The Nuts & Bolts of Flow Reallocation

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DISCLAIMER

The statements, comments, and opinions expressed by participants at the Workshop on the Nuts & Bolts of Flow Reallocation are those of the respective participants, who are solely responsible for them, and do not necessarily represent the views of The Nature Conservancy, World Wide Fund for Nature (WWF) or the International Union for Conservation of Nature.

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THE ENVIRONMENTAL FLOWS NETWORK

This workshop was an activity of the Environmental Flows Network, which will disseminate these proceedings.

The Environmental Flows Network (eFlowNet) was established to communicate, create, share, use and promote environmental flows knowledge and practice. The overall goal of the network is to integrate environmental flows into standard practices for the management and use of river basins that will benefit both people and the environment.

The Network has more than 1000 members and is supported by a number of key organizations including: the International Union for Conservation of Nature, Deltares, The Nature Conservancy, Centre for Ecology and Hydrology, the International Water Management Institute, Stockholm International Water Institute, the Global Water for Sustainability Program, Swedish Water House, World Wide Fund for Nature, Conservation International, UNEP-DHI Centre for Water and Environment, The Ramsar Convention on Wetlands and the IUCN Commission on Ecosystem Management.

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EXECUTIVE SUMMARY

Environmental flows have gained increasing recognition in water-stressed regions where the limits to hydrologic alteration and extraction have been recognized often only after they have been exceeded. The concept of basin closure describes the process of reaching or surpassing these limits; as a basin closes, shifting values and demands for water must be addressed by reallocating water from existing uses to protect other water users from involuntary losses and to preserve or enhance environmental flows. Flow reallocation is an approach to implement environmental flows by reallocating water from existing users when overallocation produces a temporary or permanent deficit in environmental flows.

Workshop panels generated a set of key findings and conclusions about (a) frameworks for flow reallocation and (b) lessons learned from efforts to design and implement flow reallocation programs.

The *framework session* concluded that flow reallocation is unlikely to occur at the necessary scale without wider water governance reforms. Reforms should address institutional shortcomings, define environmental flow requirements, and incorporate appropriate collaborative and market-based institutions to reallocate water for environmental flows.

- Institutional barriers to flow reallocation – unclear property rights, high political and economic costs, and weak institutional capacity – reinforce the need to generate political resolve to address environmental flows as part of wider water governance reforms.
- Quantifying environmental flow requirements enables assessment and implementation at multiple scales and requires substantial financial, stakeholder, and scientific resources. Holistic methods for assessment support an iterative and adaptive approach to quantify environmental flow needs with limited resources.
- Market mechanisms for water allocation can contribute to the provision of environmental flows in water scarce regions. Environmental flows are public goods, however, and will not be delivered sufficiently by water markets without collective action to define and enforce property rights in water and to develop adequate institutional and financial resources.

The session on *implemented cases* surveyed experience with flow reallocation in the Columbia Basin, U.S-Mexico border, and Australia. Although these cases are at different stages of reform and involve different blends of collaborative and market-based mechanisms for reallocation, a set of shared lessons and key differences clarify constraints and opportunities for flow reallocation.

- Collaborative governance is a common feature of all cases and has proven integral to the: recognition and specification of environmental flow needs, establishment of caps on water extraction, reform of water rights regimes to limit access to freshwater and legitimize the environment as a water use, development of authority and capacity to transfer reliable water rights for environmental purposes, and commitment to avoid or offset negative impacts to communities and other water users.

- Experiences in the Columbia and Murray Darling Basins demonstrate how governance institutions frame opportunities to harness market forces to implement environmental flows. Differences in the scale of market activity and role of government and non-profit participation explain the diverging experience with flow reallocation through water markets in the two settings.

The panel on *prospective cases* covered diverse physical and political economic settings where overallocation and an emerging recognition of environmental flows have prompted interest in the prospects for flow reallocation. Cases in China, India, South Africa, and the Middle East demonstrated an overarching theme: different stages of reform dictate different strategies and techniques for building the awareness and institutions for flow reallocation.

- The shift from awareness building to policy reform and implementation often entails a progression from simplicity to complexity when incorporating environmental flows into allocation decisions.
- Experiences in the Jiao River (China) and Krishna River (India) Basins point to the need to incorporate available scientific information to develop flow objectives in collaboration with water users and government officials, especially when flow objectives are attainable with modest reductions in water supply reliability for existing water users.
- Implementing the ecological reserve in South Africa – a prospective case with extensive implementation experience in policy reform and flow assessment – has demonstrated that flow reallocation cannot occur independently from broader social reforms and a framework of integrated water resource management.

The conclusion of the proceedings distills the major findings into a set of cross-cutting themes and outlines an agenda for next steps. Three central themes emerged:

- Enacting the water governance reforms needed to reallocate water to environmental flows will often depend on identifying and harnessing larger social, economic, and environmental drivers.
- Diverse political economic and environmental settings, as well as different stages of reform, will shape implementation prospects and strategies. Consequently, the lessons from any individual case should be balanced against the specific circumstances in a given basin or region to develop the appropriate mix of awareness building and institutional capacity.
- Experience with compulsory reallocation in regions across the world suggests that experimentation with a diversity of approaches to flow reallocation (i.e. regulation, collaboration and market mechanisms) may prove more successful in charting a way forward than relying on a single blueprint or model.

CONTENTS

1. Introduction

The workshop on the Nuts and Bolts of Reallocation convened a group of practitioners and applied researchers to review progress and obstacles to flow reallocation. Flow reallocation refers to the dedication of water to support environmental flow requirements in basins where limits to freshwater extraction and hydrologic alteration have already been exceeded. Because water supplies often are fully committed before environmental water uses have been recognized and defined, satisfying environmental flows may require reallocation from existing uses. Therefore, despite increasing international interest in the concept and science of environmental flows, implementing environmental flows remains a major challenge – where implementation refers to the successful provision of these flows (and not just the necessary precursor steps of analysis, planning, etc). Developing and implementing policy reform and on-the-ground mechanisms to reallocate water from existing users to environmental and social needs are therefore emerging as key global issues in water management.

In recognition of this issue, at the 10th Riversymposium in Brisbane in 2007, the National Fish and Wildlife Foundation (United States) and Waterfind Environment Fund (Australia) organized a well-attended and thought-provoking pre-conference workshop on water transactions for environmental flows. The Brisbane workshop assessed practical lessons from the accumulated implementation experience with market-based approaches to environmental water allocation in the Columbia (USA) and Murray Darling (Australia) Basins. Practitioners from these regions described enabling conditions and barriers in efforts to reallocate water for environmental flows through market mechanisms. This exchange identified a set of major findings and future needs and prompted interest in the prospects for reallocation in different environmental and political economic settings (Garrick et *al.* 2008, Garrick et *al*. 2009).

To continue and broaden this dialog to the needs of other regions, and particularly developing regions, The Nature Conservancy (TNC), World Wide Fund for Nature (WWF) and the International Union for Conservation of Nature (IUCN) in collaboration with the Environmental Flows Network organized *The Nuts and Bolts of Flow Reallocation* workshop as part of the International Conference on Implementing Environmental Water Allocations (IEWA) held in Port Elizabeth, South Africa in February, 2009.

The workshop aimed to take advantage of the IEWA Conference to advance international dialogue on this topic and promote an exchange of experiences with flow reallocation to meet environmental needs. As experienced at the Brisbane Workshop, such a dialogue has a number of benefits. First, this work is often difficult and the knowledge that one is not alone in promoting new approaches to water reallocation is essential to the morale of those involved. Second, sharing lessons learned from the trial and errors can assist practitioners and agencies in exploring and defining enabling conditions and best practices. Third, continuing an international dialogue can also assist those countries and states that are examining the potential of transactional or other approaches to flow reallocation in 'leapfrogging' ahead (i.e. not repeating dead ends of the past). Finally, exposure to the cross-state and cross-country experiences may ultimately lead to guidance for countries as they develop or refine their water code and as they undertake water policy reform – so as to provide a framework that enables water reallocation for environmental flows.

Ultimately, where water has been fully allocated to existing uses – whether through de jure legal means or through de facto customary practice – reallocating water to the environment implies a need to change existing patterns of water use and management. Responding to the need may involve, for example, reducing diversions of water for irrigation or changing dam operations and then rededicating the water to meet environmental needs. Reallocation mechanisms take several forms and vary between regulatory and voluntary approaches. The difference between these two approaches is one of degree. Voluntary approaches emphasize compensation and cooperation with water users affected by reallocation decisions. Regulatory approaches emphasize compulsory relicensing and may not always involve compensation.

The workshop attempted to clarify emerging frameworks for flow reallocation and catalog lessons from the growing implementation experience with the full range of reallocation approaches. Each approach differs in the types of compensation and methods for incorporating water users and other stakeholders into allocation decisions; in practice, however, these types invariably exist side by side to form hybrid approaches that present different mixes of incentives, regulations, and decision-making processes. Participants at the Port Elizabeth workshop did concur that regardless of the reallocation approach, clear regulatory frameworks and strong institutional capacity have proven essential, leading to the conclusion that flow reallocation cannot occur in isolation from wider reforms in water governance.

Over 60 conference attendees from 15 countries registered for the workshop. As the day progressed a number of additional conference registrants joined the workshop. Registrants are listed in Appendix 1 and included:

- **Practitioners** engaged in water transactions and flow reallocation from the U.S., Australia and other countries
- **Regulators** engaged in approving, enforcing and monitoring water flow reallocation
- **Agencies and not-for-profit organizations** engaged in planning and funding water transactions
- **Academics** involved in research into the various environmental, social and economic aspects of flow reallocation
- **Consulting companies** supporting the above groups

This report summarizes the proceedings of the workshop and distills its major discussion threads and findings. The report's primary goals are to clarify frameworks for flow reallocation and to generate a record of the lessons shared about progress, obstacles, and resources available for flow reallocation. The workshop employed four panels to achieve its objectives (see Appendix 2 for the full Workshop Program). The content and organization of the proceedings report draw directly from these four panel sessions as follows:

Panel 1: Frameworks for Flow Reallocation. Science, policy, and economic considerations that shape prospects for flow reallocation.

