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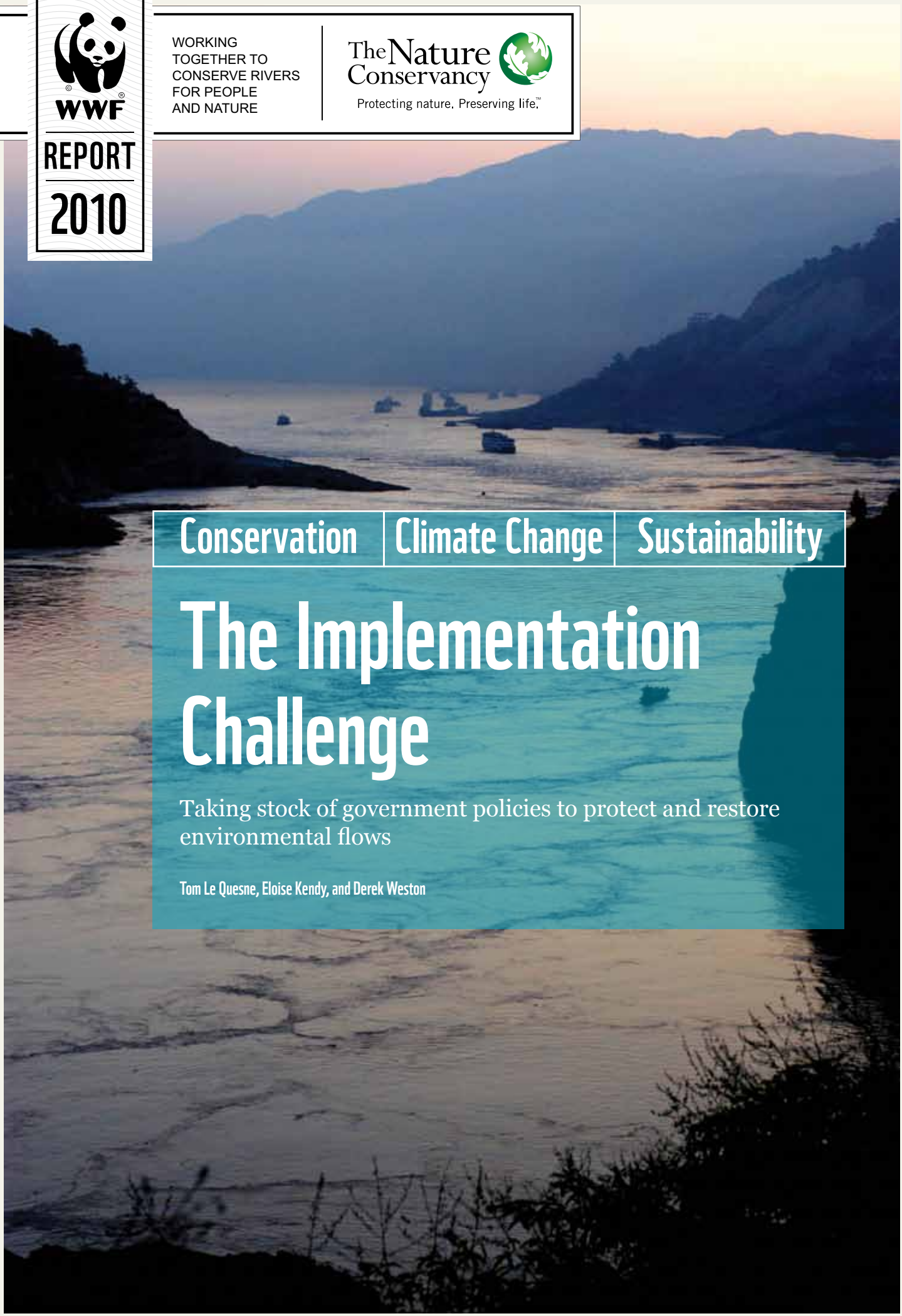

Conservation | Climate Change | Sustainability

The Implementation Challenge

Taking stock of government policies to protect and restore environmental flows

Tom Le Quesne, Eloise Kendy, and Derek Weston

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EXECUTIVE SUMMARY

Governments and water management authorities across the world have made significant and widespread progress in developing policies and laws to recognise environmental flow needs. While the concept of environmental flows long predates modern discussions of the subject, an understanding of environmental flows as a public policy imperative remains a comparatively recent development. However, there is now a proliferation of debates around environmental flows, and significant current dynamism around the development of laws and policies to recognise environmental flows across the world. Indeed, we are aware of no major nation in which environmental flows are not now being discussed or incorporated into high-level water policy decision-making.

Despite this significant policy development, in the majority of cases environmental flow provisions remain at the stage of policy and debate rather than implementation. Indeed, the defining characteristic of many contexts globally is precisely the lack of progress in translating these policies and intentions into action. While there has been progress in some places in capping future water development in recognition of environmental needs, successful re-allocation of water or re-operation of infrastructure in systems that are already stressed has been infrequent.

Several related obstacles present challenges to the implementation of environmental flow policies across the world. These include a lack of political will and stakeholder support; insufficient resources and capacity, in water management and allocation institutions generally, and for the delivery of those functions tasked with assessing and enforcing environmental requirements; and, institutional barriers and conflicts of interest.

On the basis of a number of international reviews, and the case studies and analysis undertaken for this report, a number of guidelines emerge for advancing implementation of environmental flows:

- **Undertake a phased approach to implementation.** Phased implementation can prevent an impossible pressure being placed on constrained resources, while allowing for the evolution of approaches to implementation. Phased implementation can include increasing complexity of scientific assessment, from desktop rules to complex, site-based investigations; increasing sophistication of flow regime, from basic protection of low season base flows to complex flow regimes prescribing multiple flood peaks and inter-annual variability; and, geographical phasing, starting with high priority sites. In many of the contexts surveyed for this report, implementation has started with simple approaches in a selection of locations, and evolved to more comprehensive and more sophisticated approaches over time.

- **Be opportunistic.** Institutional barriers can often be overcome by introducing and implementing environmental flow policies opportunistically. Opportunities may take the form of water resource planning, creative interpretations of existing policy, legal challenges or other crises such as social reform, or climate change. Being opportunistic may simply mean finding the right legal instrument. “Precipitating events” such as legal disputes or droughts may also provide openings for progress.
- **Don’t exceed available capacity, while building capacity from the onset of policy development**. In most contexts an approach is adopted that is too sophisticated for the relevant local capacity constraints. It is important that at any given time the policy, methods, and approaches are within the ability of the existing institutions to actually implement. By continuously building technical and managerial capacity in parallel with progressive policy implementation, the capacity to implement will not be exceeded.
- **Limit allowable water abstraction and flow alteration as soon as possible.** It is much easier to implement requirements on new users than to enact changes to existing use. Experience demonstrates that it is better to introduce a cap now that can be relaxed later if required than to allow water use to impact on environmental needs, resulting in the requirement for difficult future re-allocation processes.
- **Develop a clear statement of objectives for environmental flows policy based on an inclusive, transparent and well-communicated process.** Support for implementation is bolstered where a clear, high-level statement of objectives is achieved at the national policy and river basin level. This can provide the political commitment required to ensure that implementation occurs. Arriving at these decisions should involve as broad a range of groups, interests, and stakeholders as practical, with the best approach depending on the context: an appropriate stakeholder process for a small creek with thousands of people living in the catchment will, of necessity, be different than a river basin with tens or hundreds of millions of people living within it. While it may not always be possible to achieve consensus among all interested parties, allowing this engagement in reaching a decision can help to foresee implementation barriers.
- **Develop a clear institutional framework, including independent oversight.** Transparent, effective institutions and rules for water allocation and management are critical precursors to effective environmental flow policy; if they are lacking, then comprehensive water policy reform may be essential. Independent oversight is an important element of an effective institutional framework.

- **Create sustainable financing mechanisms, in particular financial resources where re-allocation of water is required.** Environmental flow programmes, like any other government programme, require sustainable funding. Revenue sources may range from general taxes to fishing licence fees to hydropower compensation funds and water markets. Conflicts of interest may arise if on-going institutional functions are funded by the regulated community through water use fees, as this incentivises financially strapped agencies to issue excessive water use permits. Water re-allocation from offstream uses to environmental flows presents special financing challenges.
- **Conduct proof-of-concept pilot projects.** Successful local pilot projects are vital for building technical capacity and political support, and showing that implementation is possible at much larger scales. The engagement of stakeholders in pilot projects ensures buy-in and builds trust that catalyses broader policy reform.
- **Allow flexibility for implementation methods, while setting a clear deadline and goals for implementation.** Programmatic flexibility is important for adapting approaches according to learning and local circumstances. Some flexibility allows for pragmatism; too much, however, can prevent administrations from being held accountable. Deadlines for implementation counterbalance flexibility and ensure progress.

CHAPTER 1 INTRODUCTION

Background

A river's flow is its heartbeat. Few human influences are more deadly to freshwater ecosystems than alteration of natural hydrological rhythms—the single greatest threat to our freshwater resources is the prospect that we will continue to use and manage them in the same manner as we have for the past century.

Freshwater ecosystems are losing a greater proportion of their species and habitats than ecosystems on land or in the oceans. Poorly planned dams, unbalanced and unsustainable water use, and pervasive pollution have brought too many of our lakes, rivers, wetlands, aquifers, and estuaries[1] to a tipping point. In extreme cases, some of the world's largest rivers—such as the Yellow, Colorado, Indus, and Murray—have ceased to reach the sea for periods of time.

At the most basic level, excessive withdrawal of water from ecosystems means that there is no longer enough available to support freshwater plants, animals, and the people who depend on functioning rivers and their associated ecosystems. Freshwater plants and animals have evolved with, and intimately depend upon, natural patterns of hydrologic variability. Naturally high and low water levels create habitat conditions essential to the reproduction and growth of freshwater species, or drive ecological processes required for ecosystem health. The natural rise of a river following a rainstorm may cue fish to move to spawning grounds, or enable them to move up- or downstream to access food, or freshen the water quality so it is more conducive to growth. Similarly, many wetland and floodplain plants reproduce only under certain flow conditions, such as prolonged flood recession.

Patterns of freshwater flows are crucial for a range of other services provided by river systems that are significantly important for people and societies. For example, flood pulses are responsible for sediment movement that maintains the form and function of rivers. In sediment-rich rivers, such as China's Yellow River, this movement of sediment is vital in the ongoing management of flood risk. Seasonal inundation of floodplains and wetlands can support groundwater recharge on which water supplies depend. And, the flow of freshwater to estuaries can prevent saline intrusion into coastal aquifers and drinking water supplies. The patterns of river flows are therefore integral to those river systems on which people depend.

The water flows and levels that support these processes are termed "environmental flows." Solutions that seek to identify and protect or restore environmental flows at particular sites will remain crucial for preserving key species and addressing particular crises. However, a more systematic application of environmental flows is required if freshwater

1 Throughout this report, "environmental flows" encompasses water flows and levels in wetlands, lakes, estuaries, and aquifers — not just rivers – as needed to support healthy freshwater and estuarine ecosystems.

ecosystem protection and recovery are to match the pace and extent of water resource development. Ultimately, this requires a scaling-up from site-by-site environmental flow provisions to the state, provincial, or national policy realm. Our vision is for every river in the world to be protected by government policies that effectively maintain healthy freshwater ecosystems while equitably sharing water benefits among all people.

Fortunately, a sea change is indeed underway. The importance of managing water flows for a healthy environment, and more broadly, the concept of ecological sustainability, is finally taking root in water resource planning and management.

The recent proliferation of groundbreaking environmental flow policies in hundreds of jurisdictions is a response to the growing evidence of the threats that hydrological alteration poses to ecosystem health and social values. Nevertheless, alteration of natural flow patterns continues to intensify the world over. There is a growing gap between the development of scientific methodologies on the one hand, and clear policy mechanisms for implementing across-the-board provision and protection of environmental flows on the other.

Many pathways to environmental flow policies have emerged and been tested in the past decade; many have failed or at best are deemed partial successes. Others are quietly succeeding in one way or another. We can learn from these experiences. At this time, we offer this review to reflect upon the progress made and obstacles encountered, and to share the lessons they teach us. We believe these lessons will encourage even the most frustrated that water policy reform that fully integrates environmental flow protection into the broad array of water benefits valued by society is the most expedient pathway to ecologically sustainable water management.

Definitions, objectives, and scope of this report

This report takes stock of international progress toward achieving effective environmental flow policies, and conveys the emerging lessons.

The term “environmental flows” is used to represent the quantity, timing, and quality of water flows and levels required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems.[2]

”Environmental flow policies” refers to the systematic recognition and protection of environmental flows across a jurisdiction, led by public authorities. While a first step is to recognise environmental flows in laws and high-level policy statements, the policy domain is not confined to these alone. Successful environmental flow policy requires implementation. The range of systematic approaches by which water resources are governed

2 The Brisbane Declaration *(http://tinyurl.com/yjwpnuo)*. In this context, quality refers to those elements of water quality that are impacted by the flow regime, such as temperature or estuarine salinity. It does not refer to the full range of water quality concerns in freshwater ecosystems, such as those caused by anthropogenic pollution.

and regulated includes legislation, regulations and enforcement, national strategies, accords and treaties, operational plans, as well as customary approaches.

We interpret environmental flow policy to include all aspects of water management required to give systematic and widespread protection to environmental flows, from high-level recognition to regulations, institutional implementation, and adaptive management.

