING FISH RESPONSE TO WETLAND INUNDATION UNDER DIFFERENT MANAGEMENT SCENARIOS

PRICE Amina¹, MEREDITH Shaun², BEESLEY Leah³, GAWNE Ben¹, KING Alison³, KOEHN John³, MAFFEI Simon¹, NIELSEN Daryl¹

The Murray–Darling Freshwater Research Centre¹, Swan River Trust², Arthur Rylah Institute for Environmental Research³

Session - C2F

The National Water Commission funded 'Optimising Environmental Watering Protocols to Benefit Native Fish Populations' project aims to provide critical information to water managers on how to make best use of environmental water to sustain native fish populations. A survey of wetland managers early in the project found that the primary objective of most environmental watering plans for wetlands in the MDB was to ensure the survival or maintenance of native communities, particularly riparian vegetation. The survey identified that although determination of the 'optimum' wetland inundation protocol for native fish may be of considerable scientific interest, such a protocol will seldom be able to be implemented because of the physical and bureaucratic constraints imposed on wetland managers. In response to this, a key component of the project is the development of a predictive Bayesian model which will enable managers to make informed decisions regarding timing, duration and depth of inundation and method of water delivery to maximise benefits to native fish communities in river-floodplain ecosystems.

RECONNECTING HISTORICAL SIDE CHANNELS TO THE WILLAMETTE RIVFR

PRICE Krey, HARVEY Mike, MUSSETTER Robert

Tetra Tech Australia Ptv Ltd

Session - C4F

Pressures from commercial, residential, agricultural, and industrial developments have confined the flow path of Oregon's Willamette River. As these developments have encroached on the Willamette River's historical floodplain, a number of former side channels have been left isolated. Barriers to floodplain connection include railroad embankments, industrial diversion facilities, and levees. The U.S. Army Corps of Engineers, in conjunction with local support from the City of Springfield, the City of Eugene, and the City of Portland, has undertaken a series of projects to reconnect historical side channels to the mainstem Willamette River. Benefits of these projects include the restoration of natural hydraulic and riverine functions, and the provision of refugia and habitat to native salmonids, terrestrial species, and neo-tropical migratory birds. While typical flows within the side channels provide substantial habitat benefits under project conditions, flood flows may be exacerbated by the additional conveyance afforded by the constructed rehabilitation features, potentially threatening nearby development. As a result, the addition of hydraulic control structures was required in order to limit flows through the side channels and minimise flood risks. This paper examines lessons learnt in planning, designing, and constructing three side channel rehabilitation projects along the Willamette River.

IMPACTS OF CLIMATE CHANGE ON WATER RESOURCES AS ILLUSTRATED BY CSIRO'S SUSTAINABLE YIELDS PROJECTS

PROSSER lan

CSIRO Water for a Healthy Country Flagship

Session - C4A

Australia's water resources are under pressure from a range of drivers, one of which is climate change. These pressures are causing socially unacceptable degradation of rivers and other environments and are eroding the security of water supply. Demands on water exceed supply and climate change accentuates this difference. To help assess the future prospects for Australia's water supplies CSIRO has been commissioned by the Australian Government to undertake a set of sustainable yields projects to determine the current and future threats to water availability. The presentation will use the Sustainable Yields projects to illustrate the steps that need to be taken to go from projections of future global climate to assessment of impacts on local water users. The outcomes of this analysis are not always intuitive illustrating why such detailed studies are required as part of water planning and management.

USING THE DELPHI PROCESS TO STRENGTHEN RIVER BASIN **ORGANISATIONS: THE CASE OF THE ORANGE-SENQU**

QUIBELL Gavin, PULE Rapule ORASECOM

Session – Poster (Electronic)

Any organisation gains inherent strength, value and sustainability when the costs of participating are much greater than the costs of not participating. Sadoff and Grey (2005) propose a continuum for transboundary cooperation in this context, suggesting that the major challenge is to find the right type of cooperation, where the benefits outweigh the costs. Pegram (2009) proposes that RBOs generally fall into three types, ranging from cooperative committees, through development authorities - managing infrastructure, to river basin commissions generally with an IWRM mandate. In this paper we expand Sadoff and Grey's continuum in the light of ORASECOM's role in the basin and region. We then examine ORASECOM's multilateral and basin wide mandate visà-vis the existing bilateral arrangements in the light of Pegram's RBO types. The paper then poses the question; "What value can ORASECOM provide, that cannot be provided by the existing bilateral arrangements." We then describe the application of a Delphi type process aimed at achieving consensus on the preferred form and function for ORASECOM, which recognises that the costs of ORASECOM are associated with its institutional form; while the costs of not participating are associated with its function or role in the basin

INTEGRATED TRANSBOUNDARY WATER RESOURCES MANAGEMENT: DEFINING THE CONCEPT

RAHAMAN Muhammad Mizanur

Aalto University

Session - D1F

This paper introduces a new concept "Integrated Transboundary Water Resources Management" by integrating the principles of Integrated Water Resources Management (IWRM) and principles of transboundary water resources management. The integration of these two segregated set of principles offers the possibilities of making the integrated water resources management implementable around different river basins around the world. Since the United Nations Conference on Water (1977), international water professionals have promoted the use of the IWRM concept for effective and efficient management of water resources worldwide. In the WSSD Plan of Implementation (2002), the preparation of IWRM and water efficiency plans by 2005 for all major river basins of the world was one of the major water related targets. However, as of today, the IWRM plan is not finalised in any single river basin in the world. On the other hand, the international community has developed several legal instruments that solely focus on management of transboundary water resources shared by different riparian countries, e.g., 1966 Helsinki Rules on the Uses of the Waters of International Rivers and the 1997 UN Convention on Non-Navigational Uses of International Watercourses. These legal instruments include several transboundary water resources management principles that are associated with the integrated management of shared watercourses, e.g., principle of equitable and reasonable utilization, obligation not to cause significant harm, principles of cooperation, information exchange, notification, consultation and peaceful settlement of disputes are widely acknowledged by modern international conventions, agreements and treaties. This paper argues that the contemporary IWRM concept should consider including and acknowledging these principles as a prerequisite for integrated transboundary water resources development and management.

TRANSBOUNDARY WATERS MANAGEMENT COMMISSIONS: BEST PRACTICES FROM FINLAND

RAHAMAN Muhammad Mizanur

Aalto University

Session – Poster (Hard & Electronic)

The aim of this paper is to analyse the institutional arrangements of Finnish-Russian and Finnish-Norwegian Transboundary Waters Commissions. Management of transboundary waters are always challenging, both in the third world and in the rich industrial nations. Promoting and implementing integrated management through transboundary cooperation and effective institutions could control the state of the world water and reduce water

GO?

The drying climate of the south-west of Western Australia has seen a drastic decline in streamflow at many sites, with severe implications for both water supplies and stream ecosystems. The decline in streamflow has been disproportionate to the decline in rainfall, with up to three times the decline in rainfall observed in runoff. In south-west forested catchments, the proportion of rainfall that is evaporated or transpired is very high, and increases with declining rain. In this context, and in the face of further projected decreases in rainfall, pressure is mounting to ensure that forest management does not lead to further increases in catchment evapotranspiration, ensuring that river flows in forested catchments are maintained – to the extent that the climate allows – especially in perennial streams. The work to date has shown a complex interrelationship between land use and climate for the forested catchments. Observations have included declines in streamflow, delays in onset of flow in ephemeral rivers, and a switch from perennial to ephemeral streams. How much of this is due to the drying climate and how much is due to forest management practices is the focus of this investigation by the Department of Water

TECHNIQUES FOR MANAGING SALINITY IN THE RAMSAR-LISTED COORONG, SOUTH AUSTRALIA

South Australia's Coorong, Lower Lakes and Murray Mouth (CLLMM) region is a designated Wetland of International Importance under the Ramsar Convention. Historically the Coorong lagoons were a matrix of hypersaline. brackish estuarine and marine environments favoured by wading birds and with a great diversity of fish species. However, the lagoons are rapidly becoming more turbid and saline, with declines in much of the region's biota - justifying the Ramsar listing. As a result of escalating salinity, increasingly turbid waters and low water levels during spring, the Coorong ecosystem is becoming more simplified. A comprehensive shift in ecological character is underway. Without significant and urgent intervention it may prove irreversible. The Coorong Salinity Management Strategy (CSMS) is a package of three complementary projects proposed to manage salinity in the southern Coorong and maintain connectivity between the Coorong and the sea. If achieved, it is anticipated that salinity can be reduced and maintained in the southern Coorong to return favourable conditions for key species to re-establish in order that the Coorong and Murray Mouth ecosystem will be primed to respond favourably when barrage flows return.

conflicts among the nations. Nevertheless, absence of effective and efficient management of transboundary water resources shared by two or more riparian countries always poses a difficult threat to achieve integrated and sustainable development of the shared watercourses as well as that of the riparian countries. This problem persists in most of the transboundary river basins, aquifers and lakes, where mechanisms and institutions to manage disputes over water resources are either absent or inadequate. However, for considerably long time, Finland is managing its transboundary waters peacefully through effective institutions with her neighbouring countries e.g. Finnish-Russian Commission on the Utilisation of Frontier Water Courses based on 1964 agreement and Finnish-Norwegian Transboundary Water Commission based on 1980 agreement. Analysing these institutional mechanisms could provide examples of best practises for achieving shared benefits through efficient transboundary water resources management in other regions of the world.

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CLIMATE CHANGE AND FORESTED STREAMS: WHERE DID THE WATER

RAITER Keren Department of Water Session - D1A

RICKETTS Glvnn

Department for Environment and Heritage

Session - C3D

ESTUARY AND CATCHMENT OF THE SWAN CANNING - CHANGES OVER TIME

ROBB Malcolm

Department of Water

Session - B3B

The talk will present a background on the current condition of the estuary and projected future changes. A long term dataset of 15 years is examined for changes in phytoplankton growth and water quality in response to changes in hydrology, urban development and concerted management actions both in the catchment and estuary. The estuary is becoming more marine due to decreases in rainfall and flow leading to increased penetration of salt wedge, increased stratification and increased frequencies of low oxygen events which sometimes result in fish kills. Phytoplankton productivity has increased in the upper reaches, however dinoflagellates have not increased at the expense of diatoms as is often hypothesised. With further decreases in river flows from the catchment meaning longer residence times for nutrients an increase in productivity and low oxygen events is predicted.

INTEGRATING COMMUNITY ENVIRONMENTAL ACTION INTO CATCHMENT MANAGEMENT ALONG THE CANNING RIVER

ROBERT Julie

SERCUL Inc.

Session - B2C

The South East Regional Centre for Urban Landcare Inc. (SERCUL) is a community organisation that develops and implements projects that will improve our environment & promote and participate in an integrated approach to catchment management with the purpose of improving the health of our waterways and other ecosystems. SERCUL's primary area of river management is the most weed infested river in Western Australia, the Canning. After 7 years of coordinated catchment management and community motivation the organisation has stimulated high levels of community, local government and State agency involvement in the care and repair of tributaries, drains, stormwater basins and wetlands. The community river and wetlands projects include nutrient intervention technologies, drains to living streams, industrial auditing for cleaner stormwater, drain stencilling, river restoration, community education in reducing phosphorous and fertiliser use, volunteer management, weed management including aquatics and local plants for river corridors. SERCUL works with 8 large community river care groups and numerous friends groups, assisting them to operate efficiently, source funding and get the job done on the ground. SERCUL is currently the largest urban landcare group in WA working in partnership with Government agencies and 14 Local Governments to facilitate on ground works in the Canning catchment.

HOW FLOW AND NUTRIENTS AFFECT PLANTS AND ALGAE IN THE DALY RIVER. N.T.

ROBSON Barbara

CSIRO Land and Water

Session - A2D

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Primary production in the Daly River, a perennial tropical river in the Northern Territory, is dominated by benthic algae and periphyton, and limited in the dry season by low phosphorus and nitrogen availability. In the clear, shallow water of the river, photosynthesis exceeds biomass generation, with a significant proportion of the carbon fixed believed to be exuded as EPS. Plants observed in the river include the benthic algae, Spirogyra, Nitella and Chara, the flowering aquatic plant Vallisneria, and the emergent macrophytes, Schoenplectus. Changes in biomass of each of these groups over the course of the dry season are determined by the availability of suitable substrate, shear stress (in part, a function of flow), nutrient uptake and grazing. A numerical model incorporating these factors, driven by our observations in the river, can be used to explore how the river might respond to future changes in nutrient loads and flow. The results indicate that the river is likely to be sensitive to any increase in nutrient loads, with algal biomass increasing at the expense of more complex plants.

DRAINAGE MANAGEMENT AND INITIATIVES - BETTER URBAN DRAIN MANAGEMENT

ROHAN Deborah

Department of Water WA

Session - C3A

See SWAN RIVER TRUST

SUSTAINABLE DEVELOPMENT IN NORTHERN AUSTRALIA

ROSS Joe¹, DICKSON Andrew²

Northern Australia Land and Water Taskforce - Commonwealth Department of Infrastructure, Transport, Regional Development and Local Government¹, Office of Northern Australia - Commonwealth Department of Infrastructure, Transport, Regional Development and Local Government²

Session - C4B

The final report of the Commonwealth Government's Northern Australia Land and Water Taskforce Sustainable development of northern Australia, was released in February 2010. The Taskforce addressed the complex issue of sustainable development in northern Australia and the integration of economic, social, cultural and environmental priorities in decision making. Any consideration of northern Australia must also recognise the regions significance for Indigenous people and their intrinsic connectedness to land and water, as well as the complications of remoteness and disadvantage. It is difficult to think of a policy problem that is more complex; it is a wicked policy problem. The report strongly dispels long held perceptions about the abundance of water and the potential for the north to be a major food bowl. Strong leadership and strategic focus on the region, east to west, is required to build a shared vision and establish a national path for development that is genuinely sustainable. The Taskforce has offered 15 recommendations for consideration by Government. The findings and recommendations of the report provide a valuable opportunity for governments, working together, to map a new direction for northern Australia that avoids the mistakes of the past and empowers communities to achieve their aspirations.

INFLUENCE OF HYDRO-CLIMATOLOGICAL VARIABILITY ON PHOSPHORUS BUDGETS IN PEEL-HARVEY ESTUARY

RUIBAL CONTI Ana¹, HIPSEY Matthew¹, WEAVER David², SUMMERS Rob²

The University of Western Australia¹, Centre for Ecohydrology²

Session - B3B

The Peel-Harvey Estuary located in South West Australia (SWA) was an icon for eutrophication problems in the 60's. Mass developments of macro and planktonic algae generated severe water quality problems. As a part of a remediation plan, an artificial channel was constructed with the intention of flushing the excess of phosphorus into the oceanic waters. Since this time, the implementation of Best Management Practices in the agricultural areas surrounding the estuary has also occurred to reduce the amount of phosphate fertilizer that is being applied. Since then, algal biomass has decreased significantly, however, unravelling the role of these process is further complicated since SWA has experienced a decrease in mean precipitation which in turn has reduced the stream flows by more than 60%. This paper explores to what extent each these mechanisms has contributed to the decrease of algal biomass and the importance of internal loads of phosphorus relative to these changes. The influence hydro-climatological variability and land-use change on the nutrient budgets in the estuary is assessed using a combination of data analysis and through the application of a mass-balance model to summarise key processes in wet and dry years, before and after the construction of the channel

CHANGING HYDROLOGY OF THE PIBARA RIVERS - IMPLICATIONS FOR MANAGEMENT RUPRECHT John

Department of Agriculture and Food

Session - D1A

The hydrology of rivers in the Pilbara has historically been dominated by extreme rainfall events leading to high energy river flows with short duration baseflows. Previously the extreme events driven primarily by cyclonic events were considered random. However there are decades of more frequent events leading to increased river flows. In areas with widespread mining development, both the cumulative impacts and the inter-related impacts on river environments are becoming more important. The decadal variability in river flows has implications for river management. With respect to climate change the Pilbara region of Western Australia is projected to experience the severe warming equal to any region in Australia. Summer rainfall in the Pilbara is projected to decline slightly. However rainfall intensity in summer is projected to increase. It must be noted that any climate change projections for arid areas such as the Pilbara have significant confidence intervals. The interaction of changing dynamics of tropical cyclones coupled with projected rising sea levels due to climate change has repercussions for coastal river zones, including issues such as sedimentation and erosion, both in the river and estuarine zones.