Panel 2: Cases in Implementation. Case studies where implementation of environmental flows has led to reallocation, emphasizing: the nature of the overallocation problem, reallocation approach, and the main drivers, barriers, and lessons from early implementation efforts.

Panel 3: Prospective Cases. Case studies where environmental water needs may require reallocation, describing: needs, opportunities, and impediments to reallocation.

Panel 4: Interactive Panel. An interactive panel reflected on the discussion and responded to questions and themes emerging during the previous sessions.

Each panel featured brief commentary from invited panelists followed by discussion sessions with participation from the full audience. The proceedings report provides a section for each panel. Each panel is then organized into four sub-sections, including: a panel introduction, abstracts of panelist commentaries, discussion summary, and main messages. When appropriate, the panel summary will identify key outside resources for readers seeking greater detail on all or part of the proceedings, including papers written by panelists for the main conference.

Additional Resources:

Garrick, D., M. Siebentritt, B. Aylward, C.J. Bauer, and A. Purkey. 2009. Water Markets and Freshwater Ecosystem Services: Policy Reform and Implementation in the Columbia and Murray Darling Basins. *International Conference on Implementing Environmental Water Allocations.* Port Elizabeth, South Africa.

Garrick, D., B. Aylward, M. Siebentritt, and A. Purkey. 2008. Environmental Water Transactions: Lessons Learned and Future Prospects. *Proceedings of a Workshop held at the10th Annual Riversymposium and International Conference on Environmental Flows.* National Fish and Wildlife Foundation: Washington D.C.

Box 1. Case Study Locations

The following case studies were included in presentations at the workshop.

Cases in Implementation:
1. Columbia River, Northwest U.S.A
2. Colorado River Delta, Northwest Mexico
3. Rio Conchos, Northern Mexico
4. Murray Darling Basin, Southeast Australia

Prospective Cases:
5. Jiao River, China
6. Krishna River, India
7. Middle East and North Africa Region
8. South Africa

Map Source: http://www.bc.edu/centers/cwf/global/meta-elements/jpg/global_map.jpg

2. Frameworks for Flow Reallocation (Panel 1)

This session introduced the overallocation problem and presented framework statements regarding the scientific, policy, and economic dimensions of flow reallocation.

2.1 Framing the Overallocation Problem - Robert Wigington, The Nature Conservancy

The workshop's objective was to broaden the dialogue from the Brisbane workshop to examine how the problem of overallocation has been addressed beyond the Western U.S. and South East Australia, where market-oriented approaches to flow reallocation have been attempted. The workshop revisited those regions to review key themes and emerging lessons from cases in implementation, while considering new cases and approaches. This session framed the science, policy, and economic aspects of flow reallocation and began by introducing the problem of overallocation confronting many regions globally.

The problem of overallocation is captured by the concept of river basin closure, which can occur in three stages, as developed by Molle et *al* 2007. In an *open basin* (first stage), depletion levels are low enough relative to total runoff that the magnitude, timing, and frequency of ecologically necessary streamflows are never compromised. A transition to a *closing basin* (stage two) occurs when depletion creates a partial and temporary deficit in meeting needed environmental flows and possibly other human demands. During this closing phase, overallocation conditions are not yet chronic and often occur when peak water demands coincide with natural lows in the hydrograph or drought conditions, such as the period of peak irrigation demands during the low flow conditions in late summer of a snowmelt-dominated hydrograph. A basin becomes fully *closed* (third stage) when depletion levels lead to a chronic deficiency in needed environmental flows. This condition may occur in river deltas that have become permanently dewatered.

The *primary issue* for this workshop was to consider the mechanisms for meeting environmental flows and other needs in closed and closing basins facing problems of overallocation.

Additional Resources:

Molle, F., P. Wester, P. Hirsch, J. Jensen, H. Murray-Rust, V. Paranjpye, S. Pollard, P. van der Zaag. 2007. River Basin Development and Management. In *Water for Food, Water for Life.* International Water Management Institute: Colombo, Sri Lanka.

2.2 Institutional Shortcomings in River Flow Allocation - Tom Le Quesne, WWF

The reallocation challenge is increasingly urgent as more basins close and competition for water increases across the globe. The ability to reallocate water is becoming one of the great sustainability challenges of the next century, and it is a challenge on a similar scale with carbon emissions. The *key question* is therefore: how can we make reallocation happen?

First, it is necessary to understand the context and drivers for reallocation. The reallocation challenge occurs for three primary reasons.

- **Concern for the environment** has motivated reallocation for environmental purposes in management systems that historically failed to address environmental water needs.
- **Changing social and economic demands** for water have raised a general need for reallocation among competing uses, and the environment represents one source of new demand, alongside other emerging needs for agriculture, urban and domestic supplies, and industrial water uses. New sources of demand may be driven by economic value, such as the shift from agriculture to industrial needs in Northern Mexico; new water needs may also lead to reallocation for social and political reasons, such as supplying water to formerly disadvantaged groups in parts of Africa.
- **Climate change** is creating a need for reallocation due to the disruption to runoff patterns due to increased variability and extremes. Flexibility to reallocate water in response to increased variability is going to be a key climate change adaptation.

Political resistance to reallocation has made it rare to develop reallocation mechanisms purely for environmental purposes. Institutional mechanisms for reallocating water to an environmental purpose are often introduced as part of a broader suite of water policy reforms that enable reallocation between sectors.

While several approaches to flow reallocation exist – regulatory, compensation, or market mechanisms - in almost all contexts, a combination of the three has occurred in practice. Because it is difficult to pursue any of these approaches in isolation, the challenge becomes a choice of the appropriate blend. Regardless of the chosen blend, a set of challenges to reallocation can be identified. These challenges underscore the institutional failings impeding reallocation efforts.

Six institutional failings are of primary concern, including:

- **Reallocation mechanisms do not exist** or remain weakly defined and integrated because allocation systems developed when basins were considered open. Efforts to promote water development while basins were still open have created a class of water users with vested interests that may be threatened by efforts to reallocate water from existing uses to satisfy new human and environmental water demands.
- **Property rights are unclear.** Reallocation is difficult in the absence of well-defined water entitlements. Contested or unenforced rights prevent constructive reallocation processes.
- **Reallocation efforts have high political and economic costs**. The political strength of existing water users, along with the potential concentration of the economic costs of reallocation on existing users, raises the need to address the resource implications for groups losing access to water. For example, the agricultural sector has often developed strong political resources in response to pressure for reallocation. Compensation is often necessary to avoid political problems, and this can require significant resources. Where water is being reallocated from low value-added agricultural use to higher value-added industrial or domestic use then it may be easier to generate the necessary financial resources than in cases where water is being re-allocated to ecosystems.
- **Water investments are long-term in nature.** Mechanisms for reallocation imply an increase in the flexibility of water allocation. However, the capital-intensive nature of water investments leads to high sunk costs, and water also has high option costs that encourage existing water users to maintain their future options to reallocate their water under mounting

competition and scarcity. Collectively, these costs have led to regulations and incentives that limit flexibility for reallocation to provide the security needed to encourage long-term investments in water. Where such regulations are introduced, they need to ensure that they provide a balance between the security needed for longer-term investments and the flexibility required to enable reallocation.

- **Water needs are localized.** Because water needs are tied to specific places and times, reallocation is limited by the local nature of water availability and needs. The need to account for the local nature of environmental water needs necessarily introduces complexities to any reallocation mechanisms.
- **Institutional capacity is lacking.** Because of the complexity and the high political costs of reallocation, institutional capacity for implementation is essential.

Additional Resources:

Le Quesne, T., G. Pegram and C. Von Der Heyden. 2007. *Allocating scarce water: a WWF primer on water allocation, water rights and water markets*. World Wide Fund for Nature: United Kingdom.

Le Quesne, T. 2009. Water Rights Reform and Environmental Flows: A Comparative Analysis of Mexico, Pakistan, and South Africa. *International Conference on Implementing Environmental Flows.* Port Elizabeth, South Africa.

2.3 Environmental Flow Determination: Establishing Opportunities for Flow Reallocation - Rebecca Tharme, The Nature Conservancy

The quantification of environmental flow needs is a central enabling condition for the reallocation of water in a river basin. Therefore a key framing question becomes: how do we determine and quantify environmental flows? The term 'environmental flows' refers to a regime of water (quantity and quality) across time and space that is required to maintain the ecological health of an aquatic ecosystem as well as the ecosystem services provided by that system to support social values and needs. Importantly, environmental flows have been increasingly recognized as a driver of ecosystem health. Maintaining or mimicking natural spatiotemporal patterns of flow variability can maintain the full range of biodiversity and ecological integrity needed to maintain or restore aquatic ecosystem health. Therefore, the challenge of reallocation is not just an issue of the aggregate volume of water, but instead is a matter of how water is distributed in space and time, in terms of the criteria of magnitude, timing, duration, frequency and rate of change, for different components of the flow regime. Specific flow components include low flows, higher flows, and various flood events. Internationally, there has been a strong shift away from designating a simple, unvarying minimum flow figure as the environmental flow, to defining a flow regime.

The spatial scales relevant to environmental flow assessment and reallocation can be organized hierarchically from the local to regional and national scales. A focus on scale can inform decisions whether to (a) determine a comprehensive environmental flow allocation for a high priority river system within a basin where there may be complex tradeoffs among water uses or (b) to undertake a more preliminary and precautionary estimate of environmental flow needs when assessing national level planning-level priorities or a group of lower priority river basins.