This report takes stock of the range of policies instituted to date, examines impediments to implementation and keys to success, and offers guidelines for bypassing the impediments and achieving success in a range of political, economic, and social contexts. In particular, we have identified the translation of policy into action as the predominant challenge of environmental flows. Much of the discussion in this report therefore focuses on implementing environmental flow policies, the emerging lessons on obstacles to implementation, and how these might be overcome.

The literature on environmental flow assessment methods is large and ever swelling, yet analyses of environmental flow policies and, in particular, their implementation, are few and far between outside of a handful of extremely well-documented cases in Europe, Australia, and the United States. Written material on environmental flow policy exists primarily in the form of government policies, regulations, and statutes. Much of this material is not widely available. Equally importantly, government policy statements risk providing a partial or misleading depiction of progress if taken in isolation from detailed on-the-ground evaluation. We have attempted to avoid this hazard by verifying progress through discussions with individuals familiar with the policy development and implementation in selected countries. This verification process has proved essential, but has necessarily limited the extent of geographical review. Nevertheless, our research revealed a rich body of experience from different regions of the world. Woven together, these broad experiences tell a compelling story well worth sharing.

The following chapters provide a brief synopsis of environmental flow policies around the world, describe the three major challenges to implementing those policies, and offer nine guidelines for overcoming the obstacles and moving forward to full implementation. We illustrate both the obstacles and their remedies with stories from around the world, which appear in the case studies section.

Throughout the report, we have cited our sources of information. Statements in the text that lack reference citations are based on the personal experiences of the authors. Nevertheless, given that this is a rapidly evolving field in which detailed secondary literature is often thin, the authors recognise that mistakes or misinterpretations are likely. We apologise in advance for any such errors.

CHAPTER 2 HOW FAR HAVE WE COME?

In 1838, Colonel P. T. Cautley of the Royal Artillery placed before the British government in India a proposal to build a canal from the Ganga (Ganges) River at Haridwar. The Lt. Governor of United Provinces, James Thomason, strongly favoured the project as an economic measure, a necessity for the stability of revenue, and a safeguard against the calamity of famine. Canal construction started in 1842 and was completed in 1854.

Construction was then undertaken to raise the level of water in the river to divert flow into the canal. These activities were met with an uproar from the Hindu community, who insisted that the river should flow freely. Following negotiations, it was agreed in 1914 that part of the river's width would be untouched so that the Ganga could flow on its natural bed. Agitation revived when the local community observed that implementation did not fully meet the agreement. A fresh round of negotiations in 1916 resulted in the following provisions:

- A free opening in the weir would give a minimum discharge of 400 cusecs at the cold weather low level of the river.
- A free opening would provide a permanent flow of 200 cusecs for the service of ghats at Kankhal, ultimately flowing into the Gange.

The concept of "environmental flows" therefore long predates modern discussions of the subject. Nevertheless, a sophisticated and widespread understanding of environmental flows as a public policy imperative remains a comparatively recent development. However, as this review indicates, there is now a proliferation of debates around environmental flows across the world. From our international review, two principal conclusions emerge: first, there is significant current dynamism around the development of laws and policies to recognise environmental flows across the world; second, a significant gap now exists between policy aspirations and actual implementation.

There has, therefore, been a dramatic increase in the extent to which awareness of environmental flows has permeated water policy and water resource management debates over the last two decades. Indeed, we are aware of no major nation in which environmental flows are not now being discussed and/or incorporated into high-level water policy decision-making. The following examples illustrate the international dynamism around environmental flows.

Asia's challenges of water resource management are perhaps greatest in the world, and many of its countries are starting to recognise the importance of environmental flows. Japan's 1997 revision of its 1896 River Law introduced fluvial environment conservation as a clear objective of river administration for the first time[3]. Recent revisions of China's river basin Master Plans aspire to introduce environmental flows across the country; the restoration of flows to the Yellow River stands as the world's largest-scale re-allocation of water

3 The ELOHA Toolbox *(www.conserveonline.org/workspaces/eloha)* provides the actual text from the most relevant legal, policy, and regulatory documents quoted in the body of this report. Click on "Policy Implementation."

to environmental needs yet achieved. The 1991 Water Apportionment Accord of the Indus River System between the provinces in Pakistan recognised the need for a quantity of water to maintain the Indus delta's functioning. The Mekong River Commission's transboundary plan to develop hydropower and reduce flood risk hinges squarely on the ability to maintain the river's unique flood-pulse – dependent biodiversity, which provides a natural supply of food and a bountiful livelihood for 60 million of the world's poorest people. Vietnam has initiated comprehensive national water policy reform that recognises the maintenance of healthy aquatic ecosystems. In India, a rudimentary recognition of environmental needs is included in hydropower development policy, and the establishment of a new Ganga River Basin Authority in 2008 included as an objective the "maintenance of minimum ecological flows in the river Ganga."

In Oceana, high-profile debates over protecting and restoring environmental flow needs, particularly in Australia's Murray-Darling Basin, have been ongoing for many years, attended by a series of government initiatives for restoring over-allocated flows. The latest national initiative is backed by billions of dollars of federal resources. In 2008, the New Zealand government proposed a national standard establishing environmental flows and water levels to limit "all resource consent decisions on applications to take, use, dam and divert water from rivers, lakes, wetlands and aquifers."

In Africa, the South African National Water Act of 1998 is one of the most ambitious international attempts to integrate environmental flows into the core of water policy reform. Building on South Africa's work, the 2005 Southern African Development Community Regional Water Policy, representing 200 million people and covering 9.3 million square kilometres, states that "Member States should, in their mechanisms for allocating water resources among many users, allocate sufficient water to maintain ecosystem integrity and biodiversity including marine and estuarine life." Mozambique is undertaking reform that prioritises environmental water allocation above economic water uses. Ongoing discussions are addressing the restoration of environmental flow releases from dams across the Zambezi basin. Recently introduced water laws and policies in Kenya and Tanzania recognise environmental flows, and policy debates are progressing in a number of other African states and basins.

Policies and processes around protecting and restoring environmental flows are long-standing across much of Europe. While progress toward implementation has been varied, the 2000 European Union Water Framework Directive designates restored hydrology as one of the key elements of "good ecological status," the Directive's objective.

In the Americas, a number of USA states have introduced environmental flow policies and laws. All 14 western states recognise "instream flows" and many midwestern and eastern states do as well. Texas is undergoing a basin-by-basin process to determine environmental flow needs. Several northeastern states have recently enacted or are in the process of establishing seasonally varying flow standards that are linked to biological needs. States that are partly to the Great Lakes Compact have jointly agreed to institute water

management programmes that protect “water dependent natural resources” from excessive water withdrawals. Several provinces in Canada also have environmental flow provisions that require consideration of environmental flows in water allocation and water management planning. The Mexican 1992 Water Act recognises environmental flow needs, and there is active policy development on environmental flows in many Latin American countries, such as Chile, Ecuador, Colombia, Costa Rica, and Puerto Rico. Brazilian water law recognises environmental water needs, and national policy discussions are currently underway to introduce environmental flow regulations for hydropower development.

There are therefore dozens of examples of current developments in environmental flow policies across the world. Yet, if there is such apparent policy progress, why do water flows and levels continue to be degraded on such a widespread scale? In the majority of the cases, environmental flow provisions remain at the stage of policy and debate. The defining characteristic of many of these situations is precisely the lack of progress in translating agreements and policies into action.

Success, however, has not been entirely absent. A number of countries have succeeded in checking and constraining any new or further over-exploitation of flows. This vitally important aspect of success in environmental flow policy often goes unnoticed and unheralded, as it is difficult to measure maintenance of a status quo or prevention of future problems. This stands in contrast to the more visible, less common, and considerably more challenging restoration of flows to damaged ecosystems.

It is the implementation rather than the passage of those policies that poses significant, in some cases seemingly insurmountable, obstacles. Clearly, on-the-ground implementation of policy aspirations is the foremost global challenge to achieving environmental flows.

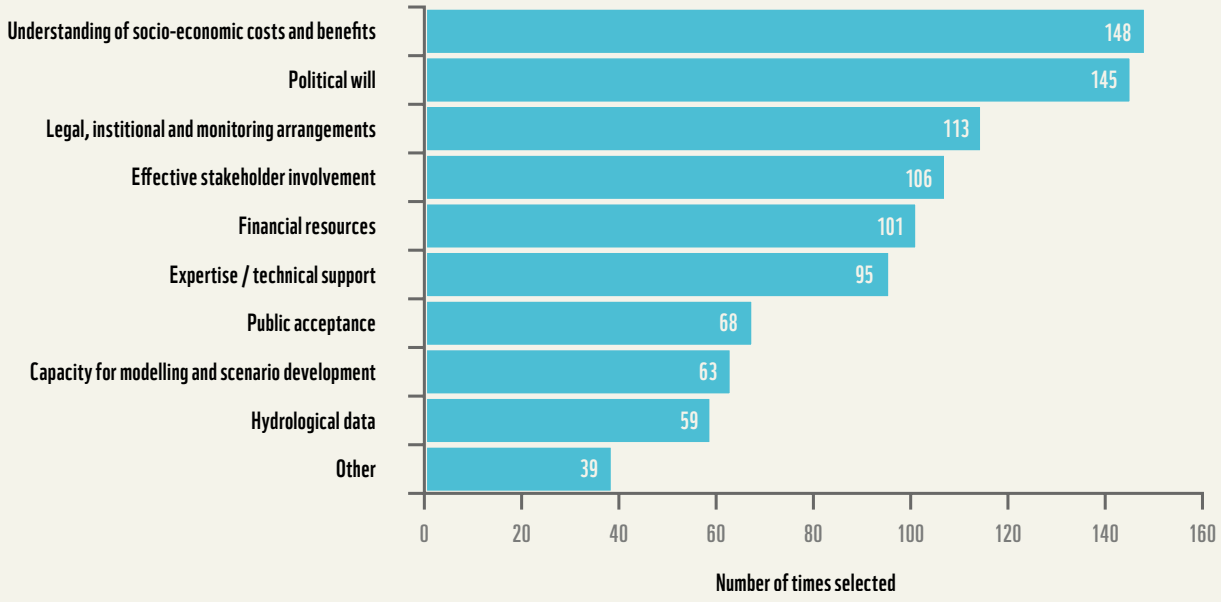
CHAPTER 3 OBSTACLES TO IMPLEMENTATION

The key challenge of environmental flow policy is the transition from high-level aspiration to actual implementation (Hirji and Davis, 2009a; Rowlston and Tharme, in press). While many countries now have some form of high-level policy or legal recognition of environmental flows, implementation has proved a significant challenge.

Two international reviews have attempted to assess environmental flow implementation challenges in detail. Based on our own review, we concur with and elaborate upon their conclusions, with our focus at the policy level.

Moore (2004) surveyed 64 countries via 272 respondents and documented the challenges perceived to be most pertinent to environmental flow establishment and application. Overall, respondents indicated that issues relating to stakeholder support and political will posed the most significant challenges. Legal and institutional arrangements also ranked high (Figure 1).

Figure 1: Difficulties and obstacles to understanding and implementing environmental flows (from Moore, 2004)



Moore examined the trends and differences between six major regions of the world: respondents from North America, Europe, and Asia cited political will as their most significant obstacle, whereas those in South America, Oceania, and Africa identified the lack of understanding of the socio-economic benefits of environmental flows among stakeholders, policy makers, and the general public.

In the second international review, the World Bank (Hirji and Davis, 2009a) evaluated how various countries have adopted environmental flows in policies and practice, and identified the following barriers to implementation:

- Maintaining political and stakeholder support to implement environmental flow provisions, especially in over-allocated catchments and basins
- Reorienting sectoral ministries to the need to include environmental water provisions in their policies and practices
- Establishing environmental goals and the benefits delivered by associated ecosystem services
- Matching environmental flow assessment procedures to the budget and time available, while still meeting the requirement for "best available science"
- Turning value-laden terms such as "over-allocation" and "sustainable levels of extraction" into practical procedures

Based upon these findings and our own global review, we identify three principal, related obstacles to implementation.

Obstacle 1.
Lack of political will and stakeholder support

Policy change alone does not result in implementation. Ongoing political and public support is essential. At the highest level, political support for environmental flow policy is crucial for setting strategic direction, securing planning resources, championing environmental requirements with stakeholders, and enforcing implementation.

However, political challenges can be monumental. Managing for environmental flows implies either that water should be removed from existing uses or constraints placed on future water uses. Agricultural, real estate, hydropower, or industrial sectors that may be impacted by these changes wield considerable political power, and may use it to resist attempts to reform water management. Competing social and economic requirements for water resources may further bias the political arena against environmental flows.

As reform efforts from South Africa's Water Act to the European Union's Water Framework Directive demonstrate, it is one thing to pass ambitious, high-level laws and policies; quite another thing to implement the on-the-ground actions that give effect to these. It is at the implementation stage that policy reforms come face to face with politically challenging realities, in particular resistance from affected sectors or concerns over politically unpopular decisions such as increased water bills. Interstate agreements on water management can pose particular challenges when the signatory states do not share common goals. This is one of several obstacles that have stalled environmental flow implementation in the lower Mekong River basin *(see case study 1, page 40).*

Obstacle 2.
Insufficient resources and capacity

Implementation cannot be achieved without strong institutions with sufficient resources and capacity to carry it out. Virtually every case study undertaken for this review reported that limited capacity of one form or another constrained implementation.

Conducting a thorough assessment and developing operational rules for environmental flows at even a single dam or river reach requires significant technical and institutional capacity. Doing so at the scale of an entire state, province, or country requires capacity that few, if any, possess at the onset of environmental flow policy implementation. Compounding the challenge, few begin with adequate financial resources to build and maintain effective environmental flow management programmes, from environmental flow assessment to incentives for flow re-allocation to long-term monitoring and adaptive management.