NOT OUT OF SIGHT BUT OUT OF MIND: POPULATION AND CONNECTIVITY

SARAC Zafer, RINGWOOD Greg

Fisheries Queensland

Session - Poster (Hard)

Human activities such as agriculture, deforestation, urban development, industrial activities and inappropriate land use, combined with an increasing demand for freshwater have resulted in negative impacts to the health of most freshwater wetlands. The underlining reason for the expansion of these activities has been the exponential growth of the human population. The impacts of an increasing human population on natural resources and the environment such as freshwater wetlands were identified in the early 20th Century. Today, it is well recognised by many analysts that population growth, affluence and technology are main causes of the decline and loss of biodiversity around the world. Current practices to rehabilitate and protect freshwater wetlands seem ineffective as they address only secondary causes of impacts. Those practices are generally localised, rather than employing a holistic approach which includes the management of human population within the carrying capacity of the region. As it was indicated by Honourable Kelvin Thomson during his speech at the House of Representatives in the Australian Parliament on 17 August 2009, without the management of population growth, the problems associated with loss of habitat and biodiversity, including freshwater wetlands, will not be solved.

SATELLITE & INTERNET TELEMETRY OPTIONS FOR RIVER WATER MEASUREMENT SYSTEMS

SAUNDERS Matt

Unidata Ptv Ltd

Session - A3F

This paper overviews satellite and internet options for telemetry communications systems which can be used to transport water parameter electronically from streams and rivers in the field to central storage systems. The paper covers satellite and cellular phone based internet telemetry options available with their pros and cons and explains how internet telemetry works. Telemetry systems have been used extensively for successfully transporting data from field measurement devices to central computer systems for many years. With the growth of the internet and telecommunications networks, especially purpose built machine to machine systems there are now more options available for telemetry. Emerging satellite systems, especially low earth orbit satellite systems, are now reasonably priced and are reasonable alternative to cellular based telemetry systems in remote areas. Broad technical aspects of the satellite technology and Internet telemetry will also be covered in this presentation Topics include Pull & Push Telemetry; Internet (TCP/IP) telemetry: Satellite Communications and Telecommunications Industry

The quality of science has rarely been questioned so fiercely as with climate change, with the so-called 'climategate' dominating media discussion. But what does this mean for river planning and policy - how do we know whether we are using reliable knowledge and the 'best available science' (BAS)? This paper presents the results of an international review of BAS, undertaken for the Murray–Darling Basin Authority (MDBA), which has the legal requirement ' In the development of the Basin Plan the MDBA must act on the basis of the best available scientific knowledge'. Following an extensive literature review and case study analysis, a practical framework for implementing BAS is recommended. The framework has two dimensions (1) Assessment of the reliability of scientific information by placing it in one of four categories: Personal Opinion; Grey Literature; Peer Reviewed; and Consensus Processed; (2) Classification into four classes of scientific maturity: Proven Science; Evolving Science; Borderline Science; and Fallacious. The paper also discusses implementation challenges including: scope and nature of science, best versus adequate science, quality peer review, who assesses BAS, sourcing BAS, use of experts and dealing with uncertainty.

The Lower Murray Reclaimed Irrigation Areas (LMRIA) are former floodplains on the River Murray between Mannum and Wellington in South Australia. Prior to the LMRIA Program, the LMRIA was flood-irrigated, with some 5,200 hectares of reclaimed land used mainly for dairying. Many of the irrigation practices in the LMRIA were inefficient, with high levels of water use and discharge of nutrients and pollutants back into the River Murray. In 2003, the Lower Murray Reclaimed Irrigation Areas (LMRIA) Program was formally established with four broad objectives: improve water quality in the River Murray by minimising drainage; enable irrigators to significantly improve their water use efficiency; devolve responsibility for government irrigation areas to irrigators; and provide for a sustainable irrigation industry in the region. The South Australian Environment Protection Authority (EPA) worked with the local community on farm and irrigation practices impacting on water use efficiency and water quality and compliance with River Murray water quality policies and regulations. The LMRIA Program successfully resulted in all eligible irrigators completing an Environmental Improvement and Management Program (EIMP). Early monitoring by the EPA has identified substantial average reductions in drainage volumes and pollutant loads returned to the River Murray following completion of rehabilitation works.

Trends; Technology considerations for LEO and GEO Satellite systems; Technology Comparisons - TCP/IP versus Short Message Service Offerings; Mobile Phone / Cellular Phone Networks for data logging; Protocols and Standards;;Examples of Satellite Service Offerings & typical costs; Case study – Satellite Telemetry for Hydro Power / River Systems in Canada.

ARE WE USING 'BEST AVAILABLE SCIENCE' IN RIVER PLANNING AND POLICY?

SCHOFIELD Nick, MADDY Peta, SANDERSON Annie, PURBRICK Steve Sinclair Knight Merz

Session - C4D

LOWER MURRAY RECLAIMED IRRIGATION AREA, AN ENVIRONMENT IMPROVEMENT MANAGEMENT PROGRAM FOR DAIRYING

SCOTT Peter

Environment Protection Authority

Session - D1B

REGULATION DRIVING INNOVATION - WORLD'S FIRST GREYWATER TREATMENT SYSTEM FOR RIVER VESSELS

SCOTT Peter

Environment Protection Authority

Session – Poster (Hard & Electronic)

The management of wastewater generated on vessels (i.e. blackwater and greywater) has been a matter of concern by industry groups, the 🧬 general public and government agencies involved with the recreational boating industry for many years. This paper will outline the key strategies and processes the Environment Protection Authority has developed and implemented over a 5 year period to minimise the potential risks to both public health and the environment created by the discharge of untreated blackwater and greywater into the River Murray. Key issues to be covered

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include vessel wastewater and its potential impacts on public health and the environment, overview of the development and implementation of the EPA Code of Practice for Vessel and Vessel Facility Management: Marine and Inland Waters 2007, industry developments and initiatives with regard to greywater treatment technology, Community, State and National consultation strategies and Government/Industry relationships. This community engagement program won the 2009 Premier's Award for 'Driving Innovation – World First Greywater Treatment Systems for River Vessels' in the category of 'Fostering Creativity and Innovation'.

MANAGEMENT TECHNIQUES IN RESPONSE TO ECOSYSTEM COLLAPSE: COORONG, LOWER LAKES|AND MURRAY MOUTH, SA

SEAMAN Russell

Department for Environment and Heritage

Session - D1D

Record low inflows from the River Murray through drought and overallocation across the Murray–Darling Basin are continuing to significantly impact the Coorong and Lower Lakes region – a South Australian Ramsarlisted Wetland of International Importance. Water levels are dropping, salinity is increasing and previously submerged sulfidic soils are exposed to air, resulting in acid sulfate soils formation. Upon rewetting, acidification of the waterbody is likely, with sulphuric acid and metals such as iron and aluminium released. This has significant toxic impacts on the region's biota as well as on livestock and human health. Ecological impacts include loss of small-bodied native fish and tortoises; increase in invasive species such as tubeworms (*Ficopomatus enigmaticus*), and disconnection of wetlands and subsequent loss of wetland functions. The situation is unprecedented world-wide, with over 20,000 hectares of sulfidic material occurring within the region. A detailed monitoring and research program is underway to learn more about the risks and options for managing acid sulfate soils in the Coorong and Lower Lakes region. Investigations include: soil mapping; measuring acidity generation and flux rates; field and laboratory mobilisation experiments using seawater and freshwater; and different remediation techniques. Following an introduction into the unprecedented environmental events that have occurred in the Coorong and Lower Lakes region over the past 18 months, this presentation will describe the acid sulfate soil problem in the region and the methods techniques

CONVERSION OF MARGOOYA LAGOON FROM A WATER STORAGE TO AN ECOLOGICALLY VALUED WETLAND

SEARLE Louise

Mallee Catachment Management Authority

Session – Poster (Hard & Electronic)

The Murray River, in its natural state, is unpredictable and seasonal flows vary significantly from year to year. The ecosystems of the Murray River's wetlands have adapted to this unreliability and many native species need variable conditions for provision of food and breeding conditions (DEH, 2000). Variable river flow conditions caused navigational restrictions for the river trade industry and provided low water security for landholders that require reliable flow all year. Regulation of the Murray River began in 1915 with the installation of locks and weirs. The role of lock and weirs is to provide a relatively constant water level to facilitate pumping for irrigation and town supply and to provide permanent navigation throughout the Murray River. The weirs have resulted in reliable water supply that has enabled many rural industries to prosper and large towns to develop. In contrast, river regulation has resulted in extensive environmental consequences, through the alteration in flow variability. Wetlands, such as Margooya Lagoon have been permanently inundated by the introduction of weirs, causing deterioration of the ecosystem. However, environmental values can be restored through cooperative management and infrastructure investment, whilst maintaining integrity of the lock and weir system for water supply.

SHADBOLT Roxane

Swan River Trust

Session - C3A

See SWAN RIVER TRUST

RISK-BASED PLANNING AND ECOLOGICAL DYNAMICS IN ENVIRONMENTAL FLOWS

SHENTON Will, BOND Nick, MACNALLY Ralph

Monash University

Session - D1E

Water management planning processes use environmental flow (eFlow) assessments to make informed decisions about sustainable water management. Most contemporary approaches for determining eFlows rely heavily on analysis of historical hydrology data and flow times series analysis. Underlying each of these methods are a number of critical assumptions that could undermine the robustness of future eFlows decision-making. Streamflow has traditionally been viewed as fluctuating around a stable mean within an envelope of variability. We can no longer assume stationarity in river systems because of climate change which is resulting in both a change in the trend of the mean and the associated envelope of variability. The incorporation of extreme events into the first step of the environmental flows planning process could be used to explicitly identify risks from future extreme events, such as floods or droughts. Tools exist and can be implemented to address the flaws in the eFlows process, tools such as non stationary extreme value analysis. The development of new environmental planning processes is therefore needed that addresses these issues through the application of additional decision support methodologies, some of which already exist in water planning and can be tailored to environmental flows.

GREENHOUSE GAS EMISSIONS FROM A SMALL RESERVOIR IN A STEEP, SUB-TROPICAL RAINFOREST CATCHMENT

SHERMAN Bradford, FORD Phillip

CSIRO Land and Water

Session - A3E

Floating chamber measurements of the seasonal, spatial and diurnal variability of methane (CH₄) and carbon dioxide (CO₂) emissions from Little Nerang Dam (volume = 9280 ML, area 49 ha, catchment area 35 km²) were made during 2009-2010. Average methane emissions from a range of sites across the storage varied from 10 to 1800 mg CH_{A} m⁻² d⁻¹. During davlight, the upstream shallow reaches of the storage were net heterotrophic and emitted CO₂ to the atmosphere at all times whereas pelagic sampling sites were autotrophic and exhibited CO₂ drawdown during daylight hours. Periodic ebullition of CH₄ was observed at a medium depth site located in 14 m of water whereas the shallow upstream reaches presented a near-continuous stream of bubbles erupting from the surface. Bubble composition ranged from 65–95% CH_4 . These results are consistent with assumed emission rates used in an earlier study which suggested that methane emissions from water storage reservoirs in southeast Queensland are comparable to approximately one half of total greenhouse emissions from all other aspects of the urban water cycle.

REVIVAL OF RIVERS: A NEW KOREA

SHIM Pil

Office of National River Restoration, Ministry of Land, Transport and Maritime Affairs

Session – A1

The Four Major Rivers Restoration Project of South Korea aims to restore the Han River, Nakdong River, Geum River and Yeongsan River, to provide water security, flood control and ecosystem vitality. It is intended to fundamentally prevent natural disasters like floods and doughts, protect the environment and promote history and cultural tourism. The project aims to create jobs and further economic growth, thereby broadening the horizon of the country's green growth. There are five key objectives to the project: to secure abundant water resources against potential water scarcity; to implement comprehensive flood control; to improve water quality and restore the ecosystems that both rely on and feed the river system; to create multi-use spaces for local residents; and to create conditions for further revitalization of these river systems under regional authorities. The Four Major Rivers Restoration Project will renew and revitalize a total of 929 km of Korea's national river system. Subsequent projects administered at the regional level will restore more than 10,000 km of local streams and 39 riparian wetlands.

WILL THERE BE ANY SURFACE WATER RESOURCES IN SOUTH-WEST WESTERN AUSTRALIA UNDER THE PROJECTED FUTURE CLIMATE?

SILBERSTEIN Richard CSIRO Land and Water

Session - C4A

Since the mid 1970s streamflows into the major water supply reservoirs in the south-west of Western Australia (SWWA) have declined markedly following a rainfall decline in the late 1960s. Since 1975 average dam inflows have been less than 50% of the value in the previous 60 years, and since 2000 have been a further 40% lower. Almost all global climate models (GCMs) project that the next century will be drier and hotter in this region than the past century. This has major implications for water resources planning, and possibly even greater implications for the preservation of aquatic and riparian ecosystems in the region. The catchments for Perth are almost entirely native eucalypt forest; the reduction in catchment flows is due to a combination of receiving less rain, catchment vegetation response to the drier climate, and how we have managed the forest under this new climate regime. Whatever the major cause, groundwater levels have declined significantly over the last 30 years, and streams have lost a major contributor to their flow. Understanding the relative impact of each of these causes may help us design management for the future.

ARE THERE INTERNATIONAL SOLUTIONS FOR THE AMUR RIVER?

SIMONOV Evgeny, DARMAN Yury2

Rivers without Boundaries Coalition1. WWF-Russia2

Session - D1F

The Amur River basin, divided between Russia, China and Mongolia, provides ecological services important for the whole world. Since a toxic spill in China in 2005, rapid formation of new regime of cooperation and competition over transboundary waters started in Amur. We analyze which cooperation mechanism and regulation concepts could provide a platform for conservation and management of transboundary river ecosystems. Ironically, Amur ecosystem was better protected by animosity between countries in the 1970s, than it is secured by increased cooperation nowadays. Despite Amur's importance in biodiversity, food production, wetlands conservation, international treaties so far could not provide a basis for integrated river basin management. The Ramsar Convention is the most relevant multilateral tool with 15 wetlands already listed in the basin. One of the key questions to be solved: securing transboundary environmental flows in the face of climate change, especially challenging, once conflict over water resource has already erupted in Argun River subbasin. Environmental NGOs have been instrumental in bringing Amur issues to the attention of governments and the international community and seem to be the only entities speaking for the river, rather than for specific corporate or national interests.