Several methods exist for assessing flow requirements across multiple scales. For system or site-specific determinations, these methods range from hydrology-based, to habitat simulation, and more recently, holistic or functional analysis methods that identify flow requirements for the entire ecosystem based on interdisciplinary expertise. An international consensus has begun to develop in support for the latter category of holistic methods as the most ecologically relevant. At the regional scale, a new holistic process for setting environmental flow standards is now in progress, termed the Ecological Limits of Hydrologic Alteration (ELOHA) framework.

The resources available (e.g. finances, time, data, technical and institutional capacity) will determine the level of investment in environmental flow assessment. Initially, limited resources may restrict the focus to hydrology-based approaches where ecologically relevant flow indices derived from historical flow records are used to calculate environmental flow needs for a river. With moderate resources for assessment, it becomes increasingly feasible to convene an interdisciplinary expert panel to make informed decisions about the environmental flow requirements of a river system. More extensive resources for assessment may enable field-based and/or modeling studies to more explicitly examine and define particular relationships between flow and ecological response in time and space. Regardless of the approach, adaptive refinement of the original flow recommendations, through monitoring, is essential.

Holistic ecosystem methods share a set of common elements. First, the estimation of the environmental flow requirements requires that stakeholders are identified and included at this stage, to develop a vision and objectives for the environmental flow determination. In this initial stage, knowledge of the ecohydrology of the river system is also compiled, including its hydrology, ecological structure and functioning, and basin water uses and users. A preliminary set of flow recommendations will incorporate this understanding of the influence of human activities on system water resources, as well as the expert panel's assessment of needs for each ecologically significant component of the flow regime through a workshop-based process. Implementation of environmental water needs may occur through several general approaches, where the policy and institutional environments are appropriately supportive: (1) a reserve satisfied before the needs of other users are met, (2) a cap on other water uses that effectively reserves remaining flows for environmental needs, (3) environmental flows are treated as an additional water use with either a higher or lower priority than other users, or (4) combinations of those policies. These approaches present distinct opportunities and compatibilities for flow implementation. Where there are major uncertainties in ecohydrological understanding and/or where environmental flow needs are incompatible with existing water distribution, research and collaborative dialogue are needed to clarify recommendations, and it is also increasingly important to monitor and refine flow recommendations and operational procedures to deliver water to users (e.g. dam release schedule) through an ongoing adaptive management process.

At regional and broader scales, it becomes necessary to up-scale such experience at the local level to a larger geographic area. The Ecological Limits of Flow Alteration (ELOHA) framework helps in the determination and management of environmental flows over these broader regions, including a large basin, state or an entire country, in a scientifically rigorous and defensible way. The framework, which comprises integrated hydrological, ecological and social elements, develops an understanding of the key relationships between the degree of flow alteration and ecological response for each of a number of different types of river systems. Assessing these relationships for an individual river type enables environmental flow standards

to be established and applied to rivers of the same type in the region rather than having to make independent assessments on a river-by-river basis. Conversely too, broad-scale environment flow determinations made across a range of degrees of river health and flow alteration for a particular river type can be used to better define the environmental flow needs of other individual rivers of the same type in the region.

Use of this kind of hierarchical, local to regional approach to setting environmental flows provides diverse opportunities for flow restoration in closing and closed (over-allocated) river systems, including through influencing the re-operation of existing water infrastructure for single schemes and multiple schemes in combination. Not only that, coupled with improved siting, design and operation of new water infrastructure, it also allows for the flow protection of high conservation value aquatic ecosystems within a region.

Additional Resources:

Poff N. L., B. D. Richter, A. H. Arthington, S.E. Bunn, R. J. Naiman, E. Kendy, M. Acreman, C. Apse, B.P. Bledsoe, M. C. Freeman, J. Henriksen, R. B. Jacobson, J. G. Kennen, D. M. Merritt, J. H. O'Keeffe, J. D. Olden, K. Rogers, R. E. Tharme and A. Warner. 2009. The ecological limits of hydrologic alteration (ELOHA): a new framework for developing regional environmental flow standards. *Freshwater Biology (in press)*.

Tharme, R.E. and E. Kendy. 2009. Ecological Limits of Hydrologic Alteration (ELOHA): Integrating Environmental Flows into Regional Water Resources Planning and Management. *International Conference on Implementing Environmental Water Allocations*. Port Elizabeth, South Africa.

Tharme, R.E. 2003. A global perspective on environmental flow assessment: emerging trends in the development and application of environmental flow methodologies for rivers. *River Research and Applications* **19**: 397-441.

Website: Ecological Limits of Hydrologic Alteration (ELOHA), The Nature Conservancy *http://conserveonline.org/workspaces/eloha*

2.4 Markets Mechanisms to Meet Environmental Flows - Bruce Aylward, Ecosystem Economics

This summary is based on the presenter's experiences with efforts to implement market mechanisms to reallocate water for environmental flows in the Western U.S. These efforts began in the Deschutes River of Central Oregon (2002-2007) and, more recently, have expanded to include Idaho, New Mexico, Texas, and Washington.

Market mechanisms to meet environmental flows depend on a group of institutional and economic considerations. First, the main argument for market mechanisms stems from the potential for economic incentives to encourage a shift toward higher valued uses in a context of resource scarcity. Second, it is important to note that market mechanisms can fit within a variety of institutional arrangements, including centralized, common property or a fairly unregulated market system for private water rights. Third, markets operate within a variety of hierarchies for assigning property rights. One option involves set-asides, or reserves, for social and environmental uses, with rights for other uses auctioned off and traded in markets. An alternative approach uses markets to redistribute all rights. In the latter case, social and environmental uses that arrive after rights are distributed must acquire water in the marketplace.

It is also useful to understand that efforts to improve water management generally will tend to create the enabling conditions for markets to develop. In many places these conditions are not present, and markets do not exist. The absence of markets is not an indicator that markets would not be useful in these places, but rather an indicator that components of effective water management, such as clear regulatory, monitoring, and enforcement capacity, are lacking.

The economic aspects of water shape the prospects for market mechanisms that implement flow reallocation. Water is a social and environmental good; because it has economic uses, it is also an economic good, although one with important public good characteristics. Economists agree that water is a public good and that it cannot be allocated by a free market due to its social and environmental interconnectedness. The public good aspects of water are sustained or restored through collective action of water users, regulators, and other stakeholders. Coordination is needed in flow reallocation to develop the political will and commitment of financial resources for environmental flow reallocation. Collective action also fosters the governance institutions that enable effective markets. It is critical to note that the use of market mechanisms does not necessarily imply a "free market" in water.

To understand markets for water rights, it helps to fit markets in the broader context of water management before incorporating environmental flow requirements into the discussion. There are four prerequisites for markets. First, resource scarcity is necessary for markets to emerge. Second, property rights need to be defined and specified so that rights to access and withdraw water can be valued and transferred. Property rights can define a hierarchy of uses (e.g. reserves for ecological and/or domestic water uses) and can establish priority amongst or between uses or within a category of uses in the hierarchy. Other conditions may apply, such as limited duration or public interest reviews. Third, an entity must be authorized and capable of enforcing exclusion. It is necessary to prevent water users from exceeding the limits of their rights, in effect regulating one use against another to ensure that the rights are clearly enforceable. This allows the regulation of all uses in effect against a total limit – whether set implicitly or explicitly. Ideally, a cap or boundary on overall water access is set and enforced so as to exclude existing and new water users from exceeding prescribed limits or thresholds. Fourth, property rights must be transferable to enable trade and to provide incentives for reallocation. In sum, property rights must be clearly defined, enforceable and tradable. If these prerequisites exist then a water market exists; even if the market is not very active.

These aspects of property rights relative to the use of water lead to three types of reallocation regimes:

- **Open access.** Permits to use water may exist but they are unenforced, so whoever wants the water and has the power to take it has the de facto rights to water. As a result, access rights may fall to the upstream user - the first in line to capture the water - or they may go to the user with power in the community.
- **Command and Control.** Exclusion is enforced and the government (via courts, legislatures, or administrative agencies) makes reallocation decisions through an administrative process, and determine whether existing users should receive compensation for lost access to water.
- **Market reallocation.** Exclusion is enforced and water rights are also transferable. Water users participate voluntarily in reallocation in response to legal and economic incentives.

There are three enabling conditions, or policy reforms, necessary to reallocate water to environmental flows. The first of the three conditions is the property right system described above: rights to and limits on freshwater extraction and allocation are clearly defined, transferable, and enforced. In order to incorporate environmental flows into this system for allocating water it is also necessary to (a) recognize the environment as a legitimate use and specify environmental flow needs; and (b) authorize mechanisms for transferring existing water rights to environmental purposes (ideally without loss of priority). If the first condition is not present, water is allocated under an open access system – in other words de facto allocation exists and water is not really being managed. If the first and second conditions are met then water is managed via command and control, i.e. by administrative fiat. If all three conditions are present market mechanisms can be employed to move water to higher value uses. Economists prefer this approach because it allows the water users themselves to interact in defining how water is allocated and used (rather than government).

These policy reforms are necessary enabling conditions; however, alone they are insufficient to reallocate water for environmental flows because water is a public good. With the benefits of environmental use of water diffuse and spread across many groups in civil society it may be hard to bring this demand to the marketplace. Collective action is therefore typically required to establish demand for environmental flows and create "environmental buyers" in the market place. The environmental buyers, water user groups, and administrative agencies must also possess sufficient organizational capacity to execute transfers and ensure that they do not harm other users and other third parties. Finally, monitoring and enforcement are necessary to ensure that the environmental flows are present after the transaction completes. These measurement and enforcement systems enable continued learning and adaptation in the marketplace.