A comprehensive framework for implementing environmental flows requires that relevant laws, policies, regulations, procedures, and institutions be in place across a wide range of water resource management functions. In each of these contexts, implementing effective environmental flow policies requires two conditions: an effective water management and allocation policy and institutional framework, and recognition of environmental flow requirements within this framework. Neither of these on its own is sufficient to ensure environmental flows.

Table 1 lists the required main mechanisms and capacities related to each of these conditions. Successful implementation of any one of the constituent elements of the framework can represent a significant challenge; the establishment of successful mechanisms across all of these is no small undertaking.

Environmental flow policies may be enacted through either comprehensive or incremental reform *(see Pathways to Environmental Flow Policy, page 23)*. Comprehensive reforms change the overall water resources management framework, providing an opportunity both to strengthen the necessary water management institutions and to incorporate environmental flow requirements within them. In general, under comprehensive reform, many of the mechanisms and processes outlined in the left-hand column of Table 1 are initiated or fundamentally changed. On the other hand, incremental reforms typically focus on the right-hand column of table 1, with just a few elements of an existing water management framework altered with the specific intention of facilitating environmental flows.

Table 1 Enabling mechanisms and capacities for successfully implementing environmental flow policies

Water management framework	Environmental flow framework
Policy and legislation	
A clear legal basis exists for issuing and regulating water use, allocations, rights and licences. National laws and policies provide a framework for national and basin water planning.	Environmental flows are legally recognised as a priority requirement, ideally with legal standing at least equal to consumptive uses. Legal status or mandate enables setting and regulation of target water flows and levels for the environment.
Assessments and modelling	
Technical capacity exists or a capacity-building plan is in place and funded for long-term hydrological data acquisition and management. Basin hydrological data are collected and accessible. Basin hydrological models account for the cumulative impacts of all water uses on water availability at all control points.	Methodologies for determining environmental flow needs are established and agreed upon. Biological and related social and economic data are compiled and publicly accessible. Environmental flow assessments are undertaken.
Allocation and licensing procedures	
Water resource demands and conservation potential are quantified and forecasted. Basin planning and water management processes exist that link water licences to water availability, using hydrological models or decision support systems. Water allocation licences and rights are clearly specified for surface and groundwater. An infrastructure construction and operation licensing system is clearly specified.	Environmental flow needs are quantified and expressed as numerical limits on flow alteration. Limits may differ by water body, according to environmental objectives. Basin planning and water management processes incorporate mechanisms to protect environmental flows. Water allocation licences protect environmental flows. Infrastructure siting, design, and operating licences protect environmental flows.
Re-allocation mechanisms	
Legal and institutional processes enable flexibility in, and adjustments to, water allocation. Financial resources are available for supporting or compensating re-allocation and licence adjustment, including water conservation measures.	Legal and institutional process exists for adjusting licences to available water and re-allocating water from consumptive uses to the environment. Incentive and market-based programmes encourage re-allocation of conserved water to the environment. Legal mechanisms protect restored water flows from abstraction by other users.

Monitoring and enforcement	
Periodic review and assessment of water abstraction licences and infrastructure operating licences are undertaken to ensure compliance. Institutional capacity and political will exists to enforce licence requirements.	Environmental quality, including biological and other indicators of flow alteration, is monitored and analysed routinely to verify that intended benefits of environmental flows are achieved. Periodic review, assessment, and revision (if warranted) of environmental flow requirements are undertaken.
Organisational requirements	
Secure sources of sufficient revenue exist for all management functions. An independent authority audits performance of the policy; legal recourse is available to resolve conflicts.	Clear institutional responsibility and capacity exist for assessing and implementing environmental flows. An independent authority audits performance of the policy; legal recourse is available to resolve conflicts.

Katmai National Park, Brooks Range, Alaska

Basic needs for building these frameworks—all requiring significant managerial, technical and financial capacity—include but are not limited to the ability to:

- Assess resource availability and environmental conditions
- Engage and facilitate stakeholders
- Undertake environmental flow assessments
- Integrate environmental flows into clear water resource allocation and reservoir siting, design, and operation plans and, ultimately, enforceable individual or group water rights
- Enforce water allocations and reservoir release schedules
- Monitor and review the outcomes of environmental flow management
- Engineer win-win solutions to water resource conflicts, including decision support tools, water transactions, and conjunctive management of groundwater and surface water

Not all of the environmental flow framework requirements will be of equal importance in every context. For example, in water-abundant basins subject to significant hydropower development, infrastructure licensing procedures may be the most important requirement, linked to sophisticated hydrological and environmental flow assessments that are capable of incorporating hydrological variability; in stressed environments, re-allocation mechanisms may be the primary enabling challenge; and, in some contexts, monitoring and enforcement may be the primary enabling need.

However, a sound water management framework is always essential. National environmental flow policies simply cannot stand alone within a water management vacuum. Environmental flow policy rests firmly upon the foundation of an effective, amendable water management framework.

Environmental flow management costs money. Sustainable financial resources are needed to conduct environmental flow assessments; build databases, tools, and the capacity to use them; coordinate stakeholders and experts; issue and enforce standards; and facilitate compliance through engineering and other potentially costly approaches. Inadequate funding stymied implementation of Alaska's environmental flow protection programme for two decades *(see case study 2, page 41).*

The inadequacy of existing information systems is a widespread challenge globally. Hydrologic monitoring networks from Kenya to the United States have been reduced in the last decade due to budget constraints, and biological monitoring networks are even more sparse.

Pathways *to environmental flow policy*

Many different management processes govern the use of water resources. Environmental flow policies may be implemented through one or more of these. We identified three different broad approaches or "pathways" to adoption and implementation of environmental flow policies:

Comprehensive Water Policy Reform: Some countries have completely overhauled their water management policy and legislation. Such major sectoral reforms are not generally driven by environmental considerations, but rather by broader economic or social concerns. The process can spawn significant opportunities to integrate environmental flows into national policy and sectoral reform.

Incremental Water Policy Reform: Environmental flows may obtain legal standing by amending existing policy or regulation, typically via progressive amendments to water licencing and to the siting, design, and operation of dams, reservoirs, and associated infrastructure, and by the addition of new regulations and supporting technical amendments to legal text. Incremental reform can also occur when existing laws are interpreted in a new way.

Interstate Treaties: The transboundary nature of certain basins has enabled the introduction of environmental flows via international or interstate agreements and treaties to coordinate basinwide water management.
A number of regions are pursuing environmental flows through several pathways simultaneously. In other cases, countries may transition from one pathway to another. For example, implementation of environmental flows to meet interstate treaty conditions may inform and lead to a more comprehensive water policy reform process within the individual signatory states.

Obstacle 3.
Institutional barriers and conflicts of interest

Environmental flows are inherently interdisciplinary and inter-sectoral. The Instream Flow Council of the USA and Canada identifies "understanding, incorporating, and improving legal and institutional frameworks" as a leading challenge to implementing environmental flow solutions (Annear *et al.*, 2004, p. 8). Agencies that plan and manage hydropower, agriculture, land use, urban and industrial development, and natural resources all operate under different legal authorities, yet all play important roles in managing environmental flows. A lack of understanding about the interdependence between various downstream water needs, including estuarine, near-shore, and aquifers, further exacerbates the institutional barriers between the respective government agencies that manage them (Hirji and Davis, 2009a).
In addition, countries whose political and academic institutions do not cooperate may be at a disadvantage in developing the scientific and decision-support tools needed to set and manage flow targets.

Throughout the United States, state (rather than federal) departments of fish and wildlife are primarily responsible for protecting instream flows, but lack authority to manage water abstractions or quality issues as these are handled by other state and federal agencies. Frustrated instream flow programme

managers struggle for political support outside their agencies (Annear *et al.*, 2009). In the UK, the Environment Agency sets flow restoration requirements for water supply companies to meet; the economic regulator, OFWAT, then denies the funding that will enable companies to comply (Le Quesne and Timlett, 2010).

Conflicts of interest may arise not only between, but also within implementing agencies—for example when they are rewarded for economic development rather than for environmental protection, or when they depend on water use fees for their revenue. This intensifies the already significant challenge of reorienting sectoral ministries to the need to include environmental water provisions in their policies and practices.

When environmental flow policies are part of comprehensive water policy reform, administrative institutions may change drastically. Enacting an entirely new suite of policies and institutions is a major undertaking. Consequently, significant delays can be expected to plague environmental flow implementation, while the entire reform process slowly becomes operational. The challenges of adjusting to major new policies include, but are not limited to, establishing new regulatory, monitoring, and enforcement institutions. Some of the perceived inefficiencies and delays in Vietnam's environmental flow policy implementation, for example, are due to the various ministries involved adjusting to the new Water Law *(see case study 3, page 41)*.

Institutional barriers become especially poignant when interstate agreements are the vehicles for environmental flow recognition. Signatory "states" may be sovereign, or in a federal system in which water resources are managed at the state or provincial level. Interstate agreements often require signatories to undertake internal reforms in order to meet the necessary requirements. The need to sign an interstate agreement typically is driven by the absence of an overarching institution with the legal mandate to manage the resources of the basin. This lack of political authority carries through into implementation. Ongoing disputes between the signatories cannot easily be resolved, even within federal systems. This challenge lies at the core of the failure to implement the environmental flow requirements enshrined in the Indus Water Accord *(see case study 4, page 42)*.

CHAPTER 4
GUIDELINES FOR OVERCOMING IMPLEMENTATION CHALLENGES

One of the key messages that emerges from our global snapshot of environmental flow policies is that there is no single correct approach to implementation of environmental flows. Nevertheless, there is very significant international dynamism around the attempts to recognise and implement environmental flows, and from this growing international experience a number of lessons are beginning to emerge. This rich body of international experience can provide guidance, in particular when considering how some of the challenges identified in chapter 3 can be addressed.

In their major international review of environmental flows, the World Bank (Hirji and Davis, 2009a) developed a set of recommendations and guidelines for environmental flow implementation, both at the policy and basin scale:

- Giving environmental water entitlements at least equal standing in law to consumptive water entitlements provides security to environmental water allocations.
- No single environmental flow assessment technique suits all basin planning requirements within a country; a range of techniques from simple to complex is needed to respond to the range of risk, intensity of water use, budgets, and timeframes.
- Environmental provisions need to be comprehensive across the water cycle to include surface water and groundwater, estuaries, and near-shore regions. All relevant components of the water cycle should be considered in environmental flow assessments.
- Caution is needed when allocating water rights or other forms of entitlement for water abstraction; once allocated, it is very difficult to reduce these entitlements at a later stage to return more water to the environment.
- Public participation is important but needs to be realistic; it should be tailored to suit the capacities of the stakeholders and the policies of the country.
- Ecological monitoring of outcomes is essential, partly to reassure stakeholders that environmental benefits are being delivered and partly to provide information for adaptive management.
- Following implementation, there is a need to demonstrate the benefits of environmental flows. It is not enough to allocate water for the environment in basin plans; managers need to demonstrate the resulting human and ecosystem benefits through monitoring and interpretation.

Many of our case studies support these observations. On the basis of the analysis undertaken for this review, and the wide-ranging personal international experience of the authors, we propose the following guidelines

for environmental flow policy implementation. These address the current obstacles to implementation, and reinforce and complement the conclusions of the World Bank study:

Guideline 1. Undertake a phased approach to implementation

Guideline 2. Be opportunistic

Guideline 3. Don't exceed available capacity, while building capacity from the onset of policy development

Guideline 4. Limit allowable water abstraction and flow alteration as soon as possible

Guideline 5. Develop a clear statement of objectives for environmental flow policy based on an inclusive, transparent, and well-communicated process.

Guideline 6. Develop a clear institutional framework, including independent oversight

Guideline 7. Create sustainable financing mechanisms, in particular financial resources where re-allocation of water is required

Guildeline 8. Conduct proof-of-concept pilot projects

Guideline 9: Allow flexibility for implementation methods, while setting a clear deadline and goals for implementation

Guideline 1. Undertake a phased approach to implementation

Water reform processes, including those that seek to introduce environmental flows, are rarely—perhaps never—straightforward. Experience suggests that policy reform should be thought of not as a single event, but as a process with cycles of development, implementation, evaluation and review (MacKay and Roux, 2004; De Coning and Sherwell, 2004; De Coning 2006). Reform typically proceeds in fits and starts over a period of time. Internationally, most countries where water sector reforms are underway are now making this step-wise progression.

Phased implementation is therefore a crucial mechanism for overcoming the barriers to implementation. It can prevent an impossible pressure being placed on constrained resources, while allowing for the evolution of approaches to and methods of implementation. Phased implementation can be undertaken in a number of different dimensions, which we discuss below:

- Increasing complexity of scientific assessment, from desktop rules to complex site-based investigations
- Increasing complexity of flow regime, from basic protection of low season base flows to complex flow regimes prescribing multiple flood peaks and inter-annual variability
- Geographical phasing, starting with high priority sites

In many of the contexts surveyed for this report, implementation started with simple approaches in a selection of locations, and evolved to more comprehensive and more sophisticated approaches over time.

The maintenance of riparian ecosystems, functions, and processes depends not just on the maintenance of a certain minimum flow level, but on a range of different elements of the natural flow regime (Poff et al., 1997). For example, sediment movement, the maintenance of channel and delta morphology, and wetland and groundwater recharge often depend on periods of high flow and flood. Similarly, fish migration and spawning are often enabled and triggered by periods of flood or freshet at specific times of year.