LINKING DIVERSIFIED WATER-ECONOMIC COMPLEX TO PLACING VALUE ON RIVER

SIRISENA Meegasmullage

Irrigation Management Division. Ministry of Irrigation

Session – Poster (Electronic)

This report through a case study of the Walawe River Basin (WRB) in Sri Lanka, provides evidence of economic valuation of the river and in each of its alternative uses, cost efficient ecosystem services, the environmental health of the river and the communities. Water trading opportunities and challenges including local enterprise, public private partnership, community participation and water market measuring social and indigenous values of the river. Further, the new management strategies

Water level decline in lakes is a relatively unstudied phenomena, but one which is likely to become increasingly prevalent as water scarcity, from climate change and extraction for human uses, increases. The ecology of Lake Alexandrina, at the end of the River Murray, is being seriously degraded as water levels decline. Decreasing light availability for primary production has been driven by wind-induced wave turbulence that resuspends fine sediments, which have been accumulating in the lake. These changes affect the base of the food-web and reduce the energy flow from phytoplankton to higher trophic organisms such as zooplankton, fish and birds. Understanding the changes to the physical structure and the dynamics of sediments in this lake is essential knowledge in restoring the ecosystem from the bottom up as water availability increases.

Groundwater resources are under increasing pressure from a range of uses in many locations worldwide. Perth, Western Australia, depends heavily on water from the Gnangara groundwater system (GGS) for municipal, industrial, and horticultural uses. The GGS provides 60% of Perth's public drinking water, and supports surrounding wetlands. The GGS is experiencing unprecedented demands and present use levels are unsustainable. Water trading can be used as a policy instrument for reducing groundwater consumption. There is currently no formal trading scheme in place for Gnangara groundwater. This paper examines the policies and institutional arrangements that relate to groundwater trading O in the GGS, as well as assessing the regulatory and legal environment into which any such trading scheme would be introduced. We assess the potential for successful implementation of a trading scheme for groundwater in the region. Major goals of the project are the identification [©] of transaction costs to trading and the analysis of their potential to inhibit the desired operation and economic efficiency of a trading system. The paper presents conclusions regarding transaction costs in the context of the GGS, and an assessment of whether or not a market could be sustained in the current environment.

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adopted by the government for placing value in the river basin and how these valuations directed to economic development of the region will be examined. Here the new system applied for valuing the river through not in charge of the whole watershed, but operates on a watershed basis in many issues, encouraging participation of its stakeholders in planning and policy making. Finally we examine the identified gaps such as lack of integrating river system with the provincial and local authorities. As well the most important requirement is a sound knowledge and information system of the resources and a decision support system with appropriate analytical tools and how they are used for social, economic and environmental development of scare freshwater resources in the watershed for placing the value on rivers

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DROUGHT IMPACT TO THE DEVELOPMENT OF RIVER HABITAT

SIRISENA Meegasmullage

Irrigation Management Division, Ministry of Irrigation

Session – Poster (Electronic)

The aim of this poster is to illustrate in general, how natural purification and filtration of Walawe Ganga will be disrupted during dry seasons particularly with intensification of drought. In this regard the health of the population and their livelihoods living in the cities, Embilipitiya, Ambalantota near this river utilizing the water for drinking purposes faces serious risks. Further reduction in the flow of Walawe River will certainly lead to increasing pollution, sedimentation and salinity of the river, and will have the impacts on the residents living along the banks of this river.

SEDIMENT DYNAMICS AFFECT PRIMARY PRODUCTIVITY DURING WATER LEVEL DECLINE IN A SHALLOW LAKE

SKINNER Dominic

The University of Adelaide

Session – A2D (Future Water Leaders Award Finalist)

THE POTENTIAL FOR A WATER MARKET IN THE GNANGARA GROUNDWATER SYSTEM OF WESTERN AUSTRALIA

SKURRAY James

University of Western Australia

Session - C3E

STREAM SALINITY LINKAGE IN (THE HELENA AND OTHER) SOUTHWEST AUSTRALIAN CATCHMENTS TO PALAEOVALLEY SEDIMENTS

SMITH Robin, DE SILVA Jayath

Department of Water WA

Session - D1F

Stream salinity is a major water supply issue for the southwest catchments of Western Australia. These mostly-forested catchments extend south from that of the Helena River. This river is dammed by the Mundaring Weir to the east of Perth. Previous studies connected stream salinity to the rainfall pattern across the southwest. Interaction of modern drainage with an unconfined, saline, palaeochannel sand aquifer can rapidly and significantly change stream salinity. Modern rivers are incised to competent gneissic bedrock and many cross-cut up to 60m thick Cainozoic palaeovalley sediments. The less-incised upper Helena, Kent, Warren, Denmark and others have higher stream salinities than their lower catchments. The Cainozoic sand aquifers transport large amounts of accumulated salt from the soil profile of adjoining weathered bedrock cleared in the last 60 years. Increased groundwater recharge following this land clearing leached salt from the soil profile and led to saline discharges where sand aquifer is exposed, mainly between 200 and 230 m AHD. The distribution of the palaeovalley sediments, especially the palaeochannel sand aquifer, has a bigger role in stream salinisation than previously appreciated. Understanding this interaction between the modern and ancient drainage is essential for stream salinity management.

THE NEED FOR ENVIRONMENTAL FLOWS TO THE GREAT SANDY STRAIT

SMITH Tanzi¹, PICKERSGILL Glenda²

Greater Mary Association Inc¹, Save the Mary River Coordinating Group² Session - C3C

The Mary River, in South East Queensland, Australia, has escaped the construction of the proposed Traveston Crossing dam, but the system remains under pressure through extraction for the South East Queensland Water Grid to the south as well as prospects of more interbasin transfer and increases in local extraction. The Federal Environment Ministers' decision in December 2009 to reject the proposed dam highlighted the significance of key species in the freshwater ecosystem of the river, but what of the estuarine ecosystem? The estuary of the Mary River is internationally recognised through Ramsar listing and inclusion in the Great Sandy Biosphere. It is a sand passage estuary sandwiched between the mainland and World Heritage listed Fraser Island which supports significant commercial and recreational fishing industries and is an important site for migratory birds, dugongs, migratory cetaceans and the rare Indo-Pacific Humpback dolphin. The Mary Basin Water Resource Plan currently provides no guarantee of environmental flows to this estuary. This paper draws on a selection of research into water quality, hypersalinity and ecology of the Great Sandy Strait to emphasise the need for environmental flow requirements to be established and delivered to the estuary. Preliminary estimates of these requirements are provided together with recommendations regarding further research.

STATUTORY PLANNING CONTROL AROUND RIVERS - UNIQUE ARRANGEMENTS

STEPHENS Paul

Swan River Trust Session - C3A

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See SWAN RIVER TRUST.

WHAT IS EVIDENCE-BASED PRACTICE FOR ENVIRONMENTAL FLOW PROGRAMS?

STEWARDSON Michael¹, WEBB Angus¹, RICHARDS Rob², WEALANDS Stephen¹

eWater CRC & The University of Melbourne¹, Environmental Evidence Australia²

Session - C4D

The paper describes a method for synthesizing the flow-ecology knowledge base to inform environmental watering programs. The process of synthesising evidence has strength in a) dismissing commonly believed untruths or paradigms and b) providing an understanding that is greater than the sum of the parts. Both of these outcomes challenge and improve our existing knowledge. We begin by describing the extent of the evidence and its distribution across ecological responses and river types based on an exhaustive (and exhausting!) literature search of 1000's of papers. We describe the use of evidence-based conceptual models and "Causal Criteria" for synthesizing this vast knowledge base. The presentation will include an introduction to the on-line Causal Criteria Evidence Database and Causal Criteria Analysis Software. We will demonstrate how these tools underpin environmental flow monitoring and evaluation using examples from the Victorian (statewide) Environmental Flow Monitoring and Assessment Program (VEFMAP). Understanding the causal mechanisms linking flow alterations to freshwater ecosystem responses is fundamental to evidence-based environmental water management. This paper provides a blueprint for making more of our existing knowledge for planning, operating and evaluating environmental flows

INTRODUCING SWIRC: A RIVER HEALTH ASSESSMENT INDEX FOR SOUTHWEST RIVERS

STORER Timothy

Department of Water

Session - C2E

An index for assessment of river condition for southwest Western Australian rivers has been developed by the Department of Water in an effort to promote consistency and comparability across the region. The SWIRC, or the South West Index of River Condition, has been designed for applicability across the southwest; accounting for both natural variability in form, function and complexity, and the range of systemspecific impacts. As such, indicators, scoring protocols and associated data required by the Index are tailored to individual systems. The SWIRC has also been developed for direct alignment with the national Framework for the Assessment of River and Wetland Health, providing the flexibility for reporting at the region, state and national levels. The methods for assessment and reporting of the SWIRC will be presented.

ESTIMATION OF ECONOMIC VALUES FOR ECOSYSTEM SERVICES OF AUSTRALIA'S TROPICAL RIVERS

STRATON Anna¹, ZANDER Kerstin²

CSIRO¹. Charles Darwin University² Session - B4C

An ongoing drought in southern Australia and increasing awareness of the value of water worldwide is drawing attention to the potential for development in northern Australia. Any development in this region will have impacts on the ecosystems and ecosystem services of tropical river systems, and on the welfare of Australians and people worldwide. Decision-makers are seeking to take these welfare impacts into consideration in assessing development pathways. This paper provides welfare estimates for changes in four tropical river ecosystem services, thereby providing information about a wider range of costs and benefits of development than was previously available. The study identifies different classes of respondents to provide policy-makers with a greater level of information about some differences in preferences and resulting impacts on welfare estimates. The finding for the whole sample is that respondents value positive outcomes for the environmental, recreational. cultural and production ecosystem services of Australia's tropical rivers and are prepared to pay to achieve these outcomes. The relative implicit prices reveal that seeing waterholes that are important to Aboriginal people in their highest possible condition is worth nearly two and a half times more than seeing the largest possible area of floodplain in a healthy

state, and worth nearly three times as much as not seeing income from irrigated agriculture at its lowest level.

OPTIMISING MULTIPLE EFFLUENT RELEASES TO AN ESTUARY IN A GROWING CITY

STUART Greg¹, MORTENSEN Simon¹, HOLLINGSWORTH Anna², KIRKPATRICK Sally³, THOMSEN Franz¹, KHAN Sayedhur², TOMLINSON Rodger³, CAPATI Guillermo², SZYLKARSKI Stefan¹, ALLERY Craig¹

DHI Water and Environment¹, Gold Coast Water², Griffith University³

Session – Poster (Hard & Electronic)

The Seaway SmartRelease Project is designed to optimise the release of recycled water from the Gold Coast City's wastewater treatment plants (WWTP), in order to minimise the impact to the estuarine water quality and reduce the energy consumption by modifying pumping schedules. In order to achieve this, an optimisation study has been undertaken involved hydrodynamic monitoring, water quality monitoring, numerical modelling and a development of web based decision support system (DSS). Several intensive monitoring campaigns provided information on water levels, currents, winds, waves, nutrients and bacterial levels within the Broadwater. These data were then used to calibrate and verify numerical models using the MIKE by DHI suite of software. The subsequent DSS therefore provides a powerful predictive tool which interacts with WWTP SCADA systems, extracts predicted meteorological conditions, runs the numerical models and generates the optimal pumping schedules to release the required amount of recycled water from the WWTP. Initial results show that this system has the ability to reduce the impact on water quality within the Broadwater, directly attributable to the WWTP by up to 70%.

DO CONVENTIONAL RIPARIAN BUFFERS IMPROVE WATER QUALITY FROM SANDY CATCHMENTS?

SUMMERS Robert¹, KEIPERT Nardia¹, STEELE Jesse²

Department of Agriculture and Food WA¹, Newmont Boddington Gold²

Session - D1B

Fencing and revegetating agricultural drains is a widely used practice to improve water quality in the sandy catchments of the Peel Inlet and Harvey Estuary in Western Australia. This paper reports a study of a 185ha headwater catchment at 2 points. The upper 720m (105ha) of drain had been fenced 10m either side in 1993, revegetated with native shrubs and trees on one side and volunteer grasses on the other. This drain then flowed into another 860m (80ha) section of drain that was unfenced and grazing cattle had access to the drain throughout the year. Whilst the vegetated drain lost a fifth of the sediment load of the unfenced drain (100 kgha-1 less), the Total Phosphorus load remained the same (2kg TPha-1). The proportion of Filterable Reactive Phosphorus (FRP) of the load was higher in the vegetated section. The water in vegetated drain also had a higher TP and FRP concentration (2006-08) with no significant difference in TP in 2009. The impact on nitrogen was less clear. This suggests that the absence of fencing allowed streamflow and livestock to stir up sediment, which interacted with soluble forms of P which settled in the unfenced reach of drain

MOVING MOUNTAINS (AND RIVERS) IN A FLAT LANDSCAPE

SWAN RIVER TRUST

Session - C3A

Protecting the ecological health and community benefit of rivers and estuaries requires long-term commitment from many people involved in the management of these systems. There are no easy, quick-fix solutions to many issues such as algal blooms, low oxygen levels and fish deaths. Population growth and climate change are expected to exert greater stress on most rivers and estuaries in the future. So what does it take to keep best practice-actions happening to meet long-term objectives and deliver real change? How can the hearts and minds of the many people involved with river management be engaged? The purpose of the feature session is to explore these questions through a series of presentations from a range of urban and rural partners following a 'catchment to coast' approach. Using the Swan Canning river system as an example in progress, topics to be presented will include: establishing a collaborative approach for all organisations with river management responsibilities to

Retrofitting a bio-retention system into a stormwater compensating basin in Cannington, an established Perth suburb, has provided the Swan River Trust, City of Canning and South East Regional Centre for Urban Landcare (SERCUL) with valuable experience in integrating multiple objectives into urban drainage improvement projects. The basin provides a point of interest for people using the park and surrounding local residents were keen to maintain views of open water in the basin and across the site. These community expectations helped shape the design and plant species selection while water quality and habitat improvement in the Canning Plain Catchment remained the focus of the Trust. The basin is part of the Wharf Street main drain flowing to the Canning River in high flows. Maintaining hydrological capacity and conductivity to the river was a requirement of the Water Corporation. The Manley Street Bio-retention system was constructed in late 2007. Early results of water quality monitoring of the inlet and peizometres in the 85metre bio-retention trench indicate that the vegetation along with the laterite and sand/ woodchip filter media has reduced total phosphorus and oxidised nitrogen in the filtered water. However, lower than expected hydraulic conductivity. through the filter media has restricted the overall effect of the nutrient concentration reductions. This poster will outline the project's water quality improvement outcomes and provide an example of an urban drainage improvement project within an established suburb.

The Murray Darling Basin is front page news on a regular basis as the extended drought over the past decade has highlighted many major challenges confronting the Australian community if it is to effectively and properly manage this critical national resource for the future. This address will cover the Basin's historical and legislative frameworks and outline the impact on the recent climatic conditions on the basin's environment, economic and social wellbeing. Comments will be made on how the Authority is moving to ensure the Basin is better managed so as to ensure that the environment is improved significantly from its current state, while addressing critical human water needs and the economic and social wellbeing of people and communities dependant on the basin for their livelihoods. Scientific, technical and engineering expertise and initiatives will be fundamental to improving the environmental management of 🧑 the Basin will be critical, and the address will specifically address these matters.

work together; achieving catchment management and behaviour change in the community; improving urban drainage management; strategic landuse planning and statutory planning controls to encourage and facilitate sustainable development around rivers; protecting and restoring foreshores; managing Riverpark - community enjoyment and use of the waterways and adjacent reserves; and engaging the community in river protection activities.

AN EXAMPLE OF A BIO-RETENTION SYSTEM RETROFITTED IN PERTH'S SUBURBS – LESSONS LEARNT

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SYLVA Kim

Swan River Trust

Session – Poster (Electronic)

FORESHORE MANAGEMENT

TAYLOR Mark

City of South Perth Session - C3A

See SWAN RIVER TRUST.