Additional Resources:

Aylward, B. 2003. Covering the Cost. In *Flow: The Essentials of Environmental Flows*, edited by M. Dyson, G. Bergkamp and J. Scanlon. Gland: IUCN

Aylward, B. 2008. Using Water Markets to Mainstream Ecosystems into Water Management. Economics *Briefing Paper#3*, Water and Nature Initiative. Gland: IUCN.

Garrick, D., M. Siebentritt, B. Aylward, C.J. Bauer, and A. Purkey. 2009. Water Markets and Freshwater Ecosystem Services: Policy Reform and Implementation in the Columbia and Murray Darling Basins. *International Conference on Implementing Environmental Water Allocations.* Port Elizabeth, South Africa.

Columbia Basin Water Transactions Program: www.cbwtp.org

2.5 Discussion Summary

Environmental Flow Requirements

Q: Do environmental flows need to be determined and quantified before implementation?

A: There are examples where the quantification of environmental flow requirements occurs at each stage - before, during and after implementation begins. Many of the most effective cases,

however, developed a preliminary understanding of flow needs before adaptively refining the flow needs after more information became available.

Importance of Broader Water Management Reform

Q: There is a recurrent theme in the commentaries by Le Quesne and Aylward: meeting environmental needs requires wider reform to the entire water management system. Is it too tall of an order to address climate change and other sectoral needs in order to address environmental flows?

A: The political challenges of reallocation are so great that they are unlikely to be overcome if you are trying to reallocate water only for environmental purposes. Rather, a bigger driver may prove necessary to overcome the inertia of political resistance and, in the process, enable environmental water reallocation to proceed at the necessary scale. Most rivers and regions where environmental flows are deficient also lack the institutions to enforce environmental water allocations, and wider reforms will be needed. However, it is important to prove the value of environmental flows at the local and regional scales. This dynamic suggests that it is beneficial to attempt small scale reallocation to demonstrate the effectiveness of the approach before seeking larger scale reforms.

Implementing and Measuring Environmental Flows

Q: Could the panel please elaborate what it means to give effect to environmental flows? Does implementing environmental flows occur through dam releases, markets, or other means of delivery? In South Africa, for example, we evaluate water conservation according to the types of goods and services delivered and the priorities for river function. After describing the implementation of environmental flows, please explain how you measure them and ensure compliance.

A: This question goes beyond environmental flows and requires consideration of the resources and socioeconomic values that inform environmental flow recommendations. In terms of measuring compliance, a number of approaches have been developed. If compliance is not measured in the receiving water body directly, we have defined recommendations for metrics based on the achievement of ecological outcomes or direct benefits for people. Although a suite of compliance measures are used, fundamentally, we need to assess the resilience of the system, and this form of assessment requires indicators of system-wide health.

The point about measurement is critical. Tharme's presentation emphasized, for example, that adaptation is crucial, and measurement is central to adaptation. Such adaptation is crucial given the importance of context in shaping implementation, as approaches will depend on physical, technological, socioeconomic, and political factors. For example, the approach used in remote South Africa will vary tremendously from a heavily regulated system in the U.S.

A number of reallocation tools are used to implement environmental flows. The range of options spans from reservoir releases to water use reductions for an individual irrigator. The monitoring technique will depend on the tool. At root, however, the monitoring challenge requires close streamflow monitoring and habitat and biological assessments to verify results and demonstrate that tools yield benefits. An adaptive management process is needed.

Benefits and risks of an economic perspective on environmental flows

Q: Can economic perspectives create obstacles to environmental flows? For example, on the Western Cape of South Africa, a trade off is required between improving and maintaining ecosystem health versus a desire to sell remaining water for profit to raise money for catchment agencies. This condition may lead a conservation-minded catchment to be poorer than other catchments.

A: The United States is coming from a different context where public sources of money are a primary source of funding for environmental flow reallocation, so the challenge often becomes a need to document benefits attained using public dollars. This issue also exists in cases where a cap exists and competition for water supplies drives the price of acquisition to a prohibitively high level. This situation leads to a condition where economic costs are inevitable, creating the need to weigh the costs of different scenarios and trade-offs against the social, environmental, and economic benefits. Either people who have the water taken away lose economic opportunity, the nation loses that economic benefit, or someone has to pay to reallocate the water. This issue highlights the distributional impacts of reallocation and reinforces the need to trace the costs and benefits of implementing flow reallocation. For example, it may be possible to link the acquisition of new water resources in water-scarce regions to a requirement to mitigate the negative impacts of the new use by supporting flow reallocation projects.

This point also highlights a quirk about the financing of water administration, namely that water management agencies raise their revenues through fees and charges on water allocation, leading to the perverse consequence where reducing water demand can reduce revenue. Therefore, it is necessary to ensure agency incentives support the establishment and maintenance of environmental flows.

2.6 Main Messages

Defining the overallocation problem

- Basin closure – a process defined by a temporary or permanent deficit in meeting environmental flow requirements – has created a condition of overallocation in many regions, requiring efforts to reallocate water from existing users.

Institutional shortcomings in flow reallocation

- Concern for the environment, changing social demands, and climate change are three primary drivers and contexts that spur reallocation for environmental flows.
- Several institutional failings inhibit flow reallocation, including a lack of reallocation mechanisms, unclear property rights, the high political and economic costs of reallocation, long-term nature of water investments, localism of water, and weak institutional capacity.
- Flow reallocation is unlikely to occur in the absence of more comprehensive reform to address demands for cross-sectoral reallocation (e.g. from lower value-added agriculture to higher value-added municipal or environmental needs) in the context of scarcity and variability.

Methods for defining environmental flow recommendations

- The quantification of environmental flow needs for aquatic ecosystems is a central enabling condition to reallocate water within a basin.
- Although environmental flow determination can occur before, coincident with, or after other elements of flow-reallocation are in place, the earlier in the process environmental flows are addressed in basin water resources planning and management, the greater is the likelihood that they will be effectively implemented.
- The assessment of environmental flow requirements can be done iteratively and at different levels of resolution, from preliminary to comprehensive, depending on resource constraints such as time, finances, access to information on hydrologic, ecologic, and social values, as well as factors such as institutional capacity and the policy environment. These various constraints underscore the need for an adaptive process to refine flow needs over time.
- International consensus is building in support of holistic methods for environmental flow assessment that incorporate the vision, needs and knowledge of a diverse range of stakeholders coupled with an interdisciplinary expert-panel driven process, to identify a flow regime that supports the health of the entire aquatic ecosystem and the ecosystem services it delivers to society.
- The Ecological Limits of Hydrologic Alteration (ELOHA) is a new, holistic framework for setting environmental flows for different river types within a region, such as a large basin, state or country, that addresses the resource intensiveness constraining local river-by-river environmental flow determinations, while building upon the wealth of knowledge gained from such site-specific applications.
- Environmental flow needs can be defined at multiple spatial scales to maximize opportunities for local- to regional-level flow protection and restoration.

Market mechanisms to meet environmental flow needs

- The main argument for market mechanisms to meet environmental flow needs is tied to the potential for economic incentives to encourage a shift toward higher valued uses in a context of resource scarcity.
- Water is an economic good and also a public good. As an economic good, the economic incentives surrounding water use can be harnessed through market mechanism. As a public good, however, water will not be efficiently allocated by a free market approach. Collective action is needed to develop the political will and commitment of financial resources for environmental flow reallocation. Collective action also fosters the governance institutions that enable effective use of market mechanisms in the reallocation of water use rights.
- Governance institutions that support effective markets depend on clear, tradable, and enforced property rights to water. Property rights can be held by both individuals and groups.
- Markets to deliver environmental flows are enabled by policy reforms that establish rights and limits to freshwater extraction; the environment as a legitimate use; and authority to transfer water from an existing use to an environmental purpose.
- Policy reforms are necessary but insufficient to implement market reallocation mechanisms. Factors driving demand and institutional development are necessary to overcome barriers and adapt to new information.

3. Cases in Implementation (Panel 2)

The second panel reported on water-stressed river basins where policy changes and implementation efforts are underway to meet environmental water needs through flow reallocation. Panelists introduced each case by reviewing the overallocation problem, drivers and strategies for reallocation, and lessons from implementation experience.

3.1 Columbia River Basin - Dustin Garrick, University of Arizona

The Columbia Basin has developed a market-oriented approach to reallocate water to restore salmon habitat along flow-limited tributaries. Overallocation problems stem primarily from water shortages during late summer when peak water demands for irrigated agriculture coincide with the natural low flows in the hydrograph, although water shortages have also affected winter flows and other components of the flow regime. As a result, streams may become seasonally dewatered during the summer, i.e. by running dry or at substantially reduced flows. These conditions harm salmon fisheries by disrupting migration patterns and reproduction behavior; chronic dewatering and low flow conditions have also begun to impair established water rights on rivers where competition for water supplies is increasing reliance on the groundwater aquifers that feed surface flows. Consequently, flow reallocation has been necessary to restore habitat and offset impacts of new demands. Market mechanisms involve willing seller, willing buyer agreements to modify existing water rights to enhance instream habitat for salmon fisheries. This approach also has been adapted to mitigate the impacts of new water uses associated with urban growth in catchments closed to further extraction.

The system of water rights in the Western U.S.A. is both a source of the overallocation problem and the basis for market-oriented solutions. Three principles guide water allocation and underpin market-based approaches to enlist existing water users in voluntary, compensated agreements to restore environmental flows. First, water is allocated on a priority basis to cope with variability by ensuring that the first person to establish and maintain a legitimate water right is the last to lose access during shortages. Water diversions must serve a "beneficial" use, and prolonged lapses in use may lead to the forfeiture of the right. Finally, changes to water use and distribution must avoid causing harm to adjoining water users upstream and downstream. This system creates an incentive to "use or lose" the right and can exacerbate water stress by favoring offstream uses to uphold the water right over the long term. These allocation rules also create a disincentive to transfer rights to new uses given the risk of forfeiting the right due to non-use and the close administrative scrutiny of proposed changes to protect other water users from being harmed.