Therefore, environmental flow regimes and policies ultimately should protect all elements of the natural hydrograph. In increasing level of sophistication, these include (Arthington and Zaluki, 1998; King and Louw, 1998):

- Wet- and dry-season base flows
- Normal high flows (also known as freshets and pulses)
- Floods
- Extreme low flows
- Inter-annual variability

Historically, environmental flow programmes have built upon minimum flow standards that were enacted to dilute pollution or to protect individual fish species. For example, Brazil is currently advancing from protecting minimum flows to protecting the full flow regime *(see case study 5, page 43)*. Interventions to protect base flows during the dry season may be an important first step, and in some contexts may go a significant way to achieving the required objectives, especially in systems with little storage where floods and pulses are unmodified. However, minimum flow standards often lead to flow regimes that overly simplify complex, dynamic ecosystems and cannot support the full suite of riverine resources.

Increasingly, new environmental flow programmes are developing holistic or percent-of-flow approaches that protect the full spectrum of the natural hydrologic regime (Richter, 2009). South Africa, Tanzania, numerous states in Australia, and certain Water Management Districts in Florida (USA) leap-frogged right over minimum flows and went directly to variable flow standards.

Environmental flow assessment methodologies can also show an increasing level of sophistication, from simple rules to very complex assessments costing millions of dollars and taking place over years. Of course, no single environmental flow assessment technique suits all social, economic, hydrologic, and ecological contexts within a country; a range of techniques from simple to complex is needed to respond to the range of risk, intensity of water use, budgets, capacity, and timeframes (Hirji and Davis, 2009a). Based on this principle, Opperman *(see Three-level heirarchy, page 28)* prescribes a three-level hierarchy of flow assessment that emphasises initiating implementation as soon as possible. South Africa was one of the first to adopt a hierarchy of methods of varying complexity. The lower Mekong River states created their own phased approach. Mexico is currently developing a similar suite of assessment methods to match the sophistication of flow recommendations to available capacity and the anticipated extent of flow alteration.

Three-level hierarchy of flow assessment, implementation, adaptive management

Opperman (written communication, October 9, 2009) prescribes a consistent three-level assessment and implementation framework that builds seamlessly from simple desktop estimates of flow needs through to a highly sophisticated programme of research and modelling to refine environmental flow targets, with each level building information, capacity, and support for subsequent levels of sophistication as deemed necessary. In this way, proactive, practical implementation can begin immediately upon completion of the level of assessment most suitable to the resources available to a particular water body or jurisdiction.

Three key characteristics of this framework include: (1) funds for research and modelling to support flow assessment and implementation are invested strategically to address the most important issues and reduce the most vexing uncertainties; methods are matched to the level of certainty required and the level of funding available; (2) the framework is iterative such that higher levels are deployed to the extent they are necessary and information generated at one level can provide the foundation for, and identify the need for, higher levels and; and (3) processes for flow assessment and flow implementation are intertwined; many of the key characteristics of the assessment process are designed to lay the foundation for flow implementation. The framework not only gets environmental flows protected quickly, but also catalyses the broader process of implementation, including capacity building and institutional strengthening.

Level 1 uses hydrologic desktop methods grounded in an understanding of the linkages between flow regime and key riverine resources. Hydrologic desktop methods are relatively quick and inexpensive. However, they generally provide overly simplistic flow levels that do not fully encompass current understanding of river functions and processes. Therefore, initial targets based on level 1 analysis should be precautionary, in line with their level of confidence, with the intent that more flow alteration may be allowed later pending refinement of targets based on higher resolution methods. For policy applications, the Ecological Limits of Hydrologic Alteration (ELOHA) is a level 1 approach that combines a desktop hydrologic analysis with a review of existing ecological databases and literature to set preliminary environmental flow standards for many rivers throughout a large geographic area simultaneously (Poff *et al.*, 2010).

Level 2 uses expert panels to refine the level 1 assessment and to design a targeted research programme for reducing uncertainties. At the site scale, this approach produces a set of initial flow recommendations that can lead to experimental flow releases. Monitoring of such releases can provide a learning opportunity to improve understanding of river processes. Scientists and water managers in the Susquehanna (USA), Magdalena (Colombia), and Potomac (USA) river basins have elevated ELOHA to level 2 by using expert panels to assess flow needs for river types, rather than for individual rivers, as a basis for initial flow standards that apply throughout the basins.

Level 3 is appropriate for situations that require a high degree of certainty before any operational changes can made. Such situations may include those where: (1) water is over-allocated and heavily contested; (2) the presence

of endangered species limits operational flexibility; (3) defined policies dictate processes; or (4) binding long-term decisions are being made. In these situations, decision makers will require a higher threshold of rigorous analysis before initiating an environmental flow program. Thus, level 3 is characterised by greater investment in highly sophisticated methods for examining tradeoffs and predicting results of operational changes.

All three levels of flow assessment are considered holistic because each explicitly addresses a range of flow levels and events and a range of riverine resources, processes, and values. The three levels are not mutually exclusive within an implementation process. Level 1 may be implemented widely across the country, with levels 2 and 3 being applied in high-priority sub-basins.

The first phase, or level, of the hierarchy may be a set of generic standards that apply to all water bodies in a country. This type of standard applies readily to water allocation permitting. The Ecological Limits of Hydrologic Alteration (ELOHA) is a flexible framework for determining and implementing generalised variable environmental flows at the regional scale, and was developed specifically to meet the needs of managing environmental flows through state, provincial, or national water policy (Poff *et al.*, 2010; Kendy *et al.*, 2009). The various steps of the framework may be carried out in a number of different ways, ranging from best professional judgment to sophisticated statistical modelling, depending on the available data and technical capacity. Likewise, the Sustainability Boundary Approach (SBA; Richter, 2009) sets limits on the percent of flow alteration from natural conditions for different types of rivers to achieve different ecological condition goals. Unlike other regional approaches, ELOHA and the SBA generate flow standards that are explicitly linked to ecological functions. For example, in the USA, Michigan *(see case study 6, page 45)* and Maine have instituted and Connecticut has proposed variable, ecology-based flow standards that apply to groups of rivers throughout their entire states. These states are demonstrating that, although there will be some cases, for example in ecologically important systems, where a site-specific flow assessment may be desired from the outset, it is possible to start by implementing general environmental flow requirements, and develop more sophisticated approaches as required.

Generic standards, however, may be difficult to apply to dam operations. Most countries with environmental flow policies are setting flow standards for dams on a site-by-site basis. For example, an expert panel in the UK concluded that simple generic rules could not apply to all rivers, and instead recommended that each water body be analyzed individually. The experts set forth detailed principles for making such analyses (Acreman and Ferguson, 2010). Likewise, South Africa established an incremental process such that not all infrastructure projects had to have environmental flow determinations immediately (R. Tharme, personal communication, 18 July 2010).

Nonetheless, national reservoir release regulations for environmental flow provision are emerging in a few places. The draft environmental flow regulation for Connecticut (USA) sets generic dam release rules that vary according to the season, reservoir storage level, and whether the preceding

period was dry or wet. Impacts of the proposed rules on reservoir volumes were modelled to ensure that their implementation would not compromise the ability to provide secure water supplies (Apse *et al.*, 2008, p. 150-153).

Once initial flow standards have been established, phasing in compliance over time can accommodate technical and financial capacity constraints while allowing for learning and development. In the United States, for example, Michigan *(see case study 6, page 45)* allowed water users one year to familiarise themselves with the Water Withdrawal Assessment Tool before requiring its use. Connecticut's (USA) draft flow regulation initially limits individual water withdrawals without considering the impacts of other users. In ten years, when decision support software will be available to account for impacts of cumulative water withdrawals, the standards will apply to each water body rather than to each user.

Implementation can also be geographically phased. In Florida (USA) *(see case study 7, page 46)*, the Department of Environmental Protection, together with the Water Management Districts, jointly develop a list of priority sites where environmental flows assessments are required. This enables the authorities to keep abreast of resource development and to target critically important resources from a conservation perspective (Wade and Tucker, 1996; D. Shaw, personal communication, 20 January 2009). In Australia, *(see case study 8, page 47)* as part of the "Living Murray" initiative, six "icon sites" have been identified for conservation status as a first step toward regaining water for environmental flows in the Murray-Darling basin. In England *(see case study 9, page 49)*, rivers and sites identified under the European Union's Habitats Directive have been preferenced for flow restoration efforts. As noted below, a useful approach to phasing may be to introduce a cap early on, while phasing the more complex and expensive process of re-allocation of water to over-abstracted or over-modified reaches.

Guideline 2.
Be opportunistic

Institutional barriers can often be overcome by introducing and implementing environmental flow policies opportunistically. Opportunities may take the form of water resource planning, creative interpretations of existing policy, legal challenges, or other crises such as social reform or climate change.

Water resource planning offers an obvious opportunity to institute environmental flow protection. For example, Colorado (USA) is, for the first time, considering ecological water needs in its comprehensive water resource planning processes. To support this process, Colorado has developed a technical tool that helps basin stakeholders understand the consequences of flow alteration on fish, invertebrates, riparian forests, and recreational uses of their rivers (CDM *et al.*, 2009). Georgia (USA) is also incorporating environmental flows into its statewide comprehensive water management plan.

Although flow releases from reservoirs are typically regulated at the project scale, their national impact can be enormous, especially if they spur

basin-scale integration of sustainable hydropower and water resource planning (Opperman and Harrison, 2008). The profusion of new hydropower proposals throughout the world has prompted ministries of environment from Vietnam to Colombia to initiate national integrated water resource planning that provides for environmental flows.

Being opportunistic may simply mean finding the right legal instrument. Modifying an existing government programme rather than instituting a new one specifically to manage water can greatly accelerate environmental flow protection. For example, Maine (USA) *(see case study 10, page 50)* modified its existing water quality programme and Mexico *(see case study 11, page 51)* is modifying its existing water availability standard to accelerate the implementation of new environmental flow policies. Creative thinkers in Mexico have even managed to re-allocate flows to the Colorado Delta in the absence of a specific legal framework not by introducing new policies, but rather by stretching the interpretation of existing water rights law.

Smith (2009) cites the importance of recognising and acting upon "precipitating events" that bring environmental flow issues onto the formal agenda of institutions. These events provide opportunities for stakeholders to work together to resolve the issues involved, often leading to significant reforms. These opportunities may be legal challenges that question the existing framework, such as the series of administrative and legal actions that brought groundwater management to the forefront in Montana (USA) *(see case study 12, page 52)* or a legal challenge to a groundwater withdrawal, which pitted the rights of riparian landowners against the groundwater rights of property owners and thereby precipitated the development of environmental flows protection in Michigan (USA) *(see case study 6, page 45)* (Smith, 2009).

Crises are often precipitating events. Environmental flow restoration efforts on the Murray-Darling *(see case study 8, page 47)*, Yellow, and Indus Rivers *(see case study 4, page 42)* all resulted from systems reaching crisis point. Crises such as droughts and associated river dewatering and water supply shortages spurred statewide flow protection in Montana *(see case study 12, page 52)*, Georgia, and Maine *(see case study 10, page 50)* in the United States. Catastrophic fish declines prompted action in British Columbia *(see case study 13, page 53).* In each of these cases, crises provided opportunities to generate awareness, improve understanding, and effect change.

Pressures other than resource stress can also open doors to new environmental flow policies. For example, South Africa *(see case study 14, page 54)* adopted its 1998 Water Act to establish more equitable access to water resources in concert with the end of apartheid. Although it was not established primarily to protect environmental flows, that is one of its major outcomes.

Climate change provides an opportunity to elevate environmental flows to the policy level, as water managers seriously assess options for coping with future water resource scenarios. The threat of climate change has prompted Australia and the United States to conduct comprehensive scientific investigations that provide a sound foundation for environmental flow management. *(see Climate Change as Opportunity, page 32)*

Being opportunistic also means choosing the right battles. In water-rich areas where hydropower dominates, water withdrawal standards may not be needed in order to significantly improve flows. Because flow restoration may require action by and regulation of only a small number of actors (the hydropower dam operators), flow improvements can proceed relatively rapidly compared to changes that involve a large number of abstractors. British Columbia demonstrates the significant improvements that can result from such a strategic approach*(see case study 13, page 53)*.

Climate change as opportunity

...in Australia...

Climate change was a driver for Australia's Murray-Darling Basin Sustainable Yields project, which links 70 surface- and groundwater models to generate a comprehensive assessment and synthesis of current and predicted water quantity throughout the 1,061,469-km^2 basin on a monthly basis (CSIRO 2008). The Ecological Outcomes of Flow Regimes project links the predicted hydrologic changes to ecological responses of native fish, water birds, riparian and floodplain vegetation, aquatic vegetation, invertebrates, plankton, biogeochemistry, and geomorphology. Water management agencies use this integrated system to assess the potential consequences of their management policies.

...and in the United States

Similarly, the U.S. Congress recently authorised[8] a national assessment of water availability in the face of climate change. The mandated data and analyses will provide a much-needed scientific basis for state environmental flow standards or targets. Related legislation[9] directed the Bureau of Reclamation, which manages water throughout the western United States, to analyze the impacts of climate change on its water supply contracts, hydropower generation, reservoir-related recreation, fish and wildlife, water quality, and flow- and water-dependent ecological resiliency, and develop adaptive strategies such as reservoir re-operation, new water management or habitat restoration plans, water conservation, ground and surface water storage, and improved hydrological models and decision support systems. A pilot project, modelled after the Sustainable Yields Project for Australia's Murray-Darling basin, is evaluating how to model and address environmental flows at ecologically meaningful scales across the Colorado River basin.

8 PL 111-11 Subtitle F Secure Water Act of 2009, Sections 9507 and 9508.
9 PL 111-11 Subtitle F Secure Water Act of 2009, Section 9503.