THE MURRAY-DARLING BASIN - THE CHALLENGES AHEAD

TAYLOR Michael

Murray-Darling Basin Authority

Session - C2B

INTEGRATING INDIGENOUS TRADITIONAL KNOWLEDGE AND WESTERN SCIENCE FOR RIVER RESTORATION

TE AHO Linda

University of Waikato

Session - C4B

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This presentation will explore a co-management solution being developed in respect of the Waikato River, the longest river, in Aotearoa New Zealand, and classified as a degraded body of water. As a result of the Crown's invasion and war by land and by the Waikato River, and subsequent confiscation of Waikato lands in the 1860s the tribal groups were denied rights and interests in the Waikato River. They filed claims to the Waitangi Tribunal citing numerous breaches of the Treaty of Waitangi, culminating in the Waikato River settlement signed on 22 August 2008 between the tribes and the Crown in relation to the Waikato River. The Crown accepts that it failed to respect, provide for and protect the special relationship the tribes have with the River as their ancestor: and accents responsibility. for the degradation of the River that has occurred while the Crown has had authority over the River. A notable feature of the settlement is that it is not about ownership, but rather the focus is on the notion of comanagement across a range of agencies and a unity of commitment to focus on the health and wellbeing of the Waikato River. The main focus of this presentation will be to review the effectiveness of the Waikato River Independent Scoping Study which will be completed by 1 June 2010 and which will identify restoration scenarios and priority actions by bringing together indigenous knowledge and knowledge systems and western science

SESAN RIVER : LIVE LIVELIHOOD AND FLOOD PROBLEMS

ΤΕΚ VANNARA

Culture and Environment Preservation Association (CEPA)

Session – Poster (Electronic)

In 2009 villagers found repeatedly difficulty with flood, so this research was established to study the villagers' livelihood and the impact of the flood in 2009 on villagers along Sesan River in Stung Treng province. The objectives of this research are to determine social economic situation, the negative impacts from the flood and to produce a document for sharing to stakeholders to find solutions. This research methodology is using a checklist to interview villagers and authorities and observing by the community committees. The study focuses on 15 villages along Sesan River in Stung Treng province. 175 samples were selected. As a result this study determines after the villages have been flooded every year, the villagers' employment is changed. The income from farming is decreased from 30-40%. The fishing is only for supporting the family. There were many changes in the village after having been flooded such as the rice was rotten very year. Famers have to leave the farm to find the new place for living. They lost fishing equipment and other equipments that they use in the family. In addition, when there is a flood, the villagers get diseases. In conclusion, most of the people livelihoods depend on natural resources.

THE CONDAMINE-BALONNE DECISION SUPPORT SYSTEM

THEW Peter, GOUWELEEUW Ben, LERAT Julien, TICEHURST Catherine, WALKER Gavin

CSIRO

Session – Poster (Hard & Electronic)

The Condamine-Balonne catchment is an area in Southern Queensland of approximately 140,000 square kilometres. The catchment is located at the upper reaches of the Murray-Darling river system and forms an important recharge area for that system. The CSIRO "Condamine-Balonne" project has the goal of developing a prototype decision-support system to continuously generate flow forecasts for the river network. To date, forecasting models are run on an ad-hoc basis to provide support for the development of water management policies, or in response to events such as flooding. The project investigates to what extent these "scenario-"based" models are suitable and robust enough to be used to generate continuous flow forecasts. The existing Sacramento and IQQM models, as used by the Queensland Government, have been taken and integrated into the Flood Early Warning System (FEWS) modelling framework. The final configuration will consist of 25 model instances, a data assimilation model to correct forecasting errors, an uncertainty processor to identify errors, and data feeds from Queensland and the Bureau of Meteorology. Forecasts will be generated every 6 hours along with an uncertainty assessment

ASSESSING RIVER HEALTH IN THREE BATTLEFIELD NATIONAL PARKS IN THE UNITED STATES

THOMAS Jane, DENNISON William, CARRUTHERS Tim

University of Maryland Center for Environmental Science

Session - C2E

As part of a nationwide effort by the National Park Service in the USA to assess natural resource conditions in 270 national parks, three battlefield parks (Antietam, Monocacy, and Manassas National Battlefields) were assessed. Despite being cultural resource parks (they were sites of battles in the US Civil War), they also contain significant natural areas such as rivers, wetlands, forests, and grasslands which often function as natural 'oases' in the desert of suburban and exurban development surrounding the nation's capital. In partnership with natural resource staff at the parks, appropriate metrics (dissolved oxygen, nutrient concentrations, etc.) were developed for each park and then ecologically relevant thresholds were applied. Data were measured against these thresholds and then the habitats were ranked from healthy to degraded. A river runs through each park, and consistent metrics allowed for comparison of the condition of these three rivers. Condition varied from fair to good to very good, and this appeared to be related to the size of the catchment and also the proportion of the catchment that was upstream of the park and therefore impacting the water quality within the park. Management priorities and goals will also be presented.

ANSWERING THE RESEARCH QUESTIONS TO BECOME A WATER SENSTIVE CITY

TORRE Antonietta

Department of Water WA

Session - A3A

Research and development of approaches for best practice urban water management suitable for Western Australian conditions has been identified as one of the highest priority water research areas in the State. The interaction of surface water and groundwater on the Swan Coastal Plain and importance of groundwater for public and private water use presents unique challenges and opportunities for urban water management. This paper will outline the urban water research priorities for Western Australia and how these priorities are being addressed. An update on research being undertaken to advance Perth's progression towards a water sensitive city will be presented. The water sensitive approach to stormwater management in Western Australia aims to maintain the predevelopment hydrologic regime. This aim can be achieved by retaining rainfall from frequent storm events 'at-source'. Research into at-source retention technologies, including biofiltration systems and rainwater storage systems, will be presented. Distributed retention and detention systems throughout the catchment will manage the quantity and quality of urban stormwater before it reaches receiving water bodies. This paper will highlight design criteria and approaches that have been developed to ensure Perth has sustainable and integrated urban water management outcomes and becomes a water sensitive city.

MONITORING TO DEMONSTRATE A DIFFERENCE

TOWNSEND Anthony, BOYS Craig

Industry and Investment NSW

Session - A2B

The implementation of demonstration reaches is critical to the success of the Murray-Darling Basin Authority's Native Fish Strategy (NFS), which aims to enhance native fish populations throughout the Basin over the next 50 years. Demonstration reaches promote the need for holistic river rehabilitation to restore fish assemblages, showcasing multiple management techniques and enhancing public awareness and involvement. Demonstration reaches also play a crucial role in refining guidelines for the restoration of rivers elsewhere in the Basin. To assist in refining management guidelines and determine the effectiveness of rehabilitation activities, an effective monitoring and evaluation program is essential. A scientifically-robust and cost-effective ecological monitoring framework has been developed that allows reach-scale cumulative changes to be monitored, as well as intervention-based monitoring that determines the effectiveness of individual management actions By adopting a standardised approach to the monitoring and reporting of demonstration reach activities across the Basin, the NFS is attempting to develop a Basin-wide perspective on river rehabilitation that encourages interstate cooperation with respect to natural resource management, whilst minimising research duplication. The monitoring of demonstration reaches also has an important role to play in demonstrating the effectiveness of rehabilitation actions to the community and assessing their understanding of the concept.

AN INTRODUCTION TO NEW. COST EFFECTIVE SATELLITE IMAGING TECHNOLOGY FOR DETECTION OF CYANOBACTERIA BLOOMS. CHLOROPHYLL-A, E- COLI, TOTAL VEGETATION COVERAGE AND SEPTIC LEAKAGE IN INLAND WATERS

TUCKER Scott

Clearwater Lakes and Ponds Ptv Ltd

Session - Poster (Electronic)

An introduction to new satellite imaging technology used to detect the presence, location, and concentration (down to parts per billion) of early Cyanobacteria blooms in the world's lakes, streams, rivers, ponds, and reservoirs. Early detection lowers chemical treatment costs and reduces damage to the water body. Satellite imaging can efficiently provide numerous data points as compared to conventional sampling methodology and as such is low cost by comparison. This technology has been ground truthed based on grants from NASA and NOAA in the US. Satellite imaging is key to improving the safety and quality of the world's drinking water supply and recreational use waters because it enables water body managers to view the status of the entire water body as opposed to point samples. This technology can also detect total Phosphorus on land and in water, Ch-a, E Coli, total vegetation coverage, and septic leakage. Images have been archived since 1982, as such; a historical perspective of a water body can be obtained for trend analysis.

COMPARISON BETWEEN EAH BOOKS OF MUNICIPAL WASTEWATER AND CARBON DIOXIDE

TSUZUKI Yoshiaki

Shimane University

Session - B2C

The concept of environment accounting housekeeping (EAH) books of domestic wastewater is derived from those of carbon dioxide (CO₂). However, water quality is more complicated than the single air quality parameter. CO₂ emission is estimated based on consumption of electricity, gas, water and so on and can be linked to household expenditures. On the contrary, municipal wastewater discharges are estimated based on the standard or average pollutant discharge amounts per capita and subtracted depending on the "soft interventions" in households. Therefore, municipal pollutant discharge reductions and household expenditures are not simply related in the current form of the EAH books of municipal wastewater. The economic aspects of municipal wastewater pollutant discharge include household expenditure decrease by decreasing detergent usage amount and a little increase of solid waste amounts by decreasing direct discharge to wastewater collection and using paper or rug to wipe out dishes and cooking apparatus. These kinds of economic aspects are discussed in the presentation. As we presented in the Symposium last year, the Social Experiment Program (YSEP) has been conducted in the Yamato-gawa River Basin, Japan, since 2005 to reduce municipal pollutant discharge and to improve river water quality. The economic aspects are considered based on YSEP

CLIMATIC VULNERABILITY AND DEVELOPING A LEADERSHIP NETWORK IN HIMALAYAN MOUNTAINS

VAJPAI KASHINATH, RAUTALA Gajendra

Prakriti, a Mountain Environment Group

Session – Poster (Hard)

Unlike other parts of the World, the Himalayan Mountains remain neglected in many ways by various national and international agencies.

The ongoing rapid economic growth and the changes thereon in consumption patterns are drastically changing the nature and scale of impact on the India's environment and natural resources. The pace of urbanization and high industrialization has also lead to major pollution sources, deteriorating the quality of water, soil and air, leading to major health hazards, economic losses and poor quality of environmental in majority of towns. In response to the experiences from ongoing city development planning process under National Urban Renewal Mission-JNNURM in India, a study was commissioned in October 2009 understanding that, there had been less focus on different environmental sustainability measures. This study developed a set of practical 120 environmental indicators on various environmental considerations and suggests that, these must be incorporated during any city development planning process. These indicators were developed as a result of thorough consultation with various stakeholders and expert institutions. The process considered institutional, implementation and operational issues of a city planning process. The important indicators covered 7 major aspects i.e. Water, Waste Water, Solid Waste, Sanitation, Air pollution, Renewable Energy and Community Participation. This paper discusses all the developed indicators in general with its elaborated focus on water, waste water and sanitation

India is known for its 1 billion plus and-still-growing population at around 2 percent per annum from the latter part of the 20th century. The heavy investments have been made on water supply, management and conservation issues since 80s, but the resulting environmental and socio-economic benefits have been severely limited. Most of its water sources and tributaries are polluted, whereas the ground water in vast 🧑 areas is suffering from high level of natural contaminants. The easy access to safe drinking water and improved sanitation facilities remains a challenge in India. About 0.2 million habitations, out of a total of 1.423 million habitation in the country, are estimated to have one or the other, or 🤗 combination of more than one contaminant in different water sources and their numbers are gradually increasing due to indiscriminate, unscientific and over-exploitation of ground water and surface water sources for different uses. Although water management in India has already been decentralized but the integrated water management and integration in different sectors seems a major issue. Despite increasing allocation of

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In this region, the governance system is dysfunctional and various leading government, inter government and research institutions are not playing their role effectively. Empirical evidences have shown that the region is already in the state of crisis, affecting the vulnerable population due to various environmental problems. A number of coalitions, regional cooperation and initiatives are working in project mode, so the efforts not sustainable. Investments are being made towards sustaining development with environment, however, the results are not only deficient in making a difference, but also poor in quality and outreach. There is missing and disconnected leadership in Himalayan region, whereas, a sheer knowledge gaps and lack of understanding on various climatic issues, and no adequate shared understanding about the regional problems as a whole, and no map of potential risks. The need of Climate Himalaya Initiative (www.climatehimalaya.net) is felt due to evident climatic vulnerability and extremes in the Himalavan Mountains, which is steadily taking toll in terms of water related hazards, biodiversity losses, ecosystem dysfunction, looming livelihood opportunities and high migration. The Climate Himalaya Initiative was initiated in early 2010, and it works on the principles of reform in the present environment governance system in Himalayan Mountains and envisages developing; an interactive platform of various stakeholders on various climate change issues, scientific and practitioners database, a vibrant leadership network and develop the capacities of people and organizations.

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ENVIRONMENTAL INDICATORS: MEASURING URBAN DEVELOPMENT PLANS: A CASE FROM INDIA

VAJPAI Kashinath, MAHESHWARI VAJPAI Bhawna

Prakriti, a Mountain Environment Group

Session - C2D

HOW TO MANAGE WATER THROUGH AN IWRM APPROACH- A CASE FROM INDIA

VAJPAI Kashinath, MAHESHWARI VAJPAI Bhawna

Prakriti, a Mountain Environment Group

Session – Poster (Hard & Electronic)

financial resources, there are serious concerns around the sustainability of investments made in the water resource sector and integrating water management. A number of studies has proved the possibilities to initiate and maximize potential benefits through IWRM approach. In India the main management challenge seems not the vision of integrated water resources management but a pragmatic but principled approach that goes through principles of efficiency, equity and sustainability. This paper sets out further discussion and analyzes upon water management problems, IWRM understanding, approaches and key challenges and proposed actions-the ways forward.

NEW MONITORING SYSTEMS TO IMPROVE RIVER MANAGEMENT FOR A MORE ROBUST FUTURE

VAN DIJK Albert

CSIRO Land and Water

Session – C4A

Adaptive water management requires comprehensive and up to date knowledge of water resources availability with accuracy and local detail. Such data is not widely available and what is available has to be collected from a variety of sources and generally takes too long to interpret for use in operational management. The Australian water resources assessment system is a new national monitoring system developed by CSIRO Water for a Healthy Country and the Bureau of Meteorology. It integrates measurements received from on-ground water measurement networks and from satellites into hydrological models, providing detailed, near-real time water balance analyses. The water balance information produced is comprehensive, describing water resources in the soil and landscape, regulated and unregulated rivers and in groundwater systems. The system will support Bureau information services, including the National Water Account and scheduled and occasional water resource assessments. Example insights that can be derived from this information and some of the ways in which it can support robust water resources management are presented

DEVELOPMENT OF ASIAN RIVER RESTORATION NETWORK FOR KNOWLEDGE SHARING

WADA Akira¹, SAGO Junzo², NUMATA Sayumi², GOTO Katsuhiro²

CTI Engineering Co LTD¹, Foundation for Riverfront Improvement and Restoration²

Session - C2D

This paper studies several recent cases of river restoration project in Asian countries, and introduces new networking activities, "Asian River Restoration Network (ARRN)", established by Korea, China and Japan in November 2006. Previous trends of river restoration efforts in Japan can be summarized as: initiation of water quality survey in the 1950s. improvement of sewage systems in the 1960s, improvement of water amenity since the 1980s, consideration for ecosystems since the 1990s and restoration of the nature itself since 2000s. Not only in Japan but also in different parts of Asian countries, projects related to river restoration have been implemented with a similar approach. Thus, Asia has been accumulating a rich experience in river restoration as well as the revitalization of the relation among people, river and city in urban areas. The countries in the Asian monsoon region have much in common as to their natural and social environment, including deterioration of living environment due to rapid urbanization, concentration of the population into low-lying areas, not to mention meteorological characteristics. To realize this, there is a growing demand for frameworks for sharing and exchanging techniques, information, experiences and lessons that are beneficial to each county and region.