Market-based approaches to reallocate water rights for environmental flows within this system have involved a common set of policy changes across the states in the U.S. portion of the Columbia River Basin. Water allocation is vested at the state level, so enabling conditions developed at the state level or within pilot catchments within the states. First, caps on water use may be implied by the priority system because it limits the availability of reliable water rights. Caps may also develop directly or indirectly through administrative regulation, court decree, or statutory reforms, but these types of caps on water use are incomplete and uneven across the

Columbia. Second, environmental water needs were recognized as beneficial uses, and transfers were authorized to convert existing water rights to instream purposes without losing the underlying priority (or reliability) of the right, although environmental flow needs have yet to be fully specified or prioritized. Non-profit water trusts and conservancies and government-run water acquisition programs have implemented flow reallocation under their authority to design and execute environmental water transfers. A series of statewide or catchment-level programs began to reallocate water rights through temporary and permanent acquisitions and irrigation efficiency savings. The Columbia Basin Water Transactions Program formed in 2002 to integrate these nascent efforts at the basin-scale by coordinating and administering funding for local partners. The program administers $4 million (U.S.) annually to fund water acquisition costs, which are often complemented by other funding sources, and to underwrite a portion of the transactions costs required to design and implement restoration projects, leading to 1.2 million m^3 of water restored instream annually in targeted tributaries as of 2007.

The implementation experience over the past 15 years offers a group of key lessons. It is important to note that policy reform is a long-term process that has occurred over multiple decades in response to crises caused by drought, new water demands, and declining habitat conditions. Second, the scale and scope of transactions are critical. Initially, flow reallocation transactions occurred on small tributary streams where a small amount of water can have a large impact on habitat; demonstrating the effectiveness of this approach proved necessary to scale up and apply it in larger systems. The scope of these transactional tools is increasingly important because it is necessary to enhance flow while also addressing other factors that impair habitat, such as fragmentation and water quality. Third, market approaches to flow reallocation depend on strong cooperation; the collaborative foundation is very different from conventional ideas about "free" markets defined by perfect competition. Non-profit groups or government officials act as conservation buyers in the marketplace with close attention to the needs of water users, community values, and regulatory safeguards. Finally, adaptation has been a central feature. Regular monitoring and evaluation enable periodic assessment of success and failure that has helped to maximize the return on public and private investments.

Additional Resources:

Garrick, D., M. Siebentritt, B. Aylward, C.J. Bauer, and A. Purkey. 2009. Water Markets and Freshwater Ecosystem Services: Policy Reform and Implementation in the Columbia and Murray Darling Basins. *International Conference on Implementing Environmental Water Allocations.* Port Elizabeth, South Africa.

3.2 Colorado River Delta and Rio Conchos, Mexico - Robert Wigington, The Nature Conservancy

The Colorado River Delta and Rio Conchos are two restoration priorities along the U.S.-Mexico border where flow reallocation has begun to occur through planning and pilot projects over the past five years. This summary will briefly introduce the cases and discuss similarities and differences in their implementation and enabling conditions. The Colorado River Delta is in Northwestern Mexico at the terminus of a river the spans seven states and two countries, and the Delta is heavily affected by management decisions upstream in the U.S. where the river is fully allocated. Substantial reservoir storage makes it rare for the Delta to receive necessary flooding and baseflows because runoff is captured and stored upstream in the U.S. to buffer against

shortages and to ensure water deliveries to Mexico required by international treaty. Consequently, flows in the Delta are generally insecure, depending on irrigation return flows and groundwater discharge, as well as inadvertent releases from the U.S.

Reallocation mechanisms are developing on two levels. First, the Delta requires periodic flooding that could be satisfied by banking water saved by improved irrigation efficiency in Mexico and storing the conserved flows within U.S.-based reservoirs to offer flexibility to deliver flood releases to the Delta. The second approach has involved the incorporation of a private water trust to purchase or lease irrigation water rights to restore the base flows in Mexico for the Colorado River or to replace the supply for the Cienaga de Santa Clara – a portion of the Delta that has benefited from saline irrigation drainage bypasses from the U.S. Water acquisitions are being pursued in conjunction with land concessions along floodplains. Cumulatively, these efforts aim to contribute toward a modernized irrigation district in the Delta region that would involve a regulated zone to protect environmental flows through federal decree in Mexico. Prospects for scaling up these efforts are promising.

The Rio Conchos is the second case. The Basin's headwaters are located in the Sierra Tarahumara and flows from south to north, positioning Mexico as the upstream country. The river enters the U.S. at its confluence with the Rio Grande above the Big Bend National Park. Although the same treaty governs both the Colorado River and Rio Conchos/Rio Grande, the international dialogue in the two basins has been largely independent. The World Wide Fund for Nature (WWF) established a pilot program in the Choguita headwaters to conserve the upper watershed by (1) improving erosion control through stone gabions in stream channels and (2) promoting a livelihood program focused on the community level to encourage small scale rainwater harvesting, backyard gardens, improved sanitary conditions, grey water reuse and source protection.

Similarities between the cases stem from shared vulnerability to climate variability and change, as both regions face extreme drought stress and pressure from climate change. The Rio Conchos exhibits several differences from the Colorado River Delta experience beyond its geographic focus on the upper watershed rather than the lower river Delta. There has been a more comprehensive environmental flow assessment in the Rio Conchos with nine sites evaluated and plans to address five more. Irrigation in the Rio Conchos is less extensive than the Colorado River Delta. There also is significant reservoir storage in the Rio Conchos in Mexico, unlike the Colorado River Delta, which lacks storage. Illegal water extraction is more pronounced in the Conchos than the Delta, as up to 60% of water use is not permitted, and groundwater use is largely unregulated. Finally, the Conchos lacks an entity to hold and manage an environmental flow entitlement like the Delta Water Trust.

The Rio Conchos does not have an environmental flow entitlement and confronts impacts from groundwater extraction on surface flows. WWF has promoted collaborative institutions to support reforms to the major irrigation district (Distrito 5: Delicias). These efforts build from a WWF-sponsored feasibility study that leveraged a $140 million investment from the North American Development Bank to reduce water use and improve compliance with treaty-mandated deliveries to the U.S. These water deliveries improve environmental flows in the Rio Conchos and have been combined with a buy-back program managed by the Mexican Agricultural

Ministry to acquire 90 Gigaliters and explore a new regime for formally allocating water to serve environmental flows.

In sum, both basins exhibit several defining elements despite their differences, including: collaboration with water users, recognition of the legitimacy of environmental flows, and assessment and quantification of environmental water needs to guide responses to overallocation. Both cases implement flow reallocation through a combination of improved irrigation efficiency, a buy-back of irrigation entitlements, and the redefinition of those entitlements through a federal decree.

Additional Resources:

Trueba, V., J.E. Barrios, A. Rodriguez, and M. de la Maza (2008). *Integrated River Basin Management in the Conchos River Basin, Mexico: A Freshwater Climate Change Adaptation Case Study.* WWF Mexico.

Zamora, F., O. Hinojosa-Huerta, E. Santiago, E. Brott, and P. Culp (2008). Collaboration in Mexico: Renewed Hope for the Colorado River Delta. *Nevada Law Journal*. 8: 871-887

3.3 Candomine-Balonne Catchment and the Murray Darling Basin, Australia - Robert Speed

Efforts to improve environmental flows in the Candomine-Balonne Catchment in the Murray Darling Basin in Australia have proceeded in two parts. Planning and environmental flow assessment occurred within the catchment in the early 2000s. The second aspect focuses on how this effort fits into the reforms that the federal government has implemented throughout the Murray-Darling Basin to acquire existing water rights for the environment. The Candomine-Balone catchment of the Murray-Darling spans 125 km^2 in a semi arid zone in southern Queensland in the upper reaches of the Murray-Darling Basin. The focus area is below Beardmore Dam (100,000 ML) to the border with New South Wales – a section defined by the presence of irrigated cotton farms and a large floodplain where farms have established offstream storage to capture periodic flood waters every three or four years. Narran Lakes is a Ramsar-listed wetland downstream of the cotton farms and a prime target for environmental water deliveries.

A draft plan was developed in 2000 to resolve conflicts, but this initial effort provoked significant community resistance. Consequently, a different approach was initiated. In response to community concerns about the science behind water management decisions, Australia's preeminent freshwater ecologist - the late Peter Cullen - was charged with reviewing the science around the Lower Balonne in close consultation with the community. The community consultation group used the resulting report to develop recommendations for a water resource plan that became the basis for new regulations about desired environmental outcomes, flow objectives, and a set of event management rules, such as the delivery of periodic floods to fill wetlands by reducing irrigator deliveries across the board by 10% rather than buying out one of the largest cotton farms and retiring 100% of its deliveries. The lessons from this effort emphasize the importance of community involvement in developing a scientific understanding behind the new management rules. This process helped to establish trust and support for new

environmental outcomes and management rules. Although the plan finished in 2004, implementation has been delayed for several reasons.

How do these efforts fit into the wider activities in the Murray Darling? Severe drought throughout Southeast Australia led the federal government to implement a number of measures aimed at improving the health of the Basin. These efforts have involved two primary elements. Institutional reforms have shifted authority over water management from the states to the federal level, resulting in a new basin authority to coordinate water planning and allocation across state jurisdictions within the Murray Darling. Secondly, there has been a large injection of cash or commitment of cash by the federal government (up to $13 billion AUS that includes approximately $6 billion for water use efficiency measures and $3 billion for buy-backs of water entitlements).

