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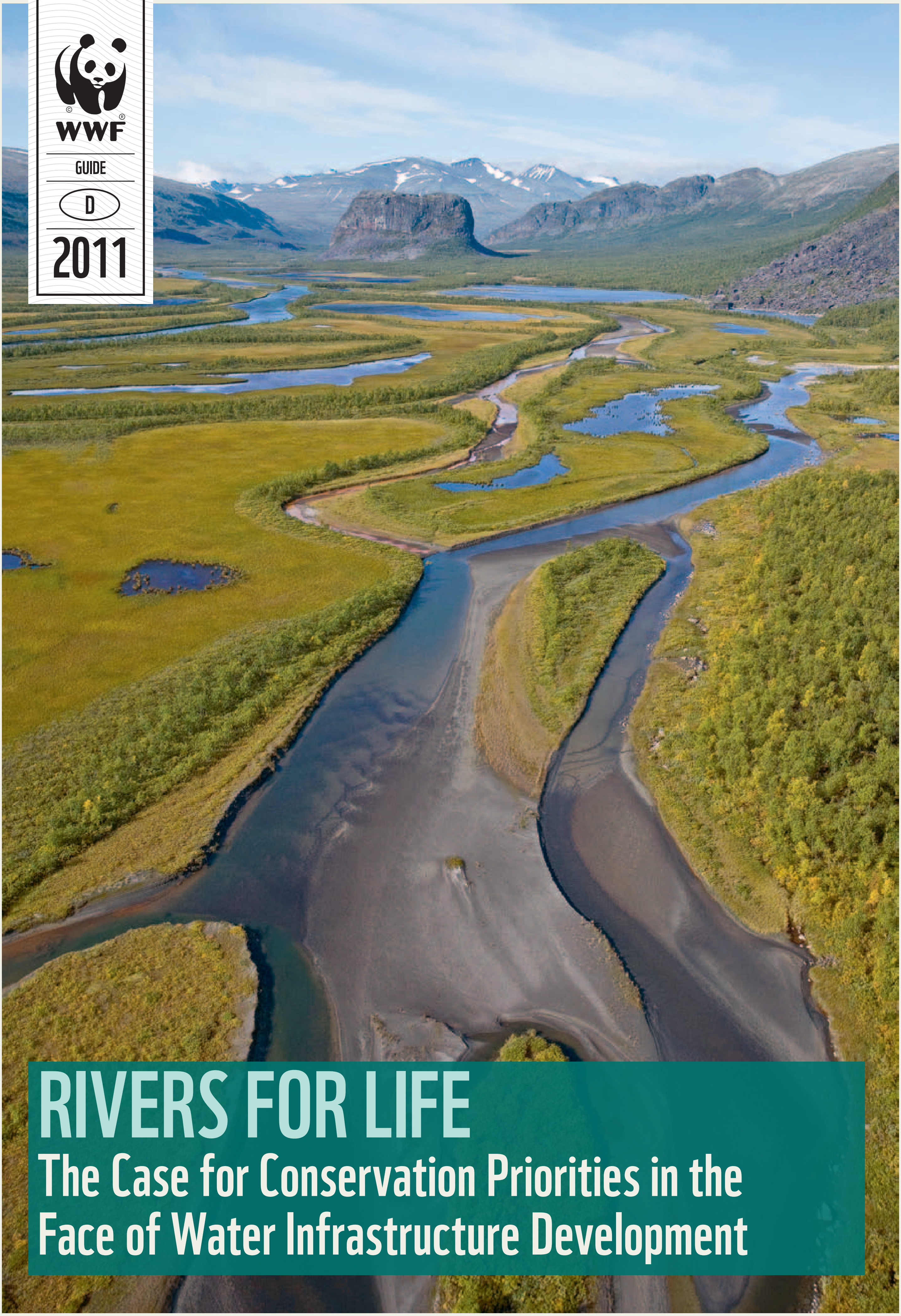

# RIVERS FOR LIFE

## The Case for Conservation Priorities in the Face of Water Infrastructure Development

Cover: Aerial view of the Laitaure Delta in the Rapadalen Valley with Skierffe and Nammatj Mountains, Sarek National Park, Laponia World Heritage Site, Lapland, Sweden

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Fisherman on a lake in the Purus River system near Sena Madureira, Acre State, Brazil. Floodplain Resources Management project in the Upper Purus River Basin.