CLIMATE IMPACTS ON FLOW IN RIVERS DOWNSTREAM OF TROPICAL RAINFOREST

dominated by the water balance of these rainforests and newly available

WALLACE Jim, McJANNET David

Session - D1A

CSIRO

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Many rivers in north-east Australia are in catchments whose headwaters are covered in tropical rainforest. Downstream flows are therefore

models of their evaporation losses have been used along with long term weather records to predict how flows may change under a range of future climate scenarios. Following recent climate change modelling for the region, future rainfall change was assumed to fall within the range 20% and temperature to increase by 1 to 3K. Using these scenarios as inputs to the rainforest water balance models we found that changes in runoff were much greater than changes in rainfall, the 'amplification' ranging from 1.5 to 5 times in the wet and dry seasons respectively. Changes in wet season rainfall could therefore have a major effect on downstream flooding. Although wet season rainfall dominated the total annual amount of downstream flow, dry season rainfall changes are also very important as they affect the timing and duration of the period when there is no runoff from the rainforest. These changes may have significant impacts on downstream freshwater biota whose life cycle is adapted to the current drv season flow regime.

RIVERBANK: ENVIRONMENTAL WATER RECOVERY AND USE IN NSW

WALPOLE Sandra, ENDERS Graeme

NSW Department of Environment, Climate Change and Water

Session - C2E

Water buy-backs have become an accepted means for the market-based recovery of water entitlements, with the aim of meeting environmental objectives and targets to achieve the sustainable management of waterdependent ecosystems. In 2005 the New South Wales Government established RiverBank, a \$101.5 million program to buy water for NSW's most stressed and valued inland rivers and wetlands, with an additional \$46 million provided by the Commonwealth Government. RiverBank was the first large program initiated to purchase environmental water entitlements in Australia, with 98 Gigalitres recovered to date. Water purchased by RiverBank has been released into a number of NSW wetlands including the Macquarie Marshes, Lower Murrumbidgee (Lowbidgee) wetlands, and the Gwydir and Gingham wetlands. This adaptive environmental water has supported river flow conditions necessary for waterbirds, frog breeding and fish spawning and migration events, as well as improving the health and condition of severely stressed native wetland vegetation. RiverBank will also trade some annual water allocations where this is consistent with its environment and business objectives. In doing so this will improve the ability of the market to achieve an economically efficient distribution and use of water for the environment over time.

SYSTEM VIEW OF CLIMATE CHANGE AND HYDROLOGICAL CYCLE IN A SMALL RIVER BASIN

WANG Xiaojun, ZHANG Jianyun

Nanjing Hydraulic Research Institute

Session - D1D

Everything in the real world does not exist in isolation from one another, as water resources is an integral part of the socio-economic-environmental system, also has dynamic interactions among the related social, economic, environmental, as well as regulatory factors, which are characterized by non-linear and multi-loop feedbacks. In this paper, we set up a complex system dynamic (SD) model focusing on the relationship between the Hydrological Cycle and Climate Change based on System Dynamics theory. The model mainly includes factors like climate change, water demand, water supply, surface flow, groundwater, economic development and population growth, and the practice process is demonstrated by taking Kuye River in northwestern China as a case. Results showed that climate change has an impact on water resources in the basin distinctly, and in the future, the situation seemed more different to deal with, so it is mercenary to bring up a new method for water management.

STUDY AND EVALUATION ON ENVIRONMENTAL FLOWS IN YELLOW **RIVER DELTA WETLAND**

WANG Xingong¹, LIAN Yu²

Yellow River Water Resources Protection Institute¹, Yellow River Water Resources Protection Bureau²

Session - B3A

Based on the principles of protecting integrity and stability of ecosystem, and aimed at improving the capacity of the ecosystem and protecting biodiversity, this study identified 23,600 ha wetlands as restoration scale which urgently needed to be supplied with freshwater in the Yellow River Delta. With the support of RS and GIS and wetlands plant physiology, ecology and hydrology, and using the principle and methodology of landscape ecology, the coupling mechanism between water and ecological process in wetlands was studied, and the environmental flow calculation and evaluation models were established, and scenario methodology and landscape ecology decision & evaluation support system were applied to forecast and evaluate ecological effects and changing of ecological landscape pattern in wetlands in different water supply scenarios. The results show that the wetlands of Yellow River delta have the potential to be the habitat for rare birds (Red-crowned crane, Oriental stork, etc.), but the present habitat quality is not good, and after supplying water to wetlands, its habitat quality and ecological carrying capacities will increase notably, and considering all restricted factors. 0.35 billion m³a⁻ ¹ freshwater was proposed in this study as a suitable required water to restore and protect the Yellow River Delta wetlands ecosystem.

WATERCAST CATCHMENT WATER QUANTITY AND QUALITY MODEL -DEVELOPMENT TO APPLICATION

WATERS David¹, COOK Freeman², JORDON Phil³, RAHMAN Joel², WALLBRINK Peter², WEBER Tony⁴, RYAN Melanie⁵, MILLER Alexandra⁶

eWater CRC¹, CSIRO², Sinclair Knight Merz³, BMT WBM⁴, University of Canberra⁵, QLD Department of Environment and Resource Management⁶

Session - A2C

The current water resource environment in Australia is complex. Issues are broad ranging from sharing of water resources between traditional water users and the environment to the need for catchment water quality targets. This complexity has necessitated the development of whole-of-catchment modeling approaches to improve the management of the water resource. The plethora of simulation tools available were often developed with a very specific application in mind, with limited applicability elsewhere. The eWater CRC's Watercast catchment scale water quantity and quality model was developed with the flexibility to meet the broader needs of the water industry. To ensure its wider applicability across Australia, Watercast was tested, applied and modified to meet the needs of industry partners through eight eWater "Applications Projects" addressing real world problems across Fastern Australia, Unique aspects of the eWater approach to software tool development include a common model engine for all products with different user interfaces, enabling true model integration. Research, product development and application of the software occur concurrently to ensure user requirements are met from the outset. The flexible approach to model construction means that models can be built at a scale and level of complexity suited to the problem and needs of the user. The unique approach to model development undertaken by the eWater CRC has ensured that Watercast (to be released in 2010) and the range of eWater software tools will meet the needs of the Australian water industry into the future.

A RIPARIAN PARADOX

WEAVER David

Department of Agriculture and Food Western Australia

Session - D1B

Many studies support the model that riparian vegetation provides physical filtering and trapping of particulate nutrients in surface runoff, but few test this models assumptions. Assumptions are that catchments are surface runoff dominated, nutrients are transported in particulate form, and riparian programs target locations that can provide water quality changes. This paper reviews studies that challenge these assumptions, demonstrates the benefits of riparian management in reducing sediment transport, but suggests that riparian buffers have little capacity to reduce P exports in catchments with sandy soils. Ignoring subsurface transport pathways could lead to significant over-estimation of the effectiveness of buffers in this environment. Significant amounts of P are transported in soluble form via leaching and subsurface pathways, hence riparian management for P control is a paradox. If riparian management functioned according to conventional models, the focus of that management in these catchments will have little impact on water quality as it is not directed to parts of the stream network where nutrients are derived, or where large changes in riparian condition can be attained. Changes in nutrient form

The health of *Palaemonetes australis* in drains discharging to the Swan Canning Estuary was assessed. A suite of biomarkers of health was validated for use in this shrimp by laboratory exposures to a known genotoxicant, benzo[a]pyrene. Laboratory results show positive responses by the shrimp, confirming its suitability as a bioindicator of health of crustaceans in the field. Shrimn from summer and winter sampled drains. show evidence of health impacts including endocrine disruption (intersex) with Ellen Brook and Southern River the most impacted sites. Summer sampling at Southern River coincided with herbicide use to control cotton bush. Biomarker results demonstrate a change in practice is required for weed control adjacent to waterways. All drains sampled had a strong bias towards females and intersex was above the incidence expected in crustaceans. Bayswater Main Drain appeared least impacted however: a female bias at this site possibly obscured negative effects. DNA repair mechanism seemed affected at this site. Biomarker and intersex results recorded in the freshwater shrimp have implications for the long term health of western school prawn populations. Further studies required into impacts on crustacean communities, impacted by anthropogenic stress, due to predicted changes in the estuarine environment due to a warming and drving climate.

On 26 January 2010 the resident population of Australia was 22,130,912. Australia's population is currently increasing at the rate of one person every 1 minute and 11 seconds. The Australian Bureau of Statistics (ABS) forecasts that by 2056 Australia's population could reach 42.5 million (ABS 2008). Should this become reality (and the current growth rate suggests it will) the infrastructure, housing, work and social opportunities which define Australia's current quality of life will need to be doubled. And yet, as we know, we need to simultaneously reduce our ecological footprint. The Australian dream of a house and garden in a suburban milieu has never been in greater demand and its sustainability never more tenuous. Whereas in the 19th century and early 20th century rampant urban growth was a sure sign of progress, the progressive city of the 21st century will be one that can adapt effectively to environmental limitations and infrastructural overload. But cities are cumbersome, deeply entrenched structures and urban planning is often a blunt, bureaucratic instrument of change. The challenges of 21st century urbanism require new means of inspiring and effecting change. Above all, the challenges of 21st century urbanism require creativity. This presentation offers an overview of potential national settlement patterns into the future and also a scenario based case study concerning the future of Perth, Western Australia. Whilst not exclusively about rivers, this presentation is designed to provide an overarching context for other deliberations regarding Australia's future.

Changes in land use including urbanisation and intensive agriculture have resulted in the accumulation of a substantial inventory of nutrients within the Swan-Canning catchment. The presence of excess bioavailable nutrients is a major factor leading to the eutrophication of natural

from particulate to soluble as a result of riparian restoration brings into question the common interpretation of water quality data as representing the processes by which nutrients are lost.

IMPLICATIONS OF EXPOSURE BY RUNOFF TO CRUSTACEANS IN THE SWAN CANNING CATCHMENT

WEBB Diane

Curtin University

Session - A3D

AUSTRALIA: THE CITY. CREATIVELY RECONCILING GROWTH WITH ENVIRONMENTAL LIMITATIONS IN THE 21ST CENTURY

WELLER Richard

University of Western Australia

Session – A4

EVALUATION OF MINING BY-PRODUCTS FOR NUTRIENT AND CARBON REMOVAL

WENDLING Laura¹, DOUGLAS Grant¹, COLEMAN Shandel¹, YUAN 📿 Zhena²

CSIRO¹, Wuhan University of Technology²

Session - B3D



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Abstracts

waters and the resultant degradation in water guality. Effective removal of nutrients and other contaminants from the catchment is essential to effective long-term management of the Swan-Canning river system and the adjoining estuary. The use of abundant, mineral-based by-products as filtration media within constructed wetlands, permeable reactive barriers, drainage channels, or as sorptive media within other nutrient intervention schemes offers a potentially cost-effective solution. The objective of this study was to evaluate optimised mixtures of mineral-based by-products for application to in-situ water treatment schemes for management of dissolved organic carbon (DOC) and nutrients within the Swan Coastal Plain. Large-scale column trials were conducted using water from Ellen Brook, a significant source of nutrient and DOC input to the Swan-Canning river system. Critical material performance indicators included nutrient and organic carbon uptake capacity, transformations and stabilisation. If appropriate low-cost materials can be identified, a prospect exists to further evaluate their efficacy in field trials.

SOUTH WEST CATCHMENTS COUNCIL COASTAL ENVIRONMENT HOTSPOT PROJECT- PEEL REGION

WRIGHT Jamie

South West Catchments Council

Session – Poster (Electronic)

The South West Catchments Council is a community representative body that coordinates natural resource management (NRM) in the South West region of Western Australia. The South West Catchments Council's Peel Region-Coastal Environment Hotspot Project is funded thought the Australian Government's Caring for Our Country. Significant parts of the wetlands of the Ramsar listed, Peel-Yalgorup System have been lost to clearing and infilling, with much of the remaining wetlands heavily modified. Extensive drainage for agricultural and urban development has also put significant stress on the system. SWCC's landscape-scale approach to managing these valuable natural resources is working towards addressing nutrient enrichment, declining water quality and algae blooms. The Coastal Environment Hotspots project will strategically implement priority actions identified in the "Water Quality Improvement Plan for the Rivers and Estuary of the Peel- Harvey System - Phosphorus Management" (Environment Protection Authority, 2008), and associated river and wetland action plans; implement on-ground works such as riparian management, invasive pest and weed control and coastal rehabilitation; address critical threats to Ramsar values and Commonwealth listed Threatened Ecological Communities within these hotspots. Threats include invasive pests, weeds and loss of fringing vegetation; and target Weeds on National Significance such as Blackberry, across the Peel-Harvey Catchment. Engaging land managers, both public and private, through education, technical advice and on ground works is the key to the projects success. SWCC, as part of this project, is working in partnership with the Department of Environment and Conservation as well as the Peel Harvey Catchment Council. SWCC is also running complementary programs in partnership with the Government of Western Australia's Fertiliser Action Plan to work with farmers to improve nutrient management on farms in the Coastal Hotspots.

SOUTH WEST CATCHMENTS COUNCIL - COORDINATING NATURAL RESOURCE MANAGEMENT (NRM) IN THE SOUTH WEST, WA

WRIGHT Jamie, LEWIS Emily

South West Catchments Council

Session - Poster (Hard)

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South West Catchments Council is a community representative body that coordinates natural resource management (NRM) in the South West region and is the recognised NRM regional body for the South West of WA. As such SWCC administers allocated regional funding provided by the Australian Government under the Caring for our Country program.

MAPPING SALINITY INGRESS USING GALDIT MODEL

YADAV Sanjaykumar, SAMTANI B, VASAWA Hemant

S.V.National Institute of Technolog

Session - A3F

The coastal tracts in India cover parts of Gujarat, Maharashtra, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal. Besides the Inherent ground water salinity in the coastal tract, Sea water intrusion is also one of the major problems in the coastal region. In certain areas the problem of increasing salinity has also been reported due to overexploitation of ground water. Problem of salinity ingress has been noticed in Minjur area of Tamil Nadu and Mangrol – Chorwad-Porbander belt along the Saurashtra coast. In Orissa, in an 8-10 km. wide belt of Subarnrekha, Salandi, Brahamani out fall regions in the proximity of the coast, the upper aquifers contain saline horizons decreasing landwards. In Pondicherry region east of Neyveli Lignite Mines salinity ingress has also been observed. The Inland Ground water salinity in India occurs mainly in the states of Maharashtra. Puniab. Rajasthan, Haryana, Gujarat, Karnataka, Uttar Pradesh, Delhi, Orissa and Bihar. The occurrence of inland salinity may be due to over exploitation of ground water, use of surface water and ground water in complete isolation, characteristics of aquifer or some other reasons. About 1.93 lakh km² area has been estimated to be affected by saline water of Electrical Conductivity >4000 m S/cm. There are several places in parts of Rajasthan and southern Harvana where EC values of ground water are greater than 10000 m S/ cm making water non-potable. In some areas of Rajasthan and Gujarat ground water salinity is so high that the well water is directly used for salt manufacturing by solar evaporation. In the present paper the salinity ingress over the coastal region of India has been discussed and a case study of mapping of salinity ingress in a South Gujarat region is discussed in particular. To measure the ingress of salinity, GALDIT index has been studied in detail for the South Gujarat region. The GALDIT index is an open ended model allowing the user for addition and deletion of one or more parameters. The parameters used in the model are ground water occurrence (aquifer type), hydraulic conductivity of aquifer, height of ground water above sea water, distance of the location from the sea shore, existing status of sea water intrusion and thickness of the aquifer. The GALDIT index for the study region is worked out to be 7.11 which is very high and immediate measures to control the salinity ingress are required. The authority proposed construction of "balloon dam "- a fresh water reservoir in the study region which will increase the rate of recharging and reduce the salinity ingress to a great extent. The case study discussed here can be an useful tool world wide to check ingress of saltwater in the coastal region.