Guideline 3.
Don't exceed available capacity, while building capacity from the onset of policy development

One of the lessons to emerge from this review is that in most, perhaps the majority of contexts, an approach is adopted that is too sophisticated for the relevant local capacity constraints. It is important that at any given time the policy, methods and approaches are within the ability of the existing institutions to actually implement them. By continuously building technical and managerial capacity in parallel with progressive policy implementation, the capacity to implement will not be exceeded.

There is a strong temptation to adopt methods and approaches that exceed the ability of management institutions to apply them. In reality, many succumb to this temptation, both in environmental flows and in water resources management more generally. International experience demonstrates that there is a real danger from attempting too sophisticated an approach too quickly. For example, the Lower Mekong Basin process *(see case study 1, page 40)* was halted in part because it was considered too complex to be useful to decision makers. Likewise, overly complex flow recommendations delayed implementation of environmental flow requirements per South Africa's ambitious 1998 Water Act *(see case study 14, page 54)*.

It is important to build technical and managerial capacity continuously in sync with progressive policy implementation, ensuring that policies, methods, and approaches remain within the ability to carry them out. By doing so, the capacity to implement will not be exceeded. In Florida (USA), progressive implementation of environmental flow policy in sync with capacity building has enabled methodology improvement, extensive data collection, and increasingly sophisticated flow provisions over the past two decades *(see case study 7, page 46)*.

Reflecting on the South African experience, MacKay and Roux (2004) strongly advocated that governments begin to build technical, social, economic, managerial, and political competencies in parallel with policy development. Otherwise, "there is a high risk of good policy failing or being rewritten before its implementation reaches full maturity, due to a lack of people with the capacity and high-level skills to manage the implementation process." Responding to this concern, Acreman *et al.* (2005) outlined a 10-point plan for building a long-term sustainable programme to support institutionalisation of environmental flow assessment into water-resources planning and management decision making in Tanzania. Some activities in the plan are large and will take several years; others are small and can be implemented rapidly. MacKay and Roux (2004) further recommended strengthening capacity building through structured reflection, or transfer of knowledge beyond written documentation.

Guideline 4.
Limit allowable abstraction and flow alteration as soon as possible

A crucial distinction needs to be made between flow protection and restoration; that is, between the introduction of a cap on further abstraction or requirements on new infrastructure, and the re-allocation of water from existing users to the environment or the re-operation of existing infrastructure. It is much easier to implement requirements on new users than to enact changes to existing use. While there are comparatively few successful international examples of the latter, there are many unheralded but vitally important examples of the former.

Re-allocation of water requires removal or amendments of water rights from existing users, either voluntarily or through a compulsory process and, as learned in UK *(see case study 9, page 49)* and Australia *(see case study 8, page 47)*, this typically is not enabled on a systematic basis by traditional and historical water management laws and policies. More comprehensive reforms may be required to enable reviews or exchanges of existing legal rights. Accordingly, Michigan's new water withdrawal regulation applies only to future abstraction and exempts existing licences, thereby institutionalising the status quo, even for altered rivers *(see case study 6, page 45)*.

Significant sunk costs are associated with the development of water resources and hydropower; reversal can be economically and politically costly. Social costs associated with reductions in economic activity also may need to be mitigated. For these reasons, it is extremely important to prevent over-allocation from occurring in the first place. Therefore, establishing a cap or control on new uses before addressing the greater challenge of re-allocation is critically important.

Introducing a cap does not imply a required prohibition on any future development of water resources. In many cases, there may remain significant potential for future development of resources before the cap is reached. Ideally, caps are introduced well before limits are reached, even where there appears to be ample water year-round or seasonally. Had the 1920s compacts governing the Colorado River capped withdrawals to protect environmental flows when they were enacted, the river would still be reaching the delta 50 years later.

Even in basins that are truly over-allocated, however, a cap should not prohibit new water uses. Instead, it is the cap on new withdrawals that incentivises legal, financial, and technical innovations for managing limited resources efficiently. These include water transactions, as in Australia and the western USA, which increasingly are facilitated by creative, market-based, financial mechanisms (Le Quesne *et al.*, 2007; Garrick *et al.*, 2009a, b), as well as engineering solutions involving dam re-operations or conjunctive groundwater and surface-water use. Many measures that drive efficient water use—water transactions, conservation, re-engineering, and other innovations—simply will not occur in the absence of an effective cap on new withdrawals.

Setting a cap should not be seen as an end point. Initial limits on withdrawals should be precautionary, allowing for relaxed limits in the future if monitoring results so warrant. Had initial caps on withdrawals from Australia's Murray-Darling Basin been more precautionary, the major financial expenditure the government is now making to buy-back water entitlements for the environment might have been avoided *(see case study 8, page 47)*.

Guideline 5.
Develop a clear statement of objectives based on an inclusive, transparent, and well-communicated process.

Support for implementation is bolstered where a clear, high-level statement of objectives is achieved at the national policy and river basin level. This can provide the political commitment required to ensure that implementation occurs. The level of detail contained within this commitment will depend on the level and scale of decision: at a national policy or large river basin level, this may be a commitment to environmental flows to achieve a certain level of environmental protection, with specific details developed and reviewed at a more local level. Measurable goals and objectives keep implementation on track and set the stage for adaptive management (Annear *et al.* 2004).

Arriving at these decisions should be based on the involvement of as broad a range of groups, interests, and stakeholders as practical. To achieve such success, public participation must be tailored to suit the capacities of the stakeholders and the policies of the country (Hirji and Davis, 2009a). The best approach will depend on the context: an appropriate stakeholder process for a small creek with thousands of people living in the catchment will, of necessity, be different than a river basin with tens or hundreds of millions of people living within it. While it may not always be possible to achieve consensus among all interested parties, allowing this engagement in reaching a decision can help to identify later implementation barriers. For example, stakeholder agreement on guiding principles from the onset of Michigan's new flow policy assured its full implementation within only a few years of its initial introduction *(see case study 6, page 45)*.

The shared vision need not call for a uniform level of protection for all water bodies across a jurisdiction. Many water management programmes establish various pragmatic levels of protection for different river systems, with highly biodiverse areas receiving greater levels of protection than highly utilised areas in economically important regions. Many states and countries, including South Africa, Maine, and Connecticut have established stakeholder processes for classifying water bodies according to river condition goals that correspond to different degrees of allowable flow alteration. Mexico is currently developing a similar process (R. Tharme, personal communication, 18 July 2010).

Reaching interstate agreements on environmental flows poses special challenges. Each state is a stakeholder, and each state represents multiple stakeholders. Implementation can only proceed when necessary parties at both levels agree on an overarching objective and the basic principles for achieving it. The Mekong River process stalled in the absence of a shared

vision among states. In contrast, the Great Lakes Compact *(see case study 15, page 56)* directly addresses the common goal of protecting water resources within a shared basin.

Agreement on databases, flow assessment protocols, and incorporation of independent scientific panels facilitates implementation of interstate treaties on environmental flows. For example, the Murray-Darling Basin Agreement in Australia *(see case study 8, page 47)* provides a detailed process for assessing, providing, monitoring, and auditing the sharing and use of water among the three Australian states in the lower basin. To assure compliance with the Great Lakes Compact (see case study 15, page 56), the U.S. Geological Survey is developing a common hydrological database for the entire basin. The Mekong River Commission (see case study 1, page 40) has a Decision Support Framework of basin hydrological and hydraulic models in accordance with the interstate agreement on data and information sharing. Shared data alone, however, proved insufficient for moving forward, as discord arose over some of the scenarios that were modelled, using the agreed-upon data as model input.

Guideline 6.
Develop a clear institutional framework, including independent oversight

Transparent, effective institutions and rules for water allocation and management are critical precursors to effective environmental flow policy; if they are lacking, then comprehensive water policy reform may be essential. Clarity is therefore required, as well as sufficient mandate for the responsible authority.

MacKay and Roux (2004) recognised that "difficulties or obstacles to successful implementation of policy, and poor delivery on policy objectives, can often have their roots in weaknesses or gaps in the policy analysis and development phase."

To avoid over-ambition, the emphasis initially should be on building sustainable institutions that maintain a clear vision, with rules and mechanisms designed to become more sophisticated as knowledge and capacity improve over time. Kenya *(see case study 16, page 57)* and Australia *(see case study 8, page 47)* are among the countries building new institutions to manage water. Even in the context of a well-established water management framework, roles need to be clearly defined and coordinated to integrate new environmental flow policies. Texas (USA) *(see case study 17, page 58)* recently developed such a process.

Independent oversight is an important element of an effective institutional framework, especially when environmental flows are recognised through an interstate treaty. An independent authority can broker fairness and trust between regulated entities and levy sanctions to ensure compliance with environmental water provisions. Australia's National Water Commission *(see case study 8, page 47)* was established specifically to review state government compliance with the Australian National Water Initiative, although there are now significant concerns as to whether it has the powers necessary to fulfil this responsibility (NWC, 2009). Under the Great Lakes Compact *(see case*

study 15, page 56), the ability to obtain legal recourse through the federal judicial system assures mutual compliance among the Great Lakes states, which otherwise retain regulatory authority for water allocation. The three riparian states in the Susquehanna River basin agreed to cede regulatory authority over water withdrawals—including environmental flow compliance – to the multi-state Susquehanna River Basin Commission in which decisions are made jointly *(see case study 18, page 58)*.

Guideline 7.
Create sustainable financing mechanisms, in particular financial resources where re-allocation is required

Environmental flow programmes, like any other government programme, require sustainable funding. Revenue sources may range from general taxes to fishing licence fees. There may be some conflicts of interest where these on-going institutional functions are funded by the regulated community through water use fees, as this incentivises financially strapped agencies to issue excessive water use permits.

Water re-allocation from offstream uses to environmental flows presents special financing challenges. From 2008, the Australian government appropriated $3.1 billion to transfer water from irrigation to the severely strained Murray-Darling River system. In 2007, an order to cease irrigation of 33,000 acres of farmland to restore flows in Idaho's Snake River (USA) was estimated to cost the state's economy more than $200 million (Christensen 2007).

Attempts to re-allocate water from users without financial compensation have led to immense political resistance in a number of places in the world. Many governments have reviewed their approach in the context of this resistance, resorting to major public programmes to purchase water rights, such as in Australia.

For re-allocation, there may the opportunity for funding to be generated through a levy on water users. Additionally, market-based mechanisms can allow for re-allocation to be undertaken in a cost-effective manner. Garrick *et al.* (2009b) explored the potential for water markets to facilitate environmental flow restoration. Market-based water rights acquisition and transactions in the Columbia (northwestern USA) and Murray-Darling basins required three enabling conditions: (1) established rights to and limits on freshwater extraction and alteration; (2) recognition of the environment as a legitimate water use; and (3) authority to transfer existing water rights to an environmental purpose. Other critical considerations include the physical, social and economic factors driving demand for environmental water allocation; administrative procedures, organisational development, and institutional capacity to effect transfers; and adaptive mechanisms to overcome legal, cultural, economic, and environmental barriers (Garrick et al. (2009b). Based on Chile's experience, Bauer (1995, 2004, 2008) warns that free-enterprise water markets may operate against the interests of river ecosystems and poor farmers if environmental and social objectives are not incorporated into the regulatory framework.

Hydropower production finances flow restoration in the Columbia River basin (USA). The Columbia Basin Water Transaction Programme is funded by the Bonneville Power Administration through a hydropower compensation fund. The programme provides funding and builds local capacity to facilitate water-rights transfers from offstream uses to environmental flows *(www.cbwtp.org)*.

Guideline 8.
Conduct proof-of-concept pilot projects

Successful local pilot projects are vital for building technical capacity and political support, and showing that implementation is possible at much larger scales. The engagement of stakeholders in pilot projects ensures buy-in and builds trust that catalyses broader policy reform. Demonstrations of individual dam re-operation paved the way to state and national environmental flow policies in Costa Rica *(see case study 19, page 59)*, Lesotho *(see case study 20, page 60)*, and the United States *(see case study 21, page 60)*. Mexico and Vietnam are among the countries currently carrying out local pilot projects to inform the implementation of new laws that recognise environmental flows.

Monitoring and interpretation of pilot-project outcomes assure stakeholders that human and ecosystem benefits are being delivered, and guide improvements in subsequent applications (Konrad, 2010). Conversely, as seen in Sweden, the inability to experiment impedes the adoption of progressive flow improvements *(see case study 22, page 61)*.

Guideline 9.
Allow flexibility for implementation methods, while setting a clear deadline for implementation

Programmatic flexibility is important for adapting approaches according to learning and local circumstances. While strict implementation regimes provide clarity in terms of compliance, it is clear from various case studies that approaches do need to shift in line with evolving levels of understanding, and to be able to meet shifting environmental and socio-economic priorities.

Some flexibility allows for pragmatism; too much, however, can prevent administrations from being held accountable. Institutional oversight or regulation that ensures ongoing progress is an important counterbalance for flexibility.

Deadlines for implementation also counterbalance flexibility and ensure progress. Endless delays can result when deadlines are not specified, as evidenced by the 1991 Indus Water Accord *(see case study 4, page 42)*. In contrast, the Agreement of the Council of Australian Governments on Water Reform committed the state governments to a clear timetable for developing water resource plans that provided for environmental flows *(see case study 8, page 47)*.