The government has adopted a policy approach to pursue water acquisition on a voluntary, willing seller arrangement. Early implementation has involved the government inviting water users to submit proposals, or expressions or interest, to sell their water entitlements and to specify the price they are willing to accept. Several challenges exist for this approach. First, acquisition is occurring before a basin plan has been developed, and there is not a clear understanding of where the water is needed most. Secondly, there is a rush to buy water for a short term and critical need; however, the initial focus has centered on acquiring long term rights to water instead of short term allocations available on the spot market. The federal government may be criticized if it buys expensive long term water rights whose short term water delivery allocations have been severely cut back. The third issue arises from the presence of a "gorilla" like the federal government in the marketplace. Irrigators also know each other well, and the potential for collusion is high among the sellers in the face of a large-scale buy-back effort.

3.4 Discussion Summary

Reverse Auctions

Q: The process of conducting a reverse auction (i.e. a solicitation for prospective sellers to express their interest in selling their water entitlements along with a bid for the price they are willing to accept) seems to have been applied successfully in the Western U.S., while the approach seems to be failing in Australia. Could you speculate about the reason this approach has fared differently in the two contexts?

A: In the Australian context, it becomes difficult for the government to use a reverse auction given the need for large-scale reallocation. Philosophically, it becomes a question of using a market approach when the government has the power and capacity to accomplish the reallocation through other means. It is still possible to compensate water users affected by the decision, but it may be more appropriate to reduce the cap by 10% across the board and offer compensation so water users can enter the market to acquire their water back if needed. The U.S. context is very different because reverse auctions occur on a small scale and are often driven by non-profits working within larger restoration efforts with strong collaborative bodies. A reverse auction can function well in small systems with homogenous water rights, such as irrigation districts, and a small pot of money and low willingness to pay.

Administrative capacity and institutional support

Q: How do you deal with the institutional shortcomings (administrative and regulatory capacity) associated with efforts that are user-driven, market-oriented, or stakeholder-based? What is the sustainability of approaches that depend on a strong regulatory setting for oversight and compliance after flow reallocation occurs?

A: Stakeholder-driven processes can stimulate regulatory bodies to exercise their authority in response to pressure from water users and non-profit groups. An NGO role can supplement institutional capacity in regions lacking resources to actively regulate allocations. For example, non-profit groups can fill an important institutional gap by supplementing monitoring activity and requesting enforcement actions to uphold flow protections.

Implementation Lags

Q: There was a significant implementation lag in the Candomine-Balonne. Given the complexity of these approaches, what is an acceptable timeframe for shifting from policy reform to implementation?

A: In the context of Queensland, the delay relates to the two-staged nature of the process. The first basin plan (discussed above) established the major goals and objective, while a second plan is needed to translate these goals into operational guidelines. This process has also been delayed due to the shadow of the federal government and the potential for the government to take over the situation.

3.5 Main Messages

Flow reallocation and markets in the Columbia Basin

- Market-based approaches to flow reallocation rely on policy reforms that may require several decades to establish enabling conditions, including: a cap on total withdrawals, water rights systems that limit access between users, recognition of the environment as a legitimate use, the ability to transfer reliable rights to restore environmental flows, and administrative capacity to uphold environmental water entitlements and protect communities and other water users from negative impacts.
- Lessons from the experience with market-based reallocation emphasize the importance of cooperation, the role of scale and scope to match transfer mechanisms to overallocation problems, and the need for adaptation.

Reallocation on the U.S.-Mexico border

- The Colorado River Delta and Rio Conchos exhibit different geographic and restoration characteristics due to the upstream-downstream relationships in transboundary systems.
- Nevertheless, a common set of enabling characteristics has developed, including: collaboration with water users, recognition of the legitimacy of environmental flows, and assessment and quantification of environmental water needs followed by a response to

overallocation that combines improved irrigation efficiency, a buy-back of irrigation entitlements, and the redefinition of those entitlements through a federal decree.

Basin planning in Queensland and the role of market-based buy-back programs

- The lessons from the Candomine-Balonne emphasize the importance of community involvement in developing a scientific understanding to guide environmental flow objectives and to develop or reform management rules to achieve flow objectives.
- Market-based water buy-back programs in the Murray-Darling have exposed some challenges associated with a large-scale government-led acquisition program, such as the lack of comprehensive plans to guide acquisition targets, a focus on long-term entitlements that lack adequate reliability over the short term to address critical environmental needs, and the potential for irrigator collusion in response to a large governmental buyer.

4. Prospective Cases (Panel 3)

The third panel examined cases where the recognition and designation of environmental flow requirements have prompted consideration of mechanisms and strategies to reallocate water from reservoir storage or existing water users to support environmental flows. Panelists examined the prospects for reallocation in four basins or regions by discussing the major barriers and opportunities for flow reallocation in each setting. The cases ranged from countries or basins with a strong mandate and authority for establishing environmental flows, such as South Africa, to regions where flow reallocation remains at an earlier stage of development pending wider reforms to water management, including basic recognition of environmental flow needs.

4.1 Water Entitlements and Trading Project, China - Robert Speed

Over the past three years, the Australian government has funded the *Water Entitlements and Trading Project* in China in response to a request from the Chinese Ministry of Water Resources for assistance in developing and implementing an entitlement-based water management system. A team of Australians has been based in Beijing to work through three phases of the project. The first phase reviewed the status of water rights and entitlements in China to develop a framework for an entitlements system that has since been endorsed by the Chinese Ministry through regulations and guidelines. The second phase developed more detailed guidelines for implementation of a full spectrum of water resource management activities. This framework encompassed allocation and planning activities from the basin to catchment levels and a permitting system linked to caps on water extraction for large irrigation districts comprised of thousands of water users. The final element of the project involved two pilot projects to apply the framework to practical water management situations, including (a) allocation and trading within a large irrigation district and (b) environmental flows assessment and planning.

The Jiao River basin – a small river basin on the southeast coast of China -- was chosen for the pilot environmental flows project. This project occurred within the context of growing interest throughout China in environmental flows, particularly in terms of the flow required to assist in sediment transport. Environmental flows are among a series of drivers prompting Chinese water managers to review the master plans for China's seven major river basins. The project attempted to demonstrate the role of catchment planning to identify and incorporate environmental flow requirements into allocation planning and rules using water resource modeling and scenario analysis. Historically, allocation planning was demand-driven and licensing occurred on an incremental basis without a cap on water extraction. Using a rapid-fire assessment coupled with limited fieldwork, the team identified environmental flow objectives tied to specific species and values expressed by the community, particularly those associated with commercial and recreational fishing. This methodology involved the FLOWS method and elements of the Ecological Limits of Hydrologic Alteration framework by setting objectives and determining the timing, duration, and frequency of flow components needed to meet those objectives.

In parallel, the team constructed a hydrological model and integrated the results of the environmental assessment to compare water management scenarios. This process examined the

effects of a proposed reservoir on water supply and environmental flow objectives. Using this model, it became possible to rank different water supply scenarios in terms of their effect on desired environmental flow objectives associated with fisheries.

The model compared alternative scenarios for managing a proposed dam by assessing the tradeoffs between water supply reliability and environmental flow objectives and between different consumptive users. The modeling and scenario-based process found that most environmental flow objectives could be reached through changes to management rules combined with a small reduction in the reliability of irrigation water supplies.

A major lesson of the pilot project emphasized the need to guide water management decisions using a limited amount of scientific information to develop an understanding of environmental water needs for species of concern. This information can be used to demonstrate that several flow objectives are attainable without major reductions to water supply reliability for irrigators. The experience also generated a broader lesson about incorporating the concept of environmental flows into planning efforts in development projects by aligning efforts with the priorities and agenda for the host country. In this case, the team operated within the guiding policy documents and planning processes established by senior policy advisors in the Chinese government and achieved strong acceptance as a result.

Additional Resources:
Water Entitlements and Trading Project
http://www.environment.gov.au/water/action/international/wet1.html
http://www.environment.gov.au/water/action/international/wet2.html

4.2 Middle East and North Africa - Ele Jan Saaf, SaafConsult

This case considers the prospects for introducing water rights trading in the Middle East and North Africa where water governance structures can pose substantial barriers to change. In these contexts, the state government manages water tightly. Water rights trading may be perceived as an opportunity for civil unrest due to the close link between water security and food security. Access to water in some countries is tied to the ability to influence government decisions through high powered arrangements; however, signs of an evolution in thinking about water trading have appeared in cases where institutional and legal systems have created a strong rule of law, such as parts of Egypt, Morocco, Jordan, and the United Arab Emirates.

A set of key questions and considerations applies in the Middle East. These questions do not differ substantially from other contexts, but they can be more complex. First, how do you value a water right? Many water rights have been developed and maintained through traditional systems during the construction of ancient infrastructure that created family water rights based on the labor of ancestors. In several cases, these rights are already being traded through informal bartering. Trading mechanisms depend on regulations and protections for the poor to maintain basic access to water. The final aspect involves social and administrative acceptance. Resistance to water trading can be a substantial barrier because perceptions of trading differ from the notions discussed here despite the fact that many people in the region have pursued trading on the traditional level.

At this stage, the concept is promising enough to motivate a pilot effort in a country with administrative capacity to support a trading framework. Extreme water scarcity makes the prospects both more necessary and more difficult within traditional administrative structures. Previous experience suggests that it is possible but requires time and a clear sense of the lessons learned elsewhere. The next step will require sharing these lessons learned with regional governments to illustrate whether and how the approach can work.

Additional Resources:

Saaf, E.J. 2009. The Potential of Water Rights Trading in the Middle-East – North Africa Region. *International Conference on Implementing Environmental Water Allocations*. Port Elizabeth, South Africa.