MANIPULATION OF WATER LEVELS OF THE UPPER MISSISSIPPI RIVER FOR HABITAT DIVERSITY: A CASE STUDY OF COLLABORATION AMONG DIVERSE STAKEHOLDERS

YIN Yao¹, BENJAMIN Gretchen²

United States Geological Survey Upper Midwest Environmental Sciences Center $^{\&2}$, The Nature Conservancy Great Rivers Partnership^2

Session - C2B

The Upper Mississippi River (UMR) flows through five states in the Upper Midwest of the United States of America. Historically, the water level of the river was controlled during low flow seasons for the sole purpose of sustaining a 2.75 meter (9 feet) commercial navigation channel. Controversies over some practices of channel maintenance and expansion resulted in expensive legal actions in the 1970s. In the mid-1990s when the distribution of aquatic vegetation in the UMR was fluctuating at levels substantially lower than in previous five decades, river managers proposed to lower the river's water level (drawdown) during one or two summers to jump-start the recovery process. However, deviation from the usual flow prescription would inconvenience certain uses of the river, therefore, creating grievances or even triggering legal action. The presentation will share the experiences of managing water levels on the UMR from conducting demonstrations to the development of a system prescription to manipulate water levels to promote habitat diversity. It will also connect how efforts like these have lead to desire to work for a shared intergenerational vision for the entire Mississippi River Basin and a recent summit meeting as a first step toward the development of this vision.

RIVER HEALTH ASSESSMENT IN TAIZI RIVER

YUAN Zhang, QU Xiadong, KONG Weijing

Chinese Research Academy of Environmental Sciences

Session - A2C

China's rivers are facing serious threats from pollution, reduced environmental flows, river habitat destruction and altered catchment land use. River health assessments provide a scientific measure of ecological condition, and are a valuable tool for evaluating the effectiveness of management interventions, and prioritising river restoration efforts. China has yet to establish a national approach to river health assessment and reporting. It is envisaged, that the development of a national assessment and reporting methodology would strongly encourage better environmental and pollution control outcomes for China's rivers. With the support of the Australian Government's AusAID funded Australia China Environment Development Partnership Project "River Health and Environmental Flows in China" a river health assessment pilot program was undertaken in the Taizi River basin, a tributary of the Liao River in China's northeast. The Taizi River health assessment project consisted of a field-based trial to test a range of potential river health indicators across the upper, middle and lower reaches of the river system, and over two seasonal sampling events in May and August 2009. The response of each indicator was then assessed against a known human disturbance gradient and as a result a comprehensive river health index based on fish, benthic macroinvertebrates, algae, riparian vegetation condition, geomorphology and water quality has been used to report on river health conditions of the Taizi River

DROUGHT AND THE ENVIRONMENT PROTECTION ACT - BALANCING EMERGENCY WORKS, ENVIRONMENT AND LAW

ZAMMIT Benjamin

Environment Protection Authority

Session - Poster (Hard & Electronic)

The current drought across the Murray Darling Basin has seen record low water levels in South Australia below Lock 1. To better inform management decisions across the Lower Lakes, the South Australian Environment Protection Agency (EPA), is monitoring water quality in the Lower Lakes for any environmental impacts associated with the declining water levels and the exposure of acid sulfate soils. Since August 2008 water and air samples have been taken fortnightly at sites across Lake Alexandrina, Goolwa Channel, Currency Creek and Finniss River tributaries, Lake Albert and Lake Alexandrina. Drought mitigation works that impact on water quality include dredging, building of flow regulators and weirs, liming of acid water, planting of drying lake beds, and disposal of dead fish. Approvals must be sought from the EPA before any soil is removed or deposited in a water body, this means that the EPA conditions all government works to ensure the lowest risk to the environment. Monitoring programs are tailored to provide timelines for intervention, such as when to apply lime, when to increase or maintain water levels to prevent the further drying out of acid sulfate soils and when to remove fish to avoid large scale fish kills



Quick Reference Guide - Oral Presentations

Last Name	First Name	Program Focus	Session	Day	Time	Room	Country	Speakers Paper Title	
ADKINS	Peter	Rivers & catchments	A2F	Mon	11:00	Astral 3	Australia	The drainage nutrient intervention program: a case study in drainage improvement	
AHEEYAR	Mohamed	Community	A2E	Mon	11:00	Astral 1	Sri Lanka	Innovative strategy in participatory water management- a case of bulk water allocation from Sri Lanka	
AMIS	Мао	Case study	B1	Tues	08:30	Grand Ballroom	South Africa	Rivers of the Cape	
ANNAN	Katrina	Water sources	C3E	Wed	13:30	Grand Ballroom	Australia	Groundwater-surface water interactions along the Brunswick River, Western Australia	
APPELS	Dave	Policy & regulations	A3C	Mon	14:00	Grand Ballroom	Australia		
BANSUAN	Abdula	Climate change	B3C	Tues	13:30	Botanical 3	Philippines	Climate change and watershed degradation: community impact and adaptation	
BARR	Anthony	Water sources	C3E	Wed	13:30	Grand Ballroom	Australia	Temporal and spatial groundwater contributions to the Southern River (WA) based on MODHMS modelling	
BAUR	Tobias	Rivers & catchments	A2F	Mon	11:00	Astral 3	Singapore	Rejuvenation of a canal into a natural river – a case study: Kallang River along Bishan Park	
BAXTER	Cassy	Rivers & catchments	C3D	Wed	13:30	Botanical 1	Australia	Lake Illawarra: back from the Murky Brink	
BEATTY	Stephen	Water sources	C3E	Wed	13:30	Grand Ballroom	Australia	Groundwater intrusion maintains endemic freshwater fishes in south-western Australia	
BIRD	Chris	Rivers & catchments	B2B	Tues	10:30	Astral 1	Australia	Setting the scene: status report on native fish distribution in Western Australia	
BOBBI	Christopher	Rivers & catchments	D1E	Thurs	08:30	Astral 2	Australia	Linking flow and ecology: making better environmental water allocation decisions in Tasmania	
BONNELYE	Veronique	Water for mining industry	B3D	Tues	13:30	Astral 2	Australia	New Source Of Water For The Industry: From Reuse To Seawater Desalination	
BRAAT	Leon	Keynote	A1	Mon	09:00	Grand Ballroom	The Netherlands	Social and economic consequences of global post 2010 biodiversity policies	
BRAIMBRIDGE	Mike	Policy & regulations	A2A	Mon	11:00	Grand Ballroom	Australia	Practical management of environmental water: case studies of two iconic groundwater based systems – Gnangara aguifer and	
		, 3						wetlands (north of Perth) and Millstream aquifer on the Fortescue River(Pilbara)	
BRICEL I	Mitia	Rivers & catchments	C2B	Wed	10:30	Astral 1	Austria	Management of a large international river basin – The Danube	
BROOKES	Helen	Community	B2C	Tues	10.30	Botanical 3	Australia	Case Study – Murray drainage and water management plan	
	Gavin	Rivers & catchments	C2F	Wed	10.00	Actral 2	Australia	Movement natterns and flow requirements of five fish species from the Clarence River Australia	
CAMKIN	loff	Community	CSE	Wed	13.30	Rotanical 3	Australia	Learning to addrose complex challenges: lessons from Australia and Europe	
	Kava		100	Mon	14.00	Actrol 2	Australia	Development and waterways - can they both be winners?	
	Staphania		AJA ADD	Mon	14.00	Rotanical 2	France	Development and waterways - can they both be winners:	
	Stephanie		AZD DOD	Tues	12.20		Australia	Demonstrating a universite	
	Jane	Rivers & catchments	DOD	Tues	10:00	Astral 3	Australia	Developing nother thresholds for macrophyte of algat dominance in rivers and estuaries	
CHILDS	Paul	Rivers & catchments	B3A	IUes	13:30	Astral	Australia	Developing a wetland management plan for Yanga National Park	
CHINN	Chris	Water sources	AZU	Mon	11:00	Astral 2	Australia	Paddock to Reef program – measuring progress towards the Reef Plan Goals and targets	
CHUNG	Laroline	Rivers & catchments	AJF	Mon	14:00	Botanical I	Australia	Dispersal, connectivity and invasion in regulated rivers: the movement dynamics of riverine weeds	
CHUWDHURY	Rezaul	Rivers & catchments	C4F	Wed	16:00	Botanical 3	Australia	Imperviousness impacts on urban creeks: restoration processes	
COLLINS	Emma	Rivers & catchments	B3A	lues	13:30	Astral I	Australia	Assessing environmental flow induced changes in the Shoalhaven River – optimising the outcomes	
COLLINS	Emma	Community	C3F	Wed	13:30	Botanical 3	Australia	World Water Monitoring Day	
COLMAN	Ron	Water for mining industry	B3D	Tues	13:30	Astral 2	Australia	Water management For The Solomon Project	
COLMAN	Ron	Water for mining industry	C4C	Wed	16:00	Astral 1	Australia	Evaluation of the feasibility of a Solomon sustainable water scheme	
CONNOR	Jeremy	Water for mining industry	C4C	Wed	16:00	Astral 1	Australia	Pilbara bottled water project	
CORDERY	lan	Water sources	C2D	Wed	10:30	Botanical 3	Australia	Effect of political neglect on urban people's access to water	
COSGROVE	Jeff	Rivers & catchments	A3D	Mon	14:00	Astral 1	Australia	The Swan Canning Research And Innovation Program (SCRIP)	
CRASE	Lin	Policy & regulations	A3C	Mon	14:00	Grand Ballroom	Australia		
CUNNINGHAM	Gemma	Community	A2E	Mon	11:00	Astral 1	Australia	Community engagement in the Coorong, Lower Lakes and Murray Mouth Region, SA	
D'ARCY	Clare	Rivers & catchments	C3C	Wed	13:30	Astral 2	Australia	NSW rivers environmental restoration program – improving e-water management in NSW	
DAVIES	Philip	Community	C3F	Wed	08:30	Grand Ballroom	Australia	River Restoration in Global Biodiversity Hotspots undergoing Climate Change	
DAVIES	Peter	Climate change	C4A	Wed	13:30	Botanical 3	Canada	Integrating science and restoration: community stewardship in the Lake Simcoe Watershed	
DAVIES	Peter	Climate change	D1A	Thurs	16:00	Grand Ballroom	Australia	Rivers in southwestern Australia: impacts of climate change and methods for optimising restoration	
DAVIS	Richard	Policy & regulations	A2A	Mon	11:00	Grand Ballroom	Australia	Groundwater dependent ecosystems – how well are they accounted for in water plans	
DAVIS	Richard	Rivers & catchments	C4D	Wed	16:00	Astral 2	Australia	Community of Practice for Environmental Water Managers	
DE GRAAF	Martin	Rivers & catchments	A2D	Mon	11:00	Botanical 1	The Netherlands	Barriers and the recovery of european eel	
DEGENS	Brad	Water sources	C3E	Wed	13:30	Grand Ballroom	Australia	Groundwater driven acidity in waterways of the Western Australian Wheatbelt	
DHEERA	Kumudinee	Water sources	B4B	Tues	16:00	Botanical 3	Sri Lanka	Dams to supplement water in water stress rivers-Sri Lankan experience	
DIXON	Nicola	Rivers & catchments	C4F	Wed	16:00	Botanical 3	Australia	An assessment of 7 'Soft' engineered riverbank stabilisation techniques	
DOBBS	Rebecca	Community	C3F	Wed	13:30	Botanical 3	Australia	Strengthening scientific research and management through on-ground community involvement	
DOCKER	Benjamin	, Rivers & catchments	ВЗА	Tues	13:30	Astral 1	Australia	The commonwealth as water holder: a Basin-Wide approach to environmental watering	
DONN	Mike	Rivers & catchments	C4F	Wed	16:00	Botanical 1	Australia	Role of high frequency water quality analysis in confirming catchment hydrology interpretation	
DONOHUF	Robert	Rivers & catchments	C3C	Wed	13:30	Astral 2	Australia	Securing environmental water in agricultural catchments of south-west Western Australia	
D'SOUZA	Frances	Climate change	R3C	Tues	13:30	Botanical 3	Australia	Climate Change Adaptation In West Australian Wetlands And Waterways	D
	Hanooo	Stilleto onango	200	1000	.0.00	Detamouro			