CHAPTER 5
CASE STUDIES

1

Mekong River: Consequences of not sharing a common vision

The 1995 Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin between the four countries that share the lower Mekong River basin has developed significant information and analysis of the environmental flow needs of the basin as a result of major international support, capacity building, and three phases of increasingly sophisticated, customised flow assessments. The Mekong River basin's Integrated Basin Flow Management environmental flows assessment approach followed a three-level framework, with levels, or phases, building upon and feeding back to each other. The first phase met the immediate need for interim protection while more detailed assessments were carried out. The second phase incorporated existing ecological and social information and generated a targeted research plan, while building public support and technical capacity. The third phase used field data collected specifically for determining flow needs, and provided a more defensible set of flow recommendations (Hirji and Davis, 2009b, p. 77). However, it is yet to lead to a plan to protect or restore environmental flows.

The agreement created the non-regulatory Mekong River Commission and, among other things, set out general principles and procedures for identifying mutually acceptable environmental flows to meet seasonal ecological needs. All parties signed agreed-upon "Procedures for the Maintenance of Flows on the Mainstem" in 2006. Although the flow assessment methodologies were revolutionary in their accounting for social, cultural, and economic values (King and Brown, 2010), they have not yet generated the consensus needed to move forward.

Several factors have contributed to the failure to reach agreement to date. These include the need to build trust between the countries, caution over impinging on national sovereignty, lack of data from China, and the nonregulatory role of the Commission. The participating countries approached environmental flows with conflicting goals of protecting ecosystem services versus facilitating water resource development. Furthermore, the consideration of environmental flows within the agreement was stipulated by outside funding agencies and was never of primary importance to the signatories (Hirji and Davis, 2009b; K. Lazarus, personal communication, 20 April 2010; 5 August 2010).

Proposed dam site near Pak Ou caves on the Mekong River not far from Luang Prabang, Laos. After much protest, the government relocated construction elsewhere.

2

Alaska:
fiscally constrained policy implementation

More than 15,000 water bodies support anadromous and resident fish species in Alaska (USA). To maintain these valuable fisheries, in 1980 the state established a clear legal framework for reserving environmental flows. Yet, 18 years later, only 237 applications for reservation of water had been completed; only 11 had been granted. With a single person funded to assess flow needs, file for water reservations, and perform other duties, the Alaska Department of Fish and Game was woefully under-equipped to implement the environmental flow policy its legislature enacted (Estes, 1998). Progress finally began in 2002, when the Department of Natural Resources agreed to fund a new staff position to adjudicate water reservations (Christopher Estes, Alaska Department of Fish and Game, written communication, 10 May 2010).

3

Vietnam:
stalled by institutional barriers

The rapid development of new hydropower infrastructure -- and Vietnam's vulnerable position as the downstream riparian sharing transboundary waters -- precipitated the adoption of its first Law on Water Resources in 1998. The law and subsequent implementing decrees and National Water Strategy fundamentally embed environmental protection into water resource management and exploitation. However, two government agencies with similar mandates compete over water resources management. Vietnam's Ministry of Agriculture and Rural Development (MARD) has long had the responsibility for water resource development and infrastructure operations, whereas the Ministry of Natural Resources and Environment (MoNRE) is a relatively new ministry and has only recently acquired responsibility for water resources management. As a new ministry, MoNRE is making efforts to build institutional capacity; however, MARD retains its research institutes and their water resource data, which it does not share readily with MoNRE. Both agencies are conducting parallel, but uncoordinated, efforts to manage water resources. These institutional challenges have impeded implementation of the inspiring new legal framework, constraining the application of best available science at the national level. As a result of the relatively recent introduction of the concepts of environmental flows and technical capacity issues, the national regulation recommends strictly hydrology-based environmental flow prescriptions. Meanwhile, on-the-ground demonstration projects are spurring adoption of more progressive approaches at the provincial level. It is hoped that these pilot projects will help build the capacity to implement the full intention of the new water resources policies nationally (Ruth Mathews and Heather MacKay, personal communication, August 2010).

A tributary of the Mekong River, Vietnam. An extensive process of assessment of the environmental flow needs of the Mekong has been undertaken in recent years. However, there has yet to be agreement on the findings between the riparian nations.

4

Indus Water Accord: institutional barriers and conflicts of interest

Water flows to the Indus River delta (called "escapages" in Pakistan) have entirely ceased for periods of time over recent decades, as a result of upstream water consumption. This has significantly degraded the delta ecology, and salinised the drinking water and land of delta communities in Sindh. Responsibility for water management in Pakistan resides at the provincial rather than the federal level. The Indus River System Water Accord of 1991 enabled the first formal agreement between provinces over water allocation, and recognised a "minimum escapage to the sea." However, the Accord lacks detail in a number of important areas, including environmental flows. The Accord specifies neither the environmental flow required, nor a process to calculate it, nor a timeframe for establishing it.

The Accord did specify that a study to determine environmental flows for the delta should be carried out. However, disagreement over data quality and assessment methods meant that this was delayed. An assessment to determine the water needs of the delta took many years to initiate and complete, and there remain interprovincial disputes over the findings and the streamflow data on which they were based. As a result, nearly 20 years later a flow requirement for the delta has been neither agreed upon nor implemented (O'Keeffe and Le Quesne, 2009). This situation has been exacerbated further by protracted discussions over a draft national water policy (prepared in 2002) that recognises environmental water needs. It shows no imminent sign of being implemented.

The Indus River, near Tarbella hydro dam site Pakistan. The 1991 Indus Water Accord recognises the need for flows of freshwater to the Indus delta, but this has yet to be implemented and dispute continues between Punjab and the Sindh over the volumes required and approach to implementation.

5

Brazil: *from minimum to environmental flows*

Hydropower development is the primary driver of environmental flow policy in Brazil. In 1934, the first federal water legislation privileged various aspects of the hydropower sector. In the 1980s, the Brazilian Environmental Council (CONAMA) approved the first Resolution imposing a mandatory Environmental Impact Assessment (EIA) and the Environmental Impact Report (EIR) for infrastructure projects. At the time, Brazil required minimum flows based on hydrological methods (Benetti et al, 2004). The natural flow regime alterations in rivers and their associated social and environmental impacts became abundantly clear in these studies. In the last decade, water experts and researchers have published scientific papers reporting the social and environmental impacts of infrastructure projects in fragile ecosystems, mainly in the Amazon Basin (Viana, 2002). At the same time, some civil society organisations (such as the Movimento de atingidos por barragens, a coalition of people affected by dams) and indigenous groups started to pressure the government to take concrete measures to mitigate the negative impacts of large dams. Recent progress in water management is reflected in the Brazilian Water Policy of 1997, the creation of the first ever national water regulatory agency (National Water Agency) in 2000 and the first National Water Resources Plan launched in 2006. However the full implementation of such instruments and policies is still necessary to ensure the protection of natural flow regimes for Brazilian rivers and watersheds. The National Water Resources Plan introduced the "ecosystem based approach" into water management, highlighting two priority issues: environmental flows and freshwater eco-regional management. Brazil is now developing the legal framework to advance from minimum flows to environmental flow provision under the National Water Resources Council leadership (G. Kimura de Freitas, personal communication, 16 June 2009).

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The Augusto falles on Jueuena River, Brazil. Hydropower development represents the major threat to environmental flows in Brazil. In 206, Brazil launches its first National Water Resources Plan which introduced an "ecosystem based approach" into water management. Brazil is now developing the legal framework to advance from minimum flows to environmental flow provision.

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6

Michigan: statewide flow standards set by stakeholders

To meet the requirements of the Great Lakes Compact, the state of Michigan (USA) recently amended its existing water law to protect environmental flows from future water withdrawals. However, because of the politically powerful interests vested in maintaining current water uses, the newly amended law exempts existing water uses and relies on current ecological conditions as its baseline. The amendment would have been impossible to pass without this exemption (R. Bowman, personal communication, 29 February, 2008).

The amendment was implemented through a Water Withdrawal Assessment Process that set statewide environmental flow standards by stream or river type statewide. An advisory committee representing both stakeholders and scientists developed the process. The committee began its work by crafting and agreeing upon a written set of guiding principles[5] defining ecological and economic goals, potentially contentious terms, and the process upon which they were embarking. The committee created an online tool (www.miwwat.org) that determines the ecological risk of proposed new surface and groundwater withdrawals. The tool links a groundwater model, surface water model, biological response model, and water use database to a decision support system for issuing or denying new water withdrawal permits. The involvement of stakeholders in the development and testing of this tool was groundbreaking and encourages future water use applicants to follow due process and consider the impacts of water use upon the environment (Herbert and Seelbach, 2009).

In July 2009, Michigan passed the Natural Resources and Environmental Protection Act mandating use of the tool to screen potential impacts of all future high-capacity groundwater and surface-water withdrawals. Scientists used the best available science to relate flow alteration to ecological condition, but stakeholders still had to make the social decision of what ecological condition is acceptable. Both the science and the social decision are incorporated into the tool. This tool was "piloted," and stakeholders were given the chance to test the system and comment for one year before its use became mandated for all new water allocations. The Council of Great Lakes Governors is currently providing technical assistance to encourage other compact signatories to follow Michigan's leadership in rigorously incorporating environmental flow protection into their water management programmes to meet the Compact requirements (Herbert and Seelbach, 2009; R. Bowman, personal communication, 29 February, 2008).

Two Hearted River in Michigan's Upper Peninsula. Michigan's new flow standards protect current conditions, but lack explicit provision for restoring more natural conditions to degraded streams.

5 Accessible at *http://www.conserveonline.org/workspaces/eloha*. Click on Case Studies.

7

Florida:
adapting policy implementation to scientific advances

Florida (USA) has had environmental flow policies firmly in place for decades. Rapid urban and industrial growth in the 1960s, exacerbated by uneven spatial and temporal water distribution, drove legislation that divorced Florida from the traditional riparian water rights system. The Water Resources Act of 1972 created five Water Management Districts with broad powers to permit consumptive uses and to establish "Minimum Flows and Levels" (Diffenderfer and Duhy, 2006; Munson *et al.*, 2005).

The first Minimum Flow and Level as envisaged by the Water Resources Act was set in 1992 for the Wekkiva River. Between 1992 and the present, as implementation has progressively spread, Water Management Districts responsible for implementation have steadily increased their capacity, which over time has enabled improved methodologies, extensive data collection, and an increasingly sophisticated interpretation of "minimum" flows. This has been accompanied by a steady increase in budgets, staff, and expertise (D. Shaw, personal communication, 11 August 2010).

Some 237 minimum flows and levels have been established for water bodies, including 19 rivers and estuaries and 13-15 large first-magnitude springs, since 1992. Technical requirements for flow assessments match the relative priority of each water body. Although the word "Minimum" is still retained, in actuality the term has been reinterpreted to mean seasonally variable minimum and maximum flows, as needed to provide for ecosystem health. Florida policy allowed the progressive development of environmental flows over time in line with advances in science and capacity, so many of the initial limits have been revisited and refined (Wade and Tucker, 1996; D. Shaw, personal communication, 20 January 2009). Thus, the policy implementation has evolved with—and arguably helped to lead—the scientific advances that now recognise the importance of varying flows seasonally and inter-annually. The 1997 Water Act further strengthened the link between water resource development and environmental flow protection by requiring Water Management Districts to facilitate resource development in basins where available water is already fully allocated and withdrawals have been capped. This requirement has launched Florida to the international forefront in innovative engineering approaches, such as artificial recharge and aquifer storage and recovery (ASR), and dispersed water storage[6] to manage the timing of environmental flows.

When Florida's water policy was reformed in 1972, it was considered visionary and potentially unachievable. Nearly 40 years later, the reform survives and has established Florida's leadership in comprehensive, science-based environmental water management.

6 Dispersed water storage involves large-scale wetland restoration on agricultural landscapes as a way of improving habitat condition and managing the timing of flows, especially those reaching the Everglades (D. Shaw, personal communication, 21 July 2010).

8

Australia: *reforming existing institutions*

Comprehensive reform of the water sector has been ongoing for more than 15 years. Initially, water reform was driven by a broader economic reform agenda, aimed at increasing competition and improving productivity across a range of sectors. This economic agenda, coupled with growing concerns over the deteriorating state of the country's rivers (especially the Murray-Darling system), led to a national agreement on water policy reform, which for the first time recognised the environment as a legitimate use of water and required water provision to meet ecological requirements. The institutional reforms segregate the government function of providing water service from that of managing water resources, thus precluding the conflict of a single government agency doing both. The reforms have been implemented through a series of policies, laws, regulations, and plans, cascading down the governmental hierarchy:

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Flooded forest along the Murray River near Tocumwal, New South Wales, Australia. A series of increasingly significant and on-going reforms over the last decade has attempted to address the environmental crisis on the Murray-Darling system.

- National policy agreements—notably the 1994 Agreement of the Council of Australian Governments (COAG) on Water Reform, and the 2004 National Water Initiative—between the various tiers of government improve the management of the nation's water resources, and provide an overarching framework
- Legislation at both the national and state levels mandate water resource planning and require environmental flows
- Water resources plans set caps on total water abstractions, regulate the annual allocation of water, prescribe infrastructure operational rules, and create "new," tradable water entitlements separate from land title
- Institutional arrangements (such as the Commonwealth Environmental Water Holder) hold and manage environmental water allocations
- Government-funded initiatives restore flows for the environment, including the ongoing "Water for the Future" program, through which AUD3.1 billion has been appropriated to buy back water entitlements from water users and return the water to the environment. Current government programmes would re-allocate around 22 percent of consumptive water back to the environment, although some scientists advise that 40 percent needs to be returned (Jamie Pittock, personal communication, 6 August 2010).