4.3 Krishna River Basin, South India - Jean Phillipe Venot, IWMI

The Krishna Basin in India provides an example where administrative allocation mechanisms may be required given the context for water management in a developing country with a strong irrigation bureaucracy. The Basin is large (260,000 km^2) and dominated by agricultural water use by 72 million inhabitants. Three states share water from the Basin, and conflict over water is a major concern across and within the states. There are several barriers to reallocation. First, the basin lacks an effective framework for reallocation because water rights are often fuzzy and weakly defined. Reallocation is also hindered by high social and economic costs, and institutional capacity and adaptability are low. Finally, it is difficult to reallocate without assessing environmental flow needs and linking these needs to widely distributed social and economic benefits.

Explaining these challenges further can frame prospects for reallocation. Allocation in India follows a prioritization or hierarchy of uses with domestic, agricultural, navigation, and environmental uses satisfied in descending order. This approach is difficult to operationalize and provides limited opportunities for environmental flows. Moreover, conflicts between the states within the Krishna have led to the formation of tribunals to determine each state's allocation based on dependable flows. Within the states, the government manages this fixed allocation through an administrative apparatus. A strong irrigation bureaucracy poses a challenge to environmental flows because the basin is closing and water for environmental needs is perceived as reducing water available for irrigation.

Because of these challenges, India and other developing countries have focused on raising awareness and trying to mainstream environmental thinking in water allocation decisions. Simplicity is the keyword in these efforts. There is both a need to change the overall institutional system of the country and to illustrate the need for reform through informed case studies. In the Krishna Basin, simple desktop methods can be used to examine the stage of river basin development in relation to environmental flow needs. In a closed basin, the case for environmental flows must be linked to clear social and economic benefits because a cap on extraction implies that flows will be limited for new uses. The Krishna Basin establishes this link between environmental flows and social and economic benefits due to the presence of an important Delta region that would suffer from salinization and decreased agricultural productivity in the absence of environmental flows. After making this connection, the environment can enter the agenda, and initial arrangements for environmental flow allocation

become possible. The initial arrangements may require refinement with new information and monitoring, but this approach provides an entry point for environmental flow reallocation in the context of developing countries with strong administrative control over allocation decisions.

Additional Resources:

Venot, J.P., V. Smakhtin, L. Bharati, and B. Sharma. 2009. Mainstreaming Environmental Flows in Basin Water Allocation Policies in Developing Countries: Insights from the Krishna Basin, South India. *International Conference on Implementing Environmental Water Allocations*. Port Elizabeth, South Africa.

4.4 South Africa - Niel van Wyk, Department of Water Affairs and Forestry

South Africa has an important history of addressing ecological water requirements. The country adopted a policy to create a reserve to satisfy both ecological water requirements and domestic water needs. However, many catchments are already overallocated by this standard. The passage of the Water Act in 1998 led to the development of a water resource strategy to enact its principles, including the reserve. This strategy involved several concepts that have been incorporated into new legislation that affects the prospects for reallocation. A move toward compulsory relicensing is a notable example. Compulsory relicensing is closely connected to the discussion of flow reallocation because relicensing involves a process of revisiting existing water use allocations and requiring license holders to reapply for their allocation. The new license may authorize a different quantity under different conditions. Other major reforms frame opportunities for flow reallocation, such as a classification system to rank the importance of particular water resource or water quality objectives that depend on water quantity.

Ten years after the Water Act a major question becomes how is South Africa doing with implementation? This question leads to a distinction between active implementation and passive implementation. Active implementation involves complex environmental flow requirements that have proven difficult to satisfy without changing existing water use patterns or pursuing reallocation. On the other hand, passive implementation has progressed through incorporation of the reserve into planning activities, investigations, and new water licenses. This passive implementation functions to halt or slow further deterioration.

The reforms and challenges in the South African experience provide insight into enabling conditions for implementation. Integrated approaches are necessary because environmental flow requirements cannot be pursued in isolation. Water allocation plans, operational requirements, and social needs must factor into the process. The complexity of environmental flow methodologies can pose a challenge to implementation, so a process of simplification and awareness building can be necessary.

Limiting factors include a lack of adequate resources to implement complex flow requirements, and political resolve is limited when a small sector of society must bear the costs. Reallocation may involve close attention to relicensing or retrofitting, and the political commitment to address disproportionate burdens on specific communities or sectors can be an important limiting factor.

Additional Resources:
South Africa Department of Water Affairs and Forestry. Undated. *A Guide to Water Allocation Reform and Compulsory Licensing.* Nelspruit, South Africa.

South Africa Department of Water Affairs and Forestry. Water Allocation Reform. http://www.dwaf.gov.za/WAR/

4.5 Discussion Summary

Simplicity and Complexity

Q: In the Krishna Basin and South Africa case studies the role of simplicity has been raised; however, it is important to consider the phase of implementation as well as the necessary complexity of ecosystems. Could you comment on this observation?

A: This point is critical. It can depend on the phase. In an early stage before environmental flows are even recognized, a simple message is needed to build awareness and get the topic into discussion, while implementation may involve refinement and complexity to restore complex systems.

Active and Passive Implementation

Q: The South African case study raised the notion of passive versus active implementation. Can you expand on that distinction?

A: This distinction is a basic feature of a two-step process of reform. An analogy is useful for the context of environmental flow reallocation where systems are already overallocated. The first step (passive) involves closing the barn door before more horses get out, i.e., to establish a cap or statutory limit that creates a reserve or halts further impairment. The second step (active) attempts to put the escaped horses back into the barn, i.e., to reallocate water to ensure the targeted flows are reincorporated.

4.6 Main Messages

Overarching

- Prospective cases demonstrate that different stages of reform and reallocation require different strategies and techniques for building awareness and incorporating environmental flow methods.
- The shift from awareness building to implementation often entails a progression from simplicity to complexity when incorporating environmental flows into allocation decisions.

China-Australia Water Entitlement and Trading Program

- The Jiao River pilot program demonstrated the importance of incorporating available scientific information to develop flow objectives.

- Management rules may be available to attain flow objectives through modest reductions in water supply reliability for irrigation.
- The pilot exhibits a broader lesson about the need to introduce environmental flow concepts by aligning them with the goals of the host country.

Middle East and North Africa

- Prospects for water trading in the Middle East raise a similar set of questions applied in other contexts, but they become more complex given tight governmental control over allocation. Key questions include the value of water supplies developed through ancient infrastructure and traditional systems, the need for regulatory protections for the poor, and social and administrative acceptance.
- Intense water scarcity makes water trading both more necessary and challenging.

Krishna Basin, India

- Administrative control over allocation can present barriers to reallocation.
- Mainstreaming environmental flows can overcome administrative resistance using simple methods to build awareness and establish clear linkages between flows and social and environmental benefits.

South Africa

- Meeting the ecological reserve cannot be accomplished in isolation; integrated water resource management provides a framework to address the reserve by integrating allocation plans, operational rules, and mechanisms to meet social needs.
- Complexity in environmental flow rules and insufficient political resolve can be limiting factors if retrofitting and relicensing impose disproportionate burdens on specific sectors of the community.

5. Interactive Panel and Discussion (Panel 4)

The final panel invited a group of four commentators with extensive experience with environmental flows and wider water governance matters. The goal of the session was to reflect on the previous panels and to stimulate a wider discussion about emergent themes. After brief remarks from the panelists, the floor opened for a wide-ranging discussion on topics tied to flow reallocation. In lieu of a summary of main messages at the end of this section, the conclusion incorporates the panel themes and discussion.

5.1 Chris Dickens, Institute for Natural Resources, South Africa

Taking the perspective of an outsider, the main observation is that the group is still attempting to understand the product (environmental flows) it aims to sell. Measuring key indicators of environmental health, such as fish species and invertebrates, represents an advance in defining the product, but there remains a great gap between these indicators and allocation decisions. Managers and stakeholders involved in allocation decisions will struggle to convert these indicators and conditions into allocation outcomes because it remains difficult to judge what is best for society. Therefore, it is necessary to understand the real value of having an ecosystem in good condition in order to convince decision-makers and the general public to act.

Additional Resources:

Dickens, C.W.S. 2009. Obstacles to the Implementation of Environmental Flows. *International Conference on Implementing Environmental Water Allocations.* Port Elizabeth, South Africa.

5.2 Cate Brown, Southern Waters, South Africa

Several central messages emerged from the presentations and discussion. First, there is a need to define development space to determine the bottom line requirements for environmental flows. The space for developing water resources must be constrained by that limit or reallocation may be necessary if the development space has been exceeded. The second and related point focuses on the context-specificity of approaches used to implement environmental flows, such as the contingencies based on geography and other contextual factors. The call for raising awareness and simplicity is a third point but one that also hinges on geography and the stage of the process. Although efforts may begin with a simple message, it becomes complex quickly if the aim is to change operating rules. A fourth point centered on the role of scale, such as the idea that economic trading has succeeded in small tributaries or basins, while larger basins or large government acquisitions may not work as well. Finally, the notion of piggy-backing reallocation onto wider reforms has been a recurring theme that emphasizes the need to integrate environmental flow reallocation into sound water management.

Additional Resources:

King, J. and C. Brown. 2009. Building Blocks and Flow Seasons: Steps Toward Integrated Flow Management. *International Conference for Implementing Environmental Water Allocations*. Port Elizabeth, South Africa.

5.3 Daniel Connell, Australia National University

Reallocation for environmental purposes becomes difficult if it is your sole purpose, and it needs to be part of a larger package of water reform. This point underscores a theme from several presentations, namely the importance of institutional design. For example, in order to have effective water markets, it is necessary to have effective water management. Institutional design is central to the discussion about improving the environmental condition of rivers. When considering institutional design, it is important to recognize that institutional reforms often layer on top of one another. The resulting complexity raises the issue of transaction costs and capacity to operate within layered institutional settings, including the need to reduce layers occasionally. These issues of institutional design are of central concern to restore rivers and alter hydrology.