Quick Reference Guide - Oral Presentations *continued....*

	Last Name	First Name	Program Focus	Session	Day	Time	Room	Country	Speakers Paper Title
	EDGAR	Nick	Community	C3F	Wed	13:30	Botanical 3	New Zealand	Farmers as 'movers and shakers' in ommunity–led river management
0	EGERRUP	Marie	Rivers & catchments	D1E	Thurs	08:30	Astral 2	Australia	Monitoring the effect of basslink downstream of the Gordon Power Station
	EN CHEE	Yung	Rivers & catchments	C4D	Wed	16:00	Astral 2	Australia	Building a science-management collaboration for large-scale monitoring o
	ERDMANN	Brenton	Water sources	A3E	Mon	14:00	Botanical 3	Australia	Carp removal at River Murray lock and weir fishways
	EVANS	Rick	Policy & regulations	A2A	Mon	11:00	Grand Ballroom	Australia	Groundwater dependent ecosystems – how well are they accounted for in wa
	EVANS	Sarah	Rivers & catchments	C3D	Wed	13:30	Botanical 1	Australia	Breath of life: artifically oxygenation the upper Swan River estuary
	EVANS	Rick	Water sources	B2D	Tues	10:30	Astral 3	Australia	
D	FENEMOR	Andrew	Rivers & catchments	C3C	Wed	13:30	Astral 2	Australia	Resilient communities, resilient ecosystems: learning about integrated cato
	FINN	Wilf	Policy & regulations	A2A	Mon	11:00	Grand Ballroom	Australia	Providing water for ecosystems in unregulated areas – how well are we doing
	FLAVELL	Donna	Community	C4B	Wed	16:00	Astral 3	New Zealand	Co-management arrangements for the Waikato River – a Waikato-Tainui per
	FORBES	Vanessa	Rivers & catchments	B3B	Tues	13:30	Astral 3	Australia	Understanding hardy inlet – a permanently open estuary under stress.
D	FRANZ DELFAU	Karen	Community	DIC	Thurs	08:30	Botanical 3	Australia	Communicating a watershed message – social marketing and social media
	GAGNON	Monique	Rivers & catchments	A3D	Mon	14:00	Astral 1	Australia	Fish health in Claisebrook Cove
1)	GARDNER	Alex	Climate change	B3C	Tues	13:30	Botanical 3	Australia	Changing character: The Ramsar Convention on wetlands and climate chan
	GEDARIA	Alice	Rivers & catchments	B3B	Tues	13:30	Astral 3	Australia	Patterns in the microbial community structure of the Swan River Estuary, W
11	GIROUD	Marnie	Community	СЗА	Wed	13:30	Astral 1	Australia	Community engagement – River Guardians
	GOUD	VINOD	Community	C3F	Wed	13:30	Botanical 3	India	Improving food security through better water management – community co
	GOUWELEEUW	Ben	Rivers & catchments	C4E	Wed	16:00	Botanical 1	Australia	Validation of satellite-based operational flood monitoring on the lower-Balo
	HALLEGRAEFF	Gustaaf	Rivers & catchments	A3D	Mon	14:00	Astral 1	Australia	What triggers fish-killing dinoflagellate blooms of Karlodinium veneficum i
	HALLETT	Chris	Rivers & catchments	A3F	Mon	14:00	Botanical 1	Australia	A fish-based estuarine health index for the Swan Estuary, WA
	HAMES	Fern	Rivers & catchments	A2B	Mon	11:00	Botanical 3	Australia	Demonstration reaches: engaging with the community
	HAMS	Alex	Rivers & catchments	A2F	Mon	11:00	Astral 3	Australia	Swan Canning water quality improvement plan: development and implemer
	HARDY	Matthew	Rivers & catchments	C2C	Wed	10:30	Astral 3	Australia	Water sensitive urban design: modelling for improved water security and eff
	HARPER	Mike	Rivers & catchments	A2B	Mon	11:00	Botanical 3	Australia	Planning for demonstration reaches – Katfish Reach case study
	HARPER	Richard	Water for mining industry	A3B	Mon	14:00	Astral 3	Australia	Mining and sustainable water use: a WA perspective
	HARRISS-BUCHAN	Arlene	Policy & regulations	A3C	Mon	14:00	Grand Ballroom	Australia	
	HARTMANN	Joerg	Water sources	B4B	Tues	16:00	Botanical 3	Germany	Sustainability performance of hydropower companies
	HARVEY	Michael	Rivers & catchments	C3C	Wed	13:30	Astral 2	USA	Ecosystem restoration in water–short rivers of the western USA
	HAUMANN	Ken	Water sources	A3E	Mon	14:00	Botanical 3	South Africa	Supplementing water supply to Mare Aux Vacoas Reservoir in Mauritius
	HIGHAM	Jason	Rivers & catchments	B3A	Tues	13:30	Astral 1	Australia	How much environmental water is enough for the Lower Murray wetlands? F
	HILL	Christine	Policy & regulations	C2E	Wed	10:30	Botanical 1	Australia	Valuing the economic benefits of reducing Thermal Pollution In New South V
	HINDMARSH	Rosanna	Community	СЗА	Wed	13:30	Astral 1	Australia	Catchment management and behaviour change
	HIPSEY	Matthew	Water sources	DID	Thurs	08:30	Astral 3	Australia	Coupled hydrodynamic-biogeochemical model of the Murray Lower Lakes fo
	HOBAN	Alan	Rivers & catchments	A3A	Mon	14:00	Astral 2	Australia	Retrofitting our cities for sustainable urban water management
	HORNE	James	Policy & regulations	A3C	Mon	14:00	Grand Ballroom	Australia	
	HOURSTON	Matt	Rivers & catchments	B2B	Tues	10:30	Astral 1	Australia	Setting the scene: status report on native fish distribution in Western Austra
	HUDON	Christiane	Climate change	D1A	Thurs	08:30	Grand Ballroom	Canada	Climate change impacts on the St. Lawrence River (Quebec, Canada)
	HUGH	Cameron	Rivers & catchments	B2B	Tues	10:30	Astral 1	Australia	Case study- community involvement in saving the critically endangered Ma
	HUGHES	Justin	Water for mining industry	A3B	Mon	14:00	Astral 3	Australia	The effects of mining on rainfall-groundwater recharge lags in the Northern
	HUGHES	Rod	Community	СЗА	Wed	13:30	Astral 1	Australia	Setting the scene
	HUMPHRIES	Robert	Rivers & catchments	C3D	Wed	13:30	Botanical 1	Australia	Maximising the value of biosolids - catchment and waterway restoration
	JACKSON	Peter	Rivers & catchments	A2B	Mon	11:00	Botanical 3	Australia	The Native Fish Strategy in the Murray–Darling Basin
	JENKINS	Sasha	Rivers & catchments	A3D	Mon	14:00	Astral 1	Australia	Effect of anoxia on water column N cycling
	JIANG	Xiaohui	Rivers & catchments	D1E	Thurs	08:30	Astral 2	China	Integrating environmental flow assessments for the Lower Yellow River, Chi
	JORDAN	Phillip	Water sources	DID	Thurs	08:30	Astral 3	Australia	Explaining declining inflows to Googong Reservoir
0	JORDAN	Phillip	Rivers & catchments	C2C	Wed	10:30	Astral 3	Australia	Managing catchment water quality and quantity
9	KATAI	Othusitse	Rivers & catchments	C2B	Wed	10:30	Astral 1	Botswana	Sharing experience in managing transboundary waters – reflections from th
0	KENDALL	Matt	Water sources	B2D	Tues	10:30	Astral 3	Australia	
• •	KHAN	ANWAR ALI	Community	DIC	Thurs	08:30	Botanical 3	India	Demand driven approach for sustainability of River Action Plan– a case stud
3	KILMINSTER	Kieryn	Water sources	A2C	Mon	11:00	Astral 2	Australia	Assessing acid sulfate soil contamination: a new indicator for waterways
	IZINA.	leonakon	Rivers & catchments	C2F	Wed	10:30	Astral 2	Republic of Korea	Assessment of fish fauna and habitat conditions
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ver, South Korea

Quick Reference Guide - Oral Presentations *continued....*

	Last Name	First Name	Program Focus	Session	Day	Time	Room	Country	Speakers Paper Title
	KIM	Sheung Kown	Water sources	A3E	Mon	14:00	Botanical 3	Republic of Korea	Nakdong River restoration project from the perspective of systems thinking
9	KOBAYASHI	Tsuyoshi	Rivers & catchments	D1E	Thurs	08:30	Astral 2	Australia	Productivity and respiration of plankton communities in a riverine-floodplai
	KRAUSE	Peter	Rivers & catchments	B4D	Tues	16:00	Astral 3	Canada	An introduction to RiverFoundation's twinning program
	KUMAR	Anu	Rivers & catchments	C2F	Wed	10:30	Astral 2	Australia	Treated effluent as environmental flows: concerns and issues from an Austr
	KUMAR	Anu	Water for mining industry	B3D	Tues	13:30	Astral 2	Australia	Current practises in Australian wineries for wastewater reuse: their advanta
2	KUMAR	Mohinder	Water sources	B4B	Tues	16:00	Botanical 3	India	Hydroelectric power developments—a threat to the existence of river, life and
	I AHIRI-DUTT	Kuntala	Kevnote	C1	Wed	08:30	Grand Ballroom	Australia	'Dancing With The River' in Deltaic Bengal: an exploration of river, land and ri
D	LARSEN	Renae	Rivers & catchments	C4F	Wed	16:00	Botanical 1	Australia	WA Native Fish Strategy: freshwater fish distribution database and website
	LAWRENCE	Craig	Rivers & catchments	B2B	Tues	10:30	Astral 1	Australia	Saving native fish from extinction-why bother ? Threatening processes and
	LENGER	lason	Rivers & catchments	B2B	Tues	10:30	Astral 1	Australia	Molecular tools for breeding & restocking programs to save native fish from
		Sonia	Community	C/B	Wed	16:00	Astral 3	Australia	Standing together: a participary model for Indigenous engagement in water
1)		Sonia		B/A	Tucc	16.00	Actrol 1	Australia	Kimberlov opco study: planning and angegement tools in Indigenous comm
		Debases		D4A	Tues	10.00	Astrol 1	Australia	How much apprisonmental water is appriable for the Lower Diver Murray Wetland
		Dunnan		DJA	Thurs	00.20	Astial 2	Australia	Management of water requires in Manik Cange Desig with community wetta
P		Ruwan	Community			10.00	Dotanical S	Shirahka	Management of water resource in Manik Ganga Basin with commonity invol
		Paul	water sources	U2D	vved	10:30	Botanical 3	Australia	Airing the dirty laundry – improving cooperation in SME environmental man
D	LUNGSTAFF	Ben	Water sources	C3E	Wed	13:30	Grand Ballroom	Canada	Progressively detailed subwatershed scale water budgets within the Lake S
	LUVEII	Siwan	Community	A2E	Mon	11:00	Astral I	Australia	Valuing people as 'natural assets' in waterway management
	LUCAS	Anna	Rivers & catchments	D1E	Thurs	08:30	Astral 2	Australia	Prioritise, protect and prove – a Yarra River case study
	LYNNE	Fiona	Policy & regulations	A2A	Mon	11:00	Grand Ballroom	Australia	Environmental water planning and management in Western Australia: wher
	MACKENZIE	John	Policy & regulations	B4A	Tues	16:00	Astral 1	Australia	Planning tools in over-allocated catchments
	MALLAWAARARCHCHI	Thilak	Water sources	DID	Thurs	08:30	Astral 3	Australia	Economic considerations in modelling the Murray Darling Basin
	MARKHAM	Andrew	Rivers & catchments	C4E	Wed	16:00	Botanical 1	Australia	Using acoustics to characterise aquatic environments
	MASAGCA	Jimmy	Policy & regulations	B4C	Tues	16:00	Astral 2	Philippines	Do we value rivers in the Philippines? Study on river management in Catand
	MASUD	Shafaq	Community	DIC	Thurs	08:30	Botanical 3	Pakistan	Together with communities moving towards environmental sustainability
	MATHER	Chris	Community	СЗА	Wed	13:30	Astral 1	Australia	Riverpark management
	MATHEWS	Warwick	Rivers & catchments	B2B	Tues	10:30	Astral 1	Australia	Case study- community involvement in rehabilitating native fish fauna in ar
	MCINTOSH	Ken	Community	СЗА	Wed	13:30	Astral 1	Australia	Drainage management and initiatives – better urban drain management
	MEDIWAKA	SUSANTHA	Water for mining industry	D1B	Thurs	08:30	Astral 1	Sri Lanka	Inter-Basin movement of water – Sri Lankan experience
	MORILLO	Sebastian	Rivers & catchments	B3B	Tues	13:30	Astral 3	Australia	Water level impacts of design storm surges on the Lower Murray River
	MOURITZ	Mike	Rivers & catchments	АЗА	Mon	14:00	Astral 2	Australia	Water sensitive urban design: a tool for restorative design and catchment re
	MURPHY	Lauren	Community	B2C	Tues	10:30	Botanical 3	Australia	Leading the community to an improved understanding of environmental wa
	MUSSETTER	Robert	, Rivers & catchments	C3C	Wed	13:30	Astral 2	USA	Challenges for ecosystem restoration in the San Joaquin River. USA
	NANDY	Suprivo	Climate change	B3C	Tues	13:30	Botanical 3	India	Climate adaptation strategies – study of Great River Ganges in Sunderbans
	NATT	Ashley	Water sources	חוח	Thurs	08.30	Astral 3	Australia	Acidification as a result of severe drought conditions and over allocation in t
		Adhtoy		010	moro	00.00	hotiato	Nootidid	and management of Currency Creek
		ASCHAR	Water sources	B/B	Tuos	16.00	Botanical 3	India	Life at the edge of a precipice: can Ottors and dame co-evict?
		Succes			Thuro	00.00	Dotanical 3	Dortugal	Chapaing communities values shout water the large dame Alguere (Dertug
		Debert			Wed	16.00	Dotanical 3	Fulloydi	The Lender Divers Action Dien, restoring siturivers
	UATES	Robert	Rivers & catchments	U4r	vved	10:00	Botanical 3		The London Rivers Action Plan – restoring city rivers
	U BAY	Unris	Water sources	BZD	IUes	10:30	Astral 3	Australia	
	OGONJO	Ulita -	Rivers & catchments	B4D	lues	16:00	Astral 3	Kenya	An update on the Iweed-Kenya Mentoring Program
	O'HALLORAN	Roger	Rivers & catchments	A2F	Mon	11:00	Astral 3	Australia	Robust real-time event detection for online wastewater monitoring data
	ORR	Stuart	Community	A2E	Mon	11:00	Astral 1	Switzerland	Corporate water risk and water policy
	PANOVSKI	Dejan	Case study	A4	Mon	16:00	Grand Ballroom	Macedona	Transfering from lakes to river basin management: Drim Dialog
	PATON	Andrew	Policy & regulations	A2A	Mon	11:00	Grand Ballroom	Australia	Practical management of environmental water: case studies of two iconic g
									(north of Perth) and Millstream aquifer on the Fortescue River(Pilbara)
9	PATTIARATCHI	Charitha	Rivers & catchments	A3D	Mon	14:00	Astral 1	Australia	Vertical mixing processes in the upper Swan River Estuary
0	PAUL	Reba	Rivers & catchments	D1F	Thurs	08:30	Botanical 1	Bangladesh	Cooperative and integrated river basin management is imperative to solve to
O	PETRONE	Kevin	Rivers & catchments	A3D	Mon	14:00	Astral 1	Australia	Quantifying and managing dissolved organic matter-derived nutrients in ag
00	PETTIT	Neil	Rivers & catchments	A2D	Mon	11:00	Botanical 1	Australia	Dynamics of aggregated river wood and importance as fish habitat
3	PICKERSGILL	Glenda	Community	DIC	Thurs	08:30	Botanical 3	Australia	The art of protest – learnings from Traveston Crossing Dam, QLD
		David	Policy & regulations	B4C	Tues	16:00	Astral 2	USA	Is the price right: can agricultural value approximate environmental water v
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Quick Reference Guide - Oral Presentations *continued....*