The COAG agreement on water reform committed the state governments to a clear timetable for developing water resource plans that provided for environmental flows. An audit process was established, and failure to meet the required timelines meant a state would risk the federal government withholding payments of significant financial incentives (totalling AUD hundreds of millions) to implement the reforms. However since this carrot-and-stick approach ended, implementation has lagged, with NSW in 2006 and Victoria in 2007 "suspending" their environmental flow plans (NWC, 2009).

In the Murray-Darling Basin, a cap was first introduced in 1995. As in many parts of the world, the cap was not based on an assessment of sustainable levels of abstraction, but was simply linked to historical management arrangements and water use. While water allocations were ostensibly capped from 1993/94 levels, in practice poor implementation meant that diversions kept rising. This was due in part to: lack of agreement with some jurisdictions, inconsistent laws in the states (provinces) that contained loopholes, no consistent monitoring system, and limited mechanisms for enforcement.

Further, the marketization of water entitlements created an incentive to sell and use water rights that had not previously been used. While some of these problems are transitional, or are belatedly being addressed, many remain. Although the cap was an important first step in moving the basin toward a sustainable footing, it is apparent that the levels of abstraction permitted under the cap are not environmentally sustainable. This in turn has led to the major financial expenditure the Australian government is now making to buy back water entitlements for the environment. A Basin Plan is scheduled to be adopted in 2011 that will set a new, lower "sustainable diversion limit." The plan is also intended to ensure key ecological assets—major wetlands—are adequately conserved through environmental flows.

9

United Kingdom: *phasing in flow standards, but stalling on water re-allocation*

The UK has introduced environmental flow policies in a stepwise manner over the last two decades. The Catchment Abstraction Management process initiated in 1999 incorporated a common standard for variable limits on abstraction across the country, with increasingly smaller amounts of abstraction permitted as flow levels decreased (Dunbar *et al.*, 2004). The standard was determined by comparing flows determined from simple hydrology-based look-up tables to water availability in catchments. The process identified those catchments where further water was available for abstraction, those where no more water was available, and those where abstraction was already judged to exceed sustainable limits. This standard was used in catchment-based assessments across the country as a basis for capping future licences. This enabled the rapid introduction of a cap across the country.

A more detailed assessment was needed in cases where reductions in abstraction were required, for example to reduce water abstraction on the River Itchen to meet the requirements of the EU Habitats Directive. A more sophisticated set of limits has now been suggested under the Water Framework Directive, with flow limits set according to river type, river condition goal, and time of year. Site-specific investigations are being undertaken to set releases from reservoirs, which were deemed too unique to be managed under generic rules (UKTAG, 2008; Acreman and Ferguson, 2010).

While legislation in 2003 enabled new licences to be time-limited, it did not provide a mechanism for the systematic revision of existing licences that impact environmental flows. Progress toward re-allocating water from existing uses to the environment is driven primarily by legal imperatives of the European Union Habitats Directive and has been slow to date. A small surcharge on water licence charges provides limited financing for re-allocation. Powers to revoke and time-limit existing licences are currently being considered by the UK government, alongside market-based mechanisms to encourage reductions in unsustainable abstraction. However, at the current time, there is no clarity on how this will be achieved.

River Kennet. Wiltshire, UK. An effective cap has been introduced on new water licenses that would impact on environmental flows in England and Wales. However, the process for addressing historic damaging licenses is currently stalled.

10

Maine: finding the right government programme

In 2007, Maine became the first state in the USA to adopt statewide environmental flow and lake level standards based on principles of natural flow variation necessary to protect aquatic life resources and important hydrological processes. Five years of public debate shaped the policy between the time the authorising statute passed and the time the regulatory standard was adopted. Because Maine lacks a statewide water abstraction management program, the new standards are implemented by staff from a pre-existing state water quality standards programme. New river condition goals did not have to be established; instead, the new seasonal flow standards are associated with existing river condition tiers, or goals, that were previously instituted under the water quality programme. Currently, Maine is helping water users meet the flow standards by providing expedited permitting and financial support for off-stream reservoir projects for storing water when excess is available, for use during low-flow periods (D L. Courtemanch, personal communication, 27 April 2010).

Maine's native wood duck population depends on healthy lakes, rivers, and wetlands. Maine was the first state in the USA to institute variable, ecology-based flow standards that apply to water bodies statewide.

11

Mexico:
finding the right legal instruments

...for standardizing flow assessment methods...

Growing pressure on water resources due to rapid agricultural development and overexploitation of groundwater prompted passage of Mexico's 1992 Water Law. The Law established a clear institutional framework with a national water agency, *Comisíon Nacional del Agua* (CONAGUA), to oversee its implementation.

Mexico is currently working to formulate a *norma*, or technical regulatory standard, for setting environmental flows for the country's water bodies. A hierarchy of methods has been proposed, ranging from simple desktop hydrology to detailed, interdisciplinary assessments, to match the sophistication of flow recommendations to available resources and capacity, ecosystem importance and condition, and the anticipated extent of hydrologic alteration.

An immediate challenge is how to incorporate the *norma* within national water legislation as quickly as possible. Introducing an entirely new legal standard specifically for environmental flows would delay implementation during the many required stages of approval. Consequently, it was agreed to append an existing standard instead. A legally-binding water availability standard, NOM-011-CNA-2000, which lays out the rules for determining the average annual volume to be allocated to different basin water users, already exists and will continue to be applied for water resource availability assessments for all basins in Mexico. The intent is to append the environmental flows *norma* as an NMX under the NOM-011-CNA-2000 in the shorter-term, to ensure that environmental flows are included in all basin water calculations. In the long-term, it is anticipated that the environmental flows standard will attain similar legal standing to the NOM-011. In November 2009, CONAGUA publicly announced its intent to publish the new NMx in 2010 (R. Tharme, personal communication, 12 June 2009; 18 July 2010).

...and for re-allocating flows to the environment

Mexico's lack of a clear policy regarding flow re-allocation to the environment did not deter conservationists in the Colorado River delta, who saw an opportunity in the existing legal framework. Although no precedent exists for ceasing irrigation to improve stream flows, moving water rights from one irrigated parcel to another is a well-established practice in Mexico. By changing the locations of irrigation rights from cropland to natural floodplain wetlands, ecological flows have successfully been re-allocated to the delta without officially changing the uses associated with their water rights. Looking to the future, the nonprofit *Pronatura Noroeste* is securing land concessions in the Colorado River's riparian zone, and changing the purchased irrigation water rights to land concessions that irrigate riparian vegetation. Once the riparian vegetation becomes well established and no longer requires irrigation, Pronatura Noroeste will seek approval to again change the location and use of purchased water rights, to increase base flows in the channel (Robert Wigington, personal communication, 7 May 2008).

12

Montana: *from limiting withdrawals to restoring environmental flows*

A series of small policy advances over three decades reformed Montana's (USA) deeply entrenched water rights system to protect, and then to restore environmental flows.

The incremental approach began with legal recognition of instream flow as a "beneficial use." Until the Montana Water Use Act of 1973 allowed state government to reserve instream flows to sustain healthy river ecosystems, the list of beneficial water uses qualifying for water rights excluded environmental flows.

Once the environmental flow needs were assessed for instream flow reserves, it became apparent that water in many of the state's basins was already over-allocated. In response, the state legislature statutorily closed (capped) over-appropriated basins to further allocations in the 1990s.

However, the closures only applied to surface water. A surge in groundwater well construction and subsequent drying of rivers due to groundwater pumping deprived not only the rivers but also farms, ranches, and hydropower turbines, of the water upon which they depended. An unlikely coalition of conservationists, irrigators, and energy producers championed the extension of basin closures to apply to groundwater. Ultimately, a 2006 Montana Supreme Court ruling required the state to strengthen the basin closures by conjunctively managing withdrawals of groundwater and surface water (Ziemer *et al*., 2006; Smith, 2009).

Although the closures helped to protect existing water uses and flow conditions, they did little to improve flows. Having gained the essential trust and support of politically powerful partners in the basin closure process, conservationists went on to achieve additional reforms that enabled water re-allocation to the environment: All western USA states and western Canadian provinces appropriate water rights under the prior appropriation doctrine on a first-come, first-served basis. Curtailing the issuance of new or "junior" instream flow rights by closing a river basin cannot in itself undo the over-extraction that is already taking place to serve existing water rights. Additional legal mechanisms were needed to re-allocate "senior" water diversions to the environment. First, temporary flow leases and other short-term arrangements were legalised. After these temporary transactions demonstrated that flow could be restored without harming other water users, the Montana legislature authorised permanent instream flow rights.

Ultimately, a variety of creative legal and financial mechanisms became available to convert valuable senior water rights—typically for agricultural irrigation—to senior instream flow rights, while protecting existing water users. Lawyers for non-governmental organisations like the Montana Water Trust and Trout Unlimited help mediate these water transactions.
The USA states of Colorado, Oregon, and Washington have made similar strides (MacDonnell, 2009) in successfully adapting their traditional prior appropriation system of water allocation to transfer water voluntarily from existing users to environmental flow, and to protect those restored flows from future appropriation.

13

British Columbia: *legal challenge as opportunity*

Conflict in the Canadian province of British Columbia during the 1990s between the federal government, provincial government, BC Hydro, and various NGOs and community groups centred upon existing hydropower infrastructure. British Columbia's dams were held to be in violation of the Canadian Fisheries Act stipulation that riverine obstructions should allow for the passage of fish and the protection of spawning grounds. The stand-off between the needs of habitat and those of socio-economic development was set for a legal battle (D. Ohlson, personal communication, 2 June 2009). Instead of a tortuous court case, the various parties established the Consultative Committee and agreed that a constructive, participative process would reap quicker results and find a more sustainable arrangement between the various stakeholders. A number of successes resulted.

A new Water Use Planning process was launched in 1996 to reverse declining trends in fish stocks by improving infrastructure operating regimes that provide for environmental needs, including possible adjustment in licence conditions, operation rules, or even a reduction in the allocated water right (British Columbia, 1998). The first plan for the Alouette River in 1996 provided much learning for the development of guidelines that were established in 1998 (Failing and Bemister, 2000). Within a decade, operations at 22 power generating facilities operated by BC Hydro (a crown corporation, owned by the provincial government) were changed, shifting the balance between competing uses of water for fish and wildlife, recreation, water supply, and power generation (D. Ohlson, personal communication, 2 June 2009; British Columbia, 1998; Locke *et. al.* 2008).

Involving stakeholders in the Consultative Committee promoted and improved understanding of the environmental requirements as well as the needs of the various groups, including the federal government, provincial government, municipal government, First Nation communities, environmental and recreational interest groups, local residents, forestry companies, developers, and small businesses (Failing and Bemister, 2000).

Pink (Humpback), salmon Fraser River, British Colombia, Canada. The operation of hydropower infrastructure plays a key role in controlling flows on many Canadian rivers.

14

South Africa: *leading-edge policy challenged by implementation*

Constitutional reform associated with the end of apartheid in 1994 provided the impetus to fundamentally overhaul water legislation in South Africa. Although environmental considerations were not the principal driver of the water policy reform, the fact that environmental flow determinations were already underway and technical capacity existed before the new law was in place steered the form of the new law.

The ensuing policies resulted in profound environmental advances that continue to inspire and inform other countries throughout the world. The South African National Water Act of 1998 not only scrapped existing riparian-based water rights, but also introduced an environmental flow component. Among many reforms, the Act designates environmental flows as one of two components of a prior right (or "Reserve")—Basic Human Needs (domestic per capita basic allocation for daily needs) and Ecological Reserve, or environmental flows—ahead of economic uses of water.

The Act and subsequent implementation process envisage that environmental water needs will be determined and secured through the development of catchment management strategies for each of South Africa's water management areas. Where necessary, the strategies are to be followed by a compulsory re-licencing process that adjusts historical water rights to achieve environmental and social objectives. In addition, environmental requirements must be met whenever infrastructure is constructed or modified.

Implementation of the ambitions contained within the South African Act, including the environmental aspects, has proved challenging, and has been plagued by a range of constraints, including delays in producing catchment management strategies, unlawful water use, public misperceptions, lack of incentives for compliance, lack of political will to enforce, scant monitoring and reassessment, insufficient institutional capacity and communication, segregated water supply and water management planning, the loss of technical capacity due to the political transformation, and other monumental challenges of implementing comprehensive social and economic reform. Environmental flow management is necessarily embedded within these challenges and struggles (Pollard et al., 2009; MacKay and Roux, 2004; R. Tharme, personal communication, 18 July 2010).

The ambitious technical requirements relating to environmental aspects of implementing the Act have almost certainly added to these broader capacity challenges. A hierarchy of environmental flow assessment methodologies was envisaged in the implementation of the Act, with methods ranging from simple desktop estimates to complex determinations based on intensive field programmes. In addition, several associated technical and assessment requirements were developed. While there remains some debate, it seems clear that the overall approach that was adopted resulted in a number of environmental flow and technical assessment requirements that were overly complex or demanding. As a result, many of the initial flow recommendations were too complicated for water managers to achieve (Pollard *et al.*, 2009) in this country with many small river systems and financial and technical capacity constraints. A decade later, the reality is that Reserve has been

defined and implemented in only a small minority of catchments, and freshwater ecosystems in South Africa continue to degrade (Pollard *et al.*, 2009).

Despite these setbacks, the 1998 Water Act remains recognised as one of the most progressive pieces of water legislation in the world. Regionally, South Africa's climate-appropriate alternative to Roman, English, and Roman-Dutch water law helped catalyse and inform similar processes, which, even in the face of severe capacity constraints, are progressing in Tanzania, Kenya, and elsewhere in southern Africa.

The Wilge River wetland, near the foothills of the Drakensberg mountain range, South Africa. South Africa's 1998 Water Act is one of the most ambitious attempts to enshrine environmental flows in water resources policy. However, capacity constraints and political challenges have delayed implementation.