Additional Resources:

Connell, D. 2009. Environmental Water in the Murray-Darling Basin – The Centre of a Political Storm. *International Conference for Implementing Environmental Water Allocations*. Port Elizabeth, South Africa.

5.4 Bruce Aylward, Ecosystem Economics, LLC

In lieu of a concluding commentary, a video was shown conveying the story of an environmental water transaction used to restore salmon habitat in the Pacific Northwest U.S. This video demonstrates the collaborative relationships involved in market-oriented approaches to flow reallocation.

The video -- "Where Water is Gold: Portrait of a Transaction" -- was produced by Narrative Labs for the Columbia Basin Water Transactions Program and is available online.

5.5 Discussion Summary

Reform status in South Africa

Q: Because water reform has become a major topic in South Africa, please share an update about the current debates and the implications for flow reallocation.

A: The current debate is focused on an element of the National Water Act that provided for "compulsory relicensing" to redress inequities in the distribution of water. Prior to social reforms in the 1990s, established white farmers controlled a substantial proportion of the water, and compulsory relicensing was viewed as component of water allocation reform. Although focused principally on issues of equity, the process opens wider questions of water distribution. In the process of water resource planning, it is necessary to reconcile water availability and other requirements, so the reserve becomes a factor, and it is possible to reset allocations to a degree. While much preparation has occurred, such as inventories of legal and illegal water use in many regions, progress has slowed recently due to a lack of resources, but is expected to resume. Models have determined the "yield" of water available for development and incorporated environmental water requirements in many places, so the scene is set.

Experience with compulsory, uncompensated reallocation

Q: Building on this discussion, is there international experience with regulatory reallocation without compensation?

A: (Australia) In the 1990s, New South Wales attempted to develop water sharing plans and environmental flow rules that proposed a process of structural adjustment that would have provided incentives to irrigators. The proposal did not provide a one-to-one level of compensation for reductions in water rights, so it may offer an example of compulsory reallocation. While the effort provided a solid foundation, the proposal generated significant community unrest and has made some people wary of the government's current attempts to buy-back water. Current buy-back efforts are acquiring water on the market but proceeding without a basin plan. It may also be impossible to acquire the level of water required via market acquisitions, so another process of structural adjustment may occur but likely with some form of compensation. At the same time, a primary drawback was the lack of clarity about the government's plans for the environmental use of the purchased water rather than the fact that is was uncompensated.

One idea for the Candomine-Balonne catchment was to combine a 10% reduction across the board with market adjustments, and this effort points to the importance of mixed approaches instead of reliance on a single model.

A key distinction in Australia is between regulated systems where reservoir storage can be used to regulate the delivery of environmental requirements and unregulated systems where multiple diversions may affect the prospects for reallocation.

(China) The Yellow River in the 1990s achieved reduced allocations through irrigation efficiencies and quasi-market expressions of interests.

(United States) Immediately to the south of the Columbia Basin, the Klamath River experienced compulsory reallocation in 2001-2, although irrigators eventually received compensation after political intervention from the federal government. The potential for the government to pursue mandatory reallocation of water stored in federal reservoir projects has been a powerful stimulus for irrigators to participate in voluntary, market-oriented programs rather than risk loss of their water rights without compensation.

(India and Jordan) In these countries, administrative reallocation and interbasin transfers are routinely done without direct compensation, particularly in intersectoral transfers from irrigation to urban and domestic uses.

(South Africa) The water allocation reform process comes to mind as an example, but the focus is redistributing water to communities rather than addressing environmental flows. The notion of piggybacking is important because these changes in water distribution trigger consideration of the ecological reserve, so environmental flow requirements may be addressed in the process of water allocation reform. In some cases, when excess water exists beyond the reserve, water is traded to generate funding for infrastructure to monitor the reserve.

(Tunisia) The Tunisian government provides an example of administrative reallocation when the water rights system was replaced with less tenured water allocations. A process of participatory irrigation management was developed to allow water users to decide their water needs for the growing season and plan for investments in infrastructure.

Lessons from experience with other resources

Q: What other types of allocation systems for resources can inform these efforts? Specifically, what can we learn from cap-and-trade systems for greenhouse gases and the role of caps for water trading? Is a cap a necessary condition?

A: A cap is necessary because without limits, anyone can access new permits, so there is no incentive to reallocate. Cap and trade schemes for environmental flows will likely be quite different from those for greenhouse gases due to the nature of the resource and scale of physical and social interactions.

Cultural values and concluding thoughts

Returning to Chris Dickens' opening commentary, it is important to recognize that environmental flows are another form of human need. It is necessary to acknowledge those needs and to be clear about those needs to build demand for reallocation. The cultural issue is central. While the core argument is that functional rivers can deliver more benefits if we keep them as functional systems, it is important not to forget the intrinsic values of rivers.

6. Conclusions

The collected insights from the previous sessions contributed to a final interactive panel where panelists and the ensuing discussion distilled the major lessons from previous sessions. Three central themes emerged:

- Enacting the water governance reforms needed to reallocate water to environmental flows will often depend on identifying and harnessing larger social, economic, and environmental drivers.
- Diverse political economic and environmental settings, as well as different stages of reform, will shape implementation prospects and strategies. Consequently, the lessons from any individual case should be balanced against the specific circumstances in a given basin or region to develop the appropriate mix of awareness building and institutional capacity.
- Experience with compulsory reallocation in regions across the world suggests that experimentation with a diversity of approaches to flow reallocation (i.e., regulation, collaboration and market mechanisms) may prove more successful than relying on a single blueprint or model.

The future agenda for flow reallocation must involve continued exchange of ideas and capacity across regional and global networks, as well as recognition that reform and implementation can span several decades and require substantial political and economic resources. Moreover, the level of complexity and uncertainty inherent to environmental flows has elevated the importance of adaptive governance institutions, which can promote learning-by-doing through regular monitoring and evaluation.

This workshop in Port Elizabeth and these proceedings seek to contribute to a widening and deepening movement that may be traced to the flow reallocation discussions between practitioners from the Columbia and Murray Darling River Basins at the workshop on environmental water transactions for the 2007 Riversymposium in Brisbane. This movement will be continued by the Environmental Flows Network (eFlowNet) in between major environmental flow conferences, by more detailed case studies and comparisons, by incremental or wholesale reforms in water governance, and by action at multiple and increasing scales to reallocate flows to restore and maintain freshwater ecosystems around the world.

Appendix 1: Registrants

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Appendix 2: Workshop Program

The Nuts & Bolts of Flow Reallocation

Pre-conference Workshop

International Conference on Implementing Environmental Water Allocations

Gilbey's Suite, Feather Market Centre, Port Elizabeth, South Africa,
12:30pm to 5:30pm, Sunday, February 22nd, 2009

Program

12:30 - 13:00 Sandwiches and Tea

13:00 - 13:15 Introductions and Review of Program

Welcome and Workshop Introduction: Robert Wigington, The Nature Conservancy, Global Freshwater Team

13:15 – 14:00 Session 1: Frameworks for Flow Reallocation

Moderator: Robert Wigington

Institutional Shortcomings in River Flow Reallocation
- Tom LeQuesne, World Wide Fund for Nature-UK

Quantifying Environmental Flow Needs
- Rebecca Tharme, The Nature Conservancy, Global Freshwater Team

Market Mechanisms to Meet Flow Needs
- Bruce Aylward, Ecosystem Economics

14:00 – 14:45 Session 2: Cases in Implementation

Moderator: Bruce Aylward

Columbia River Basin, United States
- Dustin Garrick, University of Arizona

Colorado River and Rio Conchos, Mexico
- Robert Wigington

Candomine-Balonne Catchment, Australia
- Robert Speed, Australian Department of Environment, Water, Heritage and the Arts

14:45 - 15:15 Tea Break

15:15 – 16:30 Session 3: Prospective Cases

Moderator: Katharine Cross, International Union for Conservation of Nature (IUCN)

China-Australia Water Entitlements and Trading Project, Jiao River, China
- Robert Speed

Middle East – North Africa
- Ele Jan Saaf, Saafconsult B.V./CEM-IUCN

Krishna Basin, India
- Jean Phillipe Venot, International Water Management Institute

South Africa
- N.J. (Niel) van Wyk, Department of Water Affairs and Forestry

16:15 – 17:25 Session 4: Interactive Panel and Discussion

Moderator: Tom LeQuesne
- Chris Dickens, Institute of Natural Resources, South Africa
- Cate Brown, Southern Waters Consulting, South Africa
- Bruce Aylward, Ecosystem Economics, United States
- Daniel Connell, Australian National University

17:25-17:30 Closing Remarks:
- Tom LeQuesne

Workshop Adjourned

17:30 – 19:00 Mayoral Reception

Conference Welcome Function at Feather Market Centre (drinks and snacks, no cost for registered delegates)

Appendix 3: Additional Resources

Aylward, B. 2008. Using Water Markets to Mainstream Ecosystems into Water Management. Economics Briefing Paper#3, Water and Nature Initiative. Gland: IUCN.

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Tharme, R.E. 2003. A global perspective on environmental flow assessment: emerging trends in the development and application of environmental flow methodologies for rivers. *River Research and Applications* **19**: 397-441.

Trueba, V., J.E. Barrios, A. Rodriguez, and M. de la Maza (2008). Integrated River Basin Management in the Conchos River Basin, Mexico: A Freshwater Climate Change Adaptation Case Study. WWF Mexico.

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Websites

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www.cbwtp.org

Ecological Limits of Hydrologic Alteration (ELOHA), The Nature Conservancy
http://conserveonline.org/workspaces/eloha

eFlow Network
www.eflownet.org

South Africa Department of Water Affairs and Forestry. Water Allocation Reform.
http://www.dwaf.gov.za/WAR/

Water Entitlement Trading Project
http://www.environment.gov.au/water/action/international/wet1.html
http://www.environment.gov.au/water/action/international/wet2.html