Last Name	First Name	Program Focus	Session	Day	Time	Room	Country	Speakers Paper Title
POELINA	Anne	Policy & regulations	B4C	Tues	16:00	Astral 2	Australia	Investing in the Mardoowarra, River of Life (Fitzroy River) WA
PRICE	Amina	Rivers & catchments	C2F	Wed	10:30	Astral 2	Australia	A decision-support tool for predicting fish response to wetland inundation u
PRICE	Krey	Rivers & catchments	C4F	Wed	16:00	Botanical 3	Australia	Reconnecting historical side channels to the Willamette River
PROSSER	lan	Climate change	C4A	Wed	16:00	Grand Ballroom	Australia	Impacts of climate change on water resources as illustrated by CSIRO's Sust
PULWARTY	Roger	Keynote	B1	Tues	08:30	Grand Ballroom	USA	Climate, watersheds and streams of thought – lessons learned and unlearne
QUIBELL	Gavin	Rivers & catchments	C3B	Wed	13:30	Astral 3	South Africa	Joint baseline survey of the Orange River
RAHAMAN	Muhammad	Rivers & catchments	D1F	Thurs	08:30	Botanical 1	Finland	Integrated transboundary water resources management: defining the conce
RAITER	Keren	Climate change	DIA	Thurs	08:30	Grand Ballroom	Australia	Climate change and forested streams: where did the water go?
	Stuart	Water sources	B2D	Tues	10:30	Astral 3	Australia	
PICKETTS	Glypp	Pivore & catchmonte	020	Wod	13.30	Rotanical 1	Australia	Techniques for managing salinity in the Ramsar-listed Coorong, South Austr
	Malaalm		000	Tues	13.30	Actral 3	Australia	Fotuery and established of the Swan Copping - shanged over time
	Macoun		DOD	Tues	10.20	Retenied 2	Australia	
RUBERI	JULIE		BZU	TUES	10:30	Botanical 3	Australia	Integrating community environmental action into Catchment Management
RUBERISUN	Helen	Rivers & catchments	B2B	lues	10:30	Astral	Australia	Setting the scene: frog populations in Western Australia
RUBSUN	Barbara	Rivers & catchments	A2D	Mon	11:00	Botanical I	Australia	How flow and nutrients affect plants and algae in the Daly River, NI
ROHAN	Deborah	Community	СЗА	Wed	13:30	Astral 1	Australia	Drainage management and initiatives – better urban drain management
ROSS	Joe	Community	C4B	Wed	16:00	Astral 3	Australia	Sustainable development in Northern Australia
ROWLEY	Graham	Water for mining industry	АЗВ	Mon	14:00	Astral 3	Australia	
RUIBAL CONTI	Ana	Rivers & catchments	B3B	Tues	13:30	Astral 3	Australia	Influence of hydro-climatological variability on phosphorus budgets in Peel
RUPRECHT	John	Climate change	D1A	Thurs	08:30	Grand Ballroom	Australia	Changing hydrology of the Pilbara Rivers – implications for management
SAUNDERS	Matt	Rivers & catchments	АЗF	Mon	14:00	Botanical 1	Australia	Satellite & internet telemetry options for river water measurement systems
SCHOFIELD	Nick	Rivers & catchments	C4D	Wed	16:00	Astral 2	Australia	Are we using the 'best available science' in river planning and policy?
SCOTT	Peter	Water for mining industry	DIB	Thurs	08:30	Astral 1	Australia	Lower Murray reclaimed irrigation area, an environment improvement manage
SEAMAN	Russell	Water sources	DID	Thurs	08:30	Astral 3	Australia	Management techniques in response to ecosystem collapse: Coorong, Lowe
SELLERS	Richard	Water for mining industry	A3B	Mon	14:00	Astral 3	Australia	
SHADBOLT	Roxane	Community	СЗА	Wed	13:30	Astral 1	Australia	Framework River Protection Strategy
SHENTON	Will	Rivers & catchments	DIE	Thurs	08:30	Astral 2	Australia	Risk-based planning and ecological dynamics in environmental flows
SHERMAN	Bradford	Water sources	A3E	Mon	14:00	Botanical 3	Australia	Greenhouse gas emissions from a small reservoir in a steep, sub-tropical rai
SHIM	Pil		A1	Mon	09:00	Grand Ballroom	Republic of Korea	Revival of rivers: A New Korea
SILBERSTEIN	Richard	Climate change	C4A	Wed	16.00	Grand Ballroom	Australia	Will there be any surface water resources in south-west Western Australia u
SIMONOV	Fygeny	Rivers & catchments	DIF	Thurs	08.30	Botanical 1	China	Are there international solutions for the Amur River?
SKINNED	Dominic	Pivore & catchmonte	۵2D	Mon	11.00	Botanical 1	Australia	Sediment dynamics affect primary productivity during water level decline in
	lamoo	Water sources	C2E	Wod	12.20	Crand Pallroom	Australia	The potential for a water market in the Changara groundwater eventee of We
SNURRAT	James		DIE	T	00.00		Australia	The potential for a water market in the Ghangara groundwater system of wes
SMITH	Robin	Rivers & catchments	DIF	Inurs	10.00	Botanical I	Australia	Stream satinity linkage in (the Helena and other) southwest Australian catch
SMITH	lanzi	Rivers & catchments	131	VVed	13:30	Astral 2	Australia	The need for environmental flows to the Great Sandy Strait
STEPHENS	Paul	Community	СЗА	Wed	13:30	Astral 1	Australia	Statutory planning control around rivers – unique arrangements
STEWARDSON	Michael	Rivers & catchments	C4D	Wed	16:00	Astral 2	Australia	What is evidence-based practice for environmental flow programs?
STORER	Timothy	Policy & regulations	C2E	Wed	10:30	Botanical 1	Australia	Introducing SWIRC: a river health assessment index for southwest rivers
STRATON	Anna	Policy & regulations	B4C	Tues	16:00	Astral 2	Australia	Estimation of economic values for ecosystem services of Australia's tropical
SUMMERS	Robert	Water for mining industry	D1B	Thurs	08:30	Astral 1	Australia	Do conventional riparian bufferes improve water quality from sandy catchme
TAYLOR	Michael	Rivers & catchments	C2B	Wed	10:30	Astral 1	Australia	The Murray–Darling Basin – The challenges ahead
TAYLOR	Mark	Community	СЗА	Wed	13:30	Astral 1	Australia	Foreshore management
TE AHO	Linda	Community	C4B	Wed	16:00	Astral 3	New Zealand	Integrating Indigenous traditional knowldege and western sciences for river
THOMAS	Jane	Policy & regulations	C2E	Wed	10:30	Botanical 1	USA	Assessing river health in three battlefield National Parks in the United States
TORRE	Antonietta	Rivers & catchments	A3A	Mon	14:00	Astral 2	Australia	Answering the research questions to become a water sensitive city
TOWNSEND	Anthony	Rivers & catchments	A2B	Mon	11:00	Botanical 3	Australia	Monitoring to demonstrate a difference
	Yoshiaki	Community	B2C	Tues	10:30	Botanical 3	lanan	Comparison between FAH Books of Municipal Wastewater and carbon dioxid
VAIPAI	Kashinath	Water sources	C.2D	Wed	10:30	Botanical 3	India	Environmental indicators: measuring urban development plans: a case from
	Albert	Climate change	C/A	W/ad	16.00	Grand Ballroom	Australia	New monitoring systems to improve river management for a more robust fut
			04A	Tucc	10.00		Australia	Molecular tools for broading & restabling programs to sole paths for free
				IUES	10.00	Abudu I		Notecotal tools for preventing a restocking programs to save native fish from (
WADA	Akıra	vvater sources	C2D	VVed	10:30	Botanical 3	Japan	Development of Asian River Restoration Network for knowledge sharing
WALLACE	Jim	Ulimate change	DIA	Ihurs	08:30	Grand Ballroom	Australia	Climate impacts on flow in rivers downstream of tropical rainforest
WALLACE-SMITH	Hugh	Policy & regulations	B4A	Tues	16:00	Astral 1	Australia	The role of a facilitator network in Indigenous engagement

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	Last Name	First Name	Program Focus	Session	Day	Time	Room	Country	Speakers Paper Title
	WALLBRINK	Peter	Rivers & catchments	C2C	Wed	10:30	Astral 3	Australia	Modelling for integrated river management and operation
0	WALPOLE	Sandra	Policy & regulations	C2E	Wed	10:30	Botanical 1	Australia	RiverBank: Environmental water recovery and use in NSW
	WANG	Xingong	Rivers & catchments	B3A	Tues	13:30	Astral 1	China	Study and evaluation on environmental flows in Yellow River delta wetland
	WATERS	David	Water sources	A2C	Mon	11:00	Astral 2	Australia	Watercast catchment water quantity and quality model – development to ap
1 3	WATERS	David	Rivers & catchments	C2C	Wed	10:30	Astral 3	Australia	Managing catchment water quality and quantity
	WEAVER	David	Water for mining industry	D1B	Thurs	08:30	Astral 1	Australia	A riparian paradox
	WEBB	Diane	Rivers & catchments	A3D	Mon	14:00	Astral 1	Australia	Implications of exposure by runoff to crustaceans in the Swan Canning catch
Ð	WELLER	Phillip	Rivers & catchments	C3B	Wed	13:30	Astral 3	Austria	International Danube Surveys
U	WELLER	Richard	Keynote	A4	Mon	16:00	Grand Ballroom	Australia	Australia: the city. Creatively reconciling growth with environmental $\ $ limitat
	WELLER	Phillip	Rivers & catchments	B4D	Tues	16:00	Astral 3	Austria	Experiences from the Danube–Orange River twinning project
	WENDLING	Laura	Water for mining industry	B3D	Tues	13:30	Astral 2	Australia	Evaluation of mining by-products for nutrient and carbon removal
Ð	WILSON	Michael	Water for mining industry	D1B	Thurs	08:30	Astral 1	Australia	The Basin Plan for the Murray Darling
-	WOOD	Gayle	Rivers & catchments	B4D	Tues	16:00	Astral 3	Canada	Lake Simcoe Region Conservation Authority embarking on a partnership with
	XIAOJUN	wang	Water sources	DID	Thurs	08:30	Astral 3	China	System view of climate change and hydrological cycle in a small river basin
-	YADAV	Sanjaykumar	Rivers & catchments	АЗF	Mon	14:00	Botanical 1	India	Mapping salinity ingress using GALDIT Model
(1)	YIN	Yao	Rivers & catchments	C2B	Wed	10:30	Astral 1	USA	Manipulation of water levels of the Upper Mississippi River for habitat divers
	YUAN	Zhang	Water sources	A2C	Mon	11:00	Astral 2	China	River health assessment in Taizi River

Quick Reference Guide - Poster Presentations

	Last Name	First Name	Нсору	Poster #	Electronic	Program Focus	Country	Paper Title
	BESCH	Debbie	Y	1	Y	Community	Australia	Local water quality improvement plans
	BINNEY	Jim	Y	2	Ν	Policy & regulations	Australia	Economic and social aspects of protecting environmental values of waterway
	CHOI	Heung Sik	Y	3	Y	Rivers & catchments	Republic of Korea	Analysis on scouring characteristics by submerged floating structures in rive
	CHONEY	Gary	Y	4	Y	Water sources	Australia	The impact of black swan grazing on the seagrass Halophila ovalis in the low
	CIRCOSTA	Roberta	Y	5	Y	Policy & regulations	Australia	Swan and Helena Rivers management framework
	DWIGHT	Steven	Ν	N/A	Y	Rivers & catchments	Australia	Saltmarsh rehabilitation with the removal of mangroves at Port Botany
	FARAHMAND	Aliraza	Ν	N/A	Y	Policy & regulations	Iran (Islamic Republic of)	ANN method performance in river pollution modeling with quality parameters
	FROEND	Ray	Y	6	Ν	Water sources	Australia	Modelling of vegetation ecohydrological states for groundwater planning and
	GIROUD	Marnie	Y	7	Ν	Community	Australia	Swan Canning River Guardians – a caring community
	GOLKAR	Foroogh	Ν	N/A	Y	Water sources	Iran (Islamic Republic of)	Reservoir and flood routing in Mollasadra Dam with HEC_HMS model
	GREEN	Adam	Y	8	Ν	Rivers & catchments	Australia	PADFLOW – A new approach to identifying an environmental flow regime
	HALL	Arkellah	Y	9	Ν	Rivers & catchments	Australia	Managing impacts of drought on South Australia's freshwater fish
	HALL	Joel	Y	10	Y	Water for industry	Australia	Calibration and application of a complex rainfall-runoff and nutrient model
	HAN	Man Shin	Y	11	Y	Policy & regulations	Korea	Analysis of hydraulic characteristic for natural riverbank creation
	HELFER	Fernanda	Ν	N/A	Y	Water sources	Australia	Assessing the effectiveness of aeration in reducing evaporation from dams ir
	HUGH	Cameron	Y	12	Y	Policy & regulations	Australia	Saving the Margaret River hairy marron from extinction
	HUGHES	Michael	Ν	N/A	Y	Policy & regulations	Australia	Valuing riverpark, Western Australia
	HUNT	Kelsey	Y	13	Y	Rivers & catchments	Australia	Ecological water requirements for urban water management
	JUN	Kyung Soo	Y	14	Y	Water sources	Korea	Flood level mitigation effect of the Nakdong River restoration project
	KARIM	Fazlul	Y	15	Ν	Climate change	Australia	Climate change impacts on the hydrological connectivity of freshwater wetla
	KELSEY	Peta	Y	16	Y	Community	Australia	Septic tanks in urban areas
	KELSEY	Peta	Y	17	Y	Community	Australia	Urban nutrient inputs to coastal catchments
0	KIM	Taegyun	Y	18	Y	Policy & regulations	Korea	The estimateing of curve number from river stage and antecedent rainfall co
	KLUNZINGER	Michael	Y	37	Y	Community	Australia	Community involvement in freshwater ecology: Mussel Watch WA
0	LEWIS	Emily	Ν	N/A	Y	Community	Australia	Geographe Catchment coastal environments project
9	LIU	Wei	Y	19	Y	Rivers & catchments	China	Biological index application in river health assessment in Guijiang river
1	LOCK	Paul	Y	20	Ν	Community	Australia	Fertilise wise – evidence based environmentally responsible fertiliser endorse
1	LONGSTAFF	Ben	Y	21	Y	Water sources	Canada	Too much and too little water: managing water quantity within the Lake Simo
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	Last Name	First Name H	copy P	oster # Ele	ctronic	Program Focus	Country	Paper Title
-	MACKENZIE	John	Υ	22	Y	Community	Australia	Critical times, practical measures: lessons from the trials of water planning
0	MAZZELLA	Lisa	Υ	23	Ν	Rivers & catchments	Australia	Wild rivers in the Kimberley Region, WA: a cooperative, stakeholder driven a
	MCINTYRE	Emma	Ν	N/A	Y	Community	Australia	Management of urban waterways as local government assets- a case stud
	MONTOYA	Juan Luis	Ν	N/A	Y	Community	Australia	New challenges in managing tributaries of the Peel-Harvey catchment
	MOSLEY	Luke	Υ	24	Y	Rivers & catchments	Australia	Impacts of drought and overuse of water resources on the water quality of t
U	OLIVE	Richard	Υ	25	Y	Community	Australia	Evaluating the impact of an education program for school students: the ribl
	QUIBELL	Gavin	Ν	N/A	Y	Water sources	South Africa	Using the delphi process to strengthen river basin organisations: the case o
	RAHAMAN	Muhammad	Υ	26	Y	Water sources	Finland	Transboundary waters management commissions: best practices from Finl
U)	RAYMOND	Myriam	Ν	N/A	Y	Policy & regulations	Australia	Turbidity mapping in Queensland and development of a turbidity assessme
	SARAÇ	Zafer	Υ	27	Ν	Rivers & catchments	Australia	Not out of sight but out of mind: population and connectivity
	SCOTT	Peter	Υ	28	Y	Community	Australia	Regulation driving innovation – world's first greywater treatment system fo
	SEARLE	Louise	Ν	29	Y	Water sources	Australia	Conversion of Margooya Lagoon from a water storage to an ecologically value
	SHAKYA	Deepak	Υ	29	Ν	Rivers & catchments	Australia	Real-Time modelling of the Wilyabrup Brook to maintain ecological water re
	SIRISENA	Meegasmullage	Ν	N/A	Y	Policy & regulations	Sri Lanka	Linking diversified water-economic complex to placing value on river
9	SIRISENA	Meegasmullage	Ν	N/A	Y	Rivers & catchments	Sri Lanka	Drought impact to the development of river habitat
Sec.	STUART	Greg	Υ	30	Y	Water sources	Australia	Optimising multiple effluent releases to an estuary in a growing city
	SYLVA	Kim	Ν	N/A	Y	Community	Australia	An example of a bio-retention system retrofitted in Perth's suburbs - lessor
	TEK	Vannar	Ν	N/A	Y	Water sources	Cambodia	Sesan River : live livelihood and flood problems
	THEW	Peter	Υ	31	Y	Policy & regulations	Australia	The Condamine-Balonne decision support system
	TUCKER	Scott	Ν	N/A	Y	Policy & regulations	Australia	An introduction to new, cost effective satellite imaging technology for de
								vegetation coverage and septic leakage in inland waters.
	VAJPAI	Kashinath	Υ	33	Ν	Climate change	India	Climatic vulnerability and developing a leadership network in Himalayan Mo
	VAJPAI	Kashinath	Y	32	Y	Community	India	How to manage water through an IWRM approach – a case from India
	WRIGHT	Jamie	Υ	34	Ν	Community	Australia	South West Catchments Council – coordinating natural resource managem
	WRIGHT	Jamie	Ν	N/A	Y	Community	Australia	South West Catchments Council Coastal Environment Hotspot Project- Per
	XIAOJUN	Wang	Υ	35	Y	Rivers & catchments	China	A strategy to deal with water crisis under climate change for mainstream in
	ZAMMIT	Benjamin	Y	36	Y	Rivers & catchments	Australia	Drought and the Environment Protection Act – balancing emergency works,
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