15

Great Lakes Compact:
implementing state-by-state with independent oversight

A long history of dispute over diversions from the Great Lakes basin (Annin, 2006) has spawned various interstate agreements to strengthen regional water management. Under the 2008 Great Lakes–St. Lawrence River Basin Water Resources Compact, each of the eight United States signatory states[7] must create its own water management programme that ensures *"... withdrawals overall will not result in significant impacts to the waters and water dependent natural resources of the basin, determined on the basis of significant impacts to the physical, chemical, and biological integrity of source watersheds..."*. Environmental flows are central to ensuring biological integrity.

Although each state manages water resources according to its own laws, the Compact creates a central Water Resources Council to provide oversight. Made up of the governors of each state, the Council may collect and disseminate data, institute court actions, and promulgate regulations needed to implement and enforce the Compact. Every five years, each state is required to submit a report to the Council detailing its actions to implement the Compact.

The Compact is unique in that it provides for three levels of enforcement. If one or more parties find that another has failed to conduct the activities specified in the Compact, then the Council, another party state, or any citizen may take action in federal court to compel the recalcitrant state to comply (R. Bowman, personal communication, 29 February, 2008; N. Schroeck, personal communication, 19 July 2010).

Lake Michigan – one of the Great Lakes -- as seen from the Garden Peninsula in Michigan's Upper Peninsula. The Great Lakes Compact requires signatory states to establish water withdrawal programs that protect water-dependent natural resources of the basin.

7 The two Canadian provinces are not legally bound to the Compact.

16

Kenya: *developing a clear institutional framework*

Growing resource shortages and increasing conflict over unmet needs of large, poor, and marginalised communities precipitated water policy reform in Kenya. The 1999 National Water Policy and 2002 Water Act (based in large part on South Africa's 1998 Act) sought to address issues of water resources management, water and sanitation, and necessary institutional frameworks, and redirected the government's role from service provider to regulator (Wambulwa, 2008). Kenya's Water Act defines an Environmental Flow Reserve as *"the quantity and quality of water required to (a) satisfy basic human needs for all people who are or may be supplied from the water resource, and (b) protect aquatic ecosystems in order to secure ecologically sustainable development and use of the water resource."*

Recognising the governance challenges, Kenya's legislation included a clear institutional reform process to facilitate effective implementation (Wambulwa, 2008). Efforts to date have focused largely upon making the institutional arrangements required by law, including the creation of an independent Water Resources Management Authority at a national level and the establishment of six Catchment Area Advisory Committees, at a regional level (Mumma, 2007).

Currently, implementation strategies for setting environmental flow standards and adopting regulations for achieving them are being developed for each of Kenya's six catchments. Because the institutional framework development has proved to be a significant effort, Kenya is only now "piloting" environmental flow methodologies on a few sites.

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Lake Nakuru, Kenya. Water withdrawals have had a negative impact on a number of Kenya's world famous Rift Valley lakes. Kenya's 2002 Water Act includes provisions for environmental water needs, although implementation remains a challenge.

17

Texas: *defining science, stakeholder, and agency roles*

Texas (USA) has established an environmental flow policy process with clearly defined state and local roles *(www.texaswatermatters.org/flows.htm)*. State environmental agencies and an ad hoc statewide environmental flows science committee provide technical guidance, information, and data for basin environmental flow science teams. Basin science and stakeholder teams recommend environmental flows in their respective basins. The Texas Commission on Environmental Quality (TCEQ) considers the basin recommendations when it sets enforceable standards and implements them through a state water allocation system. The Texas Department of Parks and Wildlife provides technical support. This process is currently nearing completion in the first test basins.

18

Susquehanna River basin: *implementing through an interstate authority*

The 1972 Susquehanna River Basin Compact between New York, Pennsylvania, and Maryland established the Susquehanna River Basin Commission (SRBC), a shared water management agency with authority to regulate water withdrawals within the three states that share the basin. Currently, the SRBC is facilitating a science- and stakeholder-driven process to determine environmental flow needs throughout the basin and to assess options for meeting those needs while providing for other existing and future water uses. Because the SRBC has interstate regulatory authority, the resulting recommendations are expected to translate into enforced conditions for water withdrawals and water releases from reservoirs within the interstate basin.

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Susquehanna River at Harrisburg, Pennsylvania. The interstate Susquehanna River Basin Commission, which regulates water withdrawals from the Susquehanna River and its tributaries, is currently determining environmental flow needs throughout the basin.

19

Costa Rica: from pilot assessment to national policy

In Costa Rica, an environmental flow assessment for the highly utilised Tempisque watershed by the International Union for Conservation of Nature (IUCN) and the Organization for Tropical Studies in 2004-05 raised awareness among stakeholders and politicians of the importance and feasibility of protecting flows to conserve ecosystem services. Following successful completion of the project, national and international experts worked with the environmental commission of the national congress to draft a new water law. At least five drafts and public reviews later, stakeholders and experts agreed that the draft law expresses important environmental flow concepts and features. The draft law defines environmental flows as the *"quantity of water expressed in terms of magnitude, duration, seasonality and frequency of flows and the quality of water expressed in terms of ranges, frequencies and duration of the concentration of key constituents required to maintain a desired level of health in the ecosystem"* and prioritises environmental flow secondary to human water supply and food security, but ahead of other economic sectors. Although the bill has so far failed to become law, the Instituto Costarricense de Electricidad, which is responsible for hydropower, is already attempting to operate schemes to the best possible environmental standards as outlined in the draft (Jimenez *et al.*, 2005; R. Córdoba, personal communication, 15 May 2009).

Waterfall in Braulio Carrillo National Park, Costa Rica.

20

Lesotho:
dam operations paved the way for national Water Act

Lessons learned from infrastructure construction and re-operation for environmental flows contributed to Lesotho's 2008 Water Act, instituting a water Reserve to maintain aquatic ecosystems. The Lesotho Highlands Water Project (LHWP), which diverts water from Lesotho to South Africa, is one of the world's largest water resource developments. Assessments of the project's impacts on downstream ecosystems and communities significantly advanced the use of environmental flows in water-resource decisions in the world. In 2006-07, nine years after completion of Katse Dam and four years after the completion of Mohale Dam and Matsoku Weir, rivers downstream of the structures either achieved or exceeded their target conditions. The cost of releasing environmental flows and of paying millions of USA dollars compensation to downstream villagers amounted to 0.5% of project costs and did not significantly affect the project's economic rate of return. One lesson learned the hard way is that it is easier to plan for environmental flows in the feasibility and design phases than to address them retroactively, as was the case when dam outlet valves had to be changed. The capacity built in conjunction with the LHWP prepared the country to implement the 2008 Water Act nationwide (Hirji and Davis, 2009b; Brown, 2008; King and Brown, 2010).

21

United States:
federally mandated dam re-operations spur state water policy reforms

Generally, water in the United States is managed at the state level. However, the U.S. Federal Energy Regulatory Commission (FERC) shares authority over hydropower. FERC licences each non-federal hydropower project that is located on navigable water or otherwise affects interstate commerce. A typical licence specifies a minimum flow schedule, a ramping rate, and other operational conditions to protect environmental quality. A licence has a term of 30 to 50 years, after which it may be reissued. The relicencing process begins not less than 5 years before licence expiration, and involves a stakeholder process to characterise riverine resources affected by the project, identify corresponding management goals and objectives, and propose analytical methods to determine the nature and scope of the project's existing impacts under the original licence and alternatives to mitigate such impacts (Roos-Collins and Gantenbein, 2005). Because most dam licences issued 30 to 50 years ago lacked downstream flow objectives, relicencing opens the door to dam re-operation for environmental flows. In some cases, FERC relicencing reveals that the cost of meeting new flow requirements exceeds the revenues generated, leading to dam removal (Locke *et al.*, 2008, p. 303-306). Through the FERC relicencing process, conservation stakeholders have fostered creative solutions that protect biodiversity through improved environmental flow releases and meet power and other demands of the Roanoke River in North Carolina, the Baker and Skagit Rivers in Washington, Upper Delaware River in New York, Little Tennessee River basin in Tennessee, and many others. The measurable ecological outcomes of these successful dam re-operations (Konrad, 2010) have helped build scientific expertise and public support for broader environmental flow policy initiatives in each of these states.

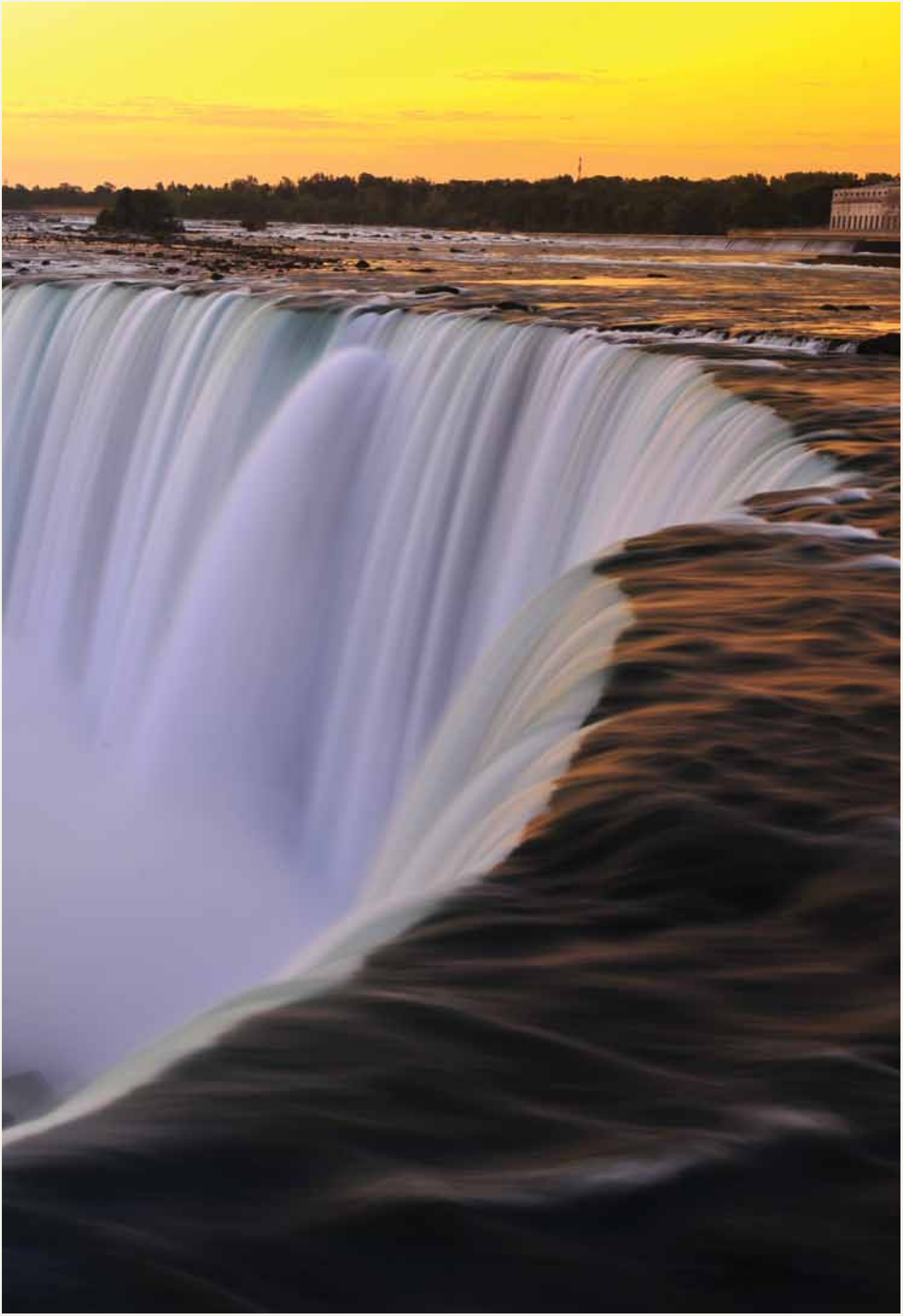
22

Sweden:
stalled by lack of proof

Chapter 3 of the Swedish Environment Code (2000) stipulates that environmental quality standards are to be set. These are articulated as a maximum or minimum flows or levels. It also provides for a maximum or minmum level of occurance of "organisms" to act as indicators of the state of the environment. In addition, the Swedish Environmental Objectives Council has developed 16 environmental quality objectives one of which provides for "Flourishing Lakes and Streams". This objective notes that watercourses must be ecologically sustainable and their variety of habitats preserved. The Council hopes to achieve this through increased environmental allocations, more strategic interventions and the development of water management goals.

Despite these statements of intent, there is in reality a lack of environmental flows policy which can provide the legal mechanism to achieve the environmental quality objective. Water resources are relatively abundant in Sweden and the population is small, and therefore, there is little understanding of the benefits that a thorough environmental flows approach would bring. Hydropower generated by approximately 200 large and 1,600 smaller power plants accounts for almost half of Sweden's total annual electricity production and hence rivers are highly regulated. New and renegotiated water use conditions require the provision of minimum flows in the original channel; however, seasonal flow variations are not typically required, and the prescribed flow regime may be unnaturally high in the summer and low in the winter. The lack of large-scale experimentation and tests to measure the ecological benefits of seasonally varying flow regimes impedes their adoption and the requisite amendments to policy (B. Malm Renofält, personal communication, 18 June 2009).

Almost half of Sweden's electricity is generated through hydropower. This means that many of Sweden's rivers are highly regulated, with resulting modification to flows.



CHAPTER 6 READING AND RESOURCES

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