Freshwater ecosystems play a vital role in the lives of humans by providing ecosystem services. Most economic activities depend on reliable and good quality water availability. Fish resources are among the provisioning services that freshwater ecosystems provide.

# Executive Summary

Effective freshwater ecosystem protection, as well as sustainable management and use of water resources, requires adequate and timely knowledge about areas of conservation value within river systems. Methods for the identification and subsequent prioritization of areas of conservation value – both terrestrial and aquatic – are increasingly available. The World Wide Fund For Nature (WWF) is developing and using such methods to identify priority areas for freshwater conservation and to contribute in guiding sustainable development and human use in river basins, while also protecting important natural assets.

In the face of development, human population growth, and increasing competition between freshwater uses and users, sustainable development must be carefully planned such that the vital services that freshwater ecosystems provide are maintained and that irreplaceable ecosystems and species are not lost. So that these areas remain intact and actively protected, strict "No-Go" Areas to disruptive infrastructure are needed. Other areas might not qualify as strict "No-Go" Areas; however, it may often be a good societal choice to also maintain and protect those adequately.

For good and credible decision-making, areas and river stretches of interest need to be evaluated according to their functions and values. Such evaluation-based prioritization processes feed into integrated river basin planning and management to ensure the conservation and sustainable use of freshwater resources. While numerous approaches or methodologies are available to obtain credible results, there are a set of core planning principles that are critical in any freshwater prioritization process.

In order to guide development and to allocate water resources in a sustainable manner, all involved planners, decision makers, regulators, developers, financiers, and affected communities should be aware of all possible effects and threats to existing freshwater ecosystems and collaboratively apply this knowledge into sustainable practice. The buy-in of both key decision-makers and stakeholders is necessary to achieve optimal outcomes; indeed, stakeholder participation and transparency are crucial for building support for the results of the process. Ultimately, ensuring legitimacy through wide acceptance by stakeholders will increase the chance of the outputs being integrated into legal, policy, and management frameworks. From this perspective, governments and river authorities, developers, inhabitants, and freshwater conservationists share the requirement for good, integrative knowledge of where freshwater-related assets lie, which rivers or river stretches should be kept free-flowing, and which can be sustainably utilized.

WWF's work in the Amazon, Austria, China, India, the Mekong, and Mexico highlights an array of prioritization exercises spanning from intense data-rich cases to cases that rely mostly on experts' knowledge. In most of the cases, a scientific assessment was the initial purpose and often led to a more exhaustive stakeholder dialogue over water use. However, the ultimate goal was in many cases the institutionalization of the priority area status (e.g. for Mexico the "water reserves", for Austria the official listing of "No-Go" rivers) through a high-level political process or through integration into a legal framework. The main characteristics of successful approaches were:

- Balance between scientific work (e.g. sound methodology, involvement of experts, or thorough data analysis) and practical considerations (resource availability, access to data, timing, etc.)

- Involvement of key stakeholders (such as, water agencies, national government, local communities) from the earliest possible stages to increase ownership and secure public acceptance and effective buy-in from decision-makers

- Using the river basin as a minimum scale, even if this implies working in a transboundary context

- Sustained advocacy work at higher political levels

When engaging in a prioritization plan, WWF recommends that:

**National or regional authorities in charge of water management:**

- Conduct assessments identifying freshwater areas of conservation value at the appropriate scale (including transboundary)

- Inform relevant stakeholders and involve them in freshwater prioritization assessments/processes at an early stage and obtain public acceptance

- Ensure that identified freshwater areas of conservation value obtain a legally-binding status

- Ensure enforcement of the legal and regulatory framework on priority freshwater conservation areas

- Require Strategic Environmental Assessments (SEAs) for river basins and/or infrastructure development according to internationally recognized standards, the precautionary principle, and under full consideration of environmental services

- Regularly monitor the integrity of freshwater areas of conservation value to update conservation status and adjust management, as needed

**Private sector:**

- Adopt the precautionary principle in its approach to infrastructure development
- Recognize responsibility towards sustainable development and the conservation of critically important natural assets
- Comply with the mandatory provisions for freshwater areas of conservation value in planning procedures and approval processes
- Foresee appropriate mitigation and/or compensation measures where adverse impacts of projects cannot be avoided
- Be transparent and inclusive in project development plans

**Civil society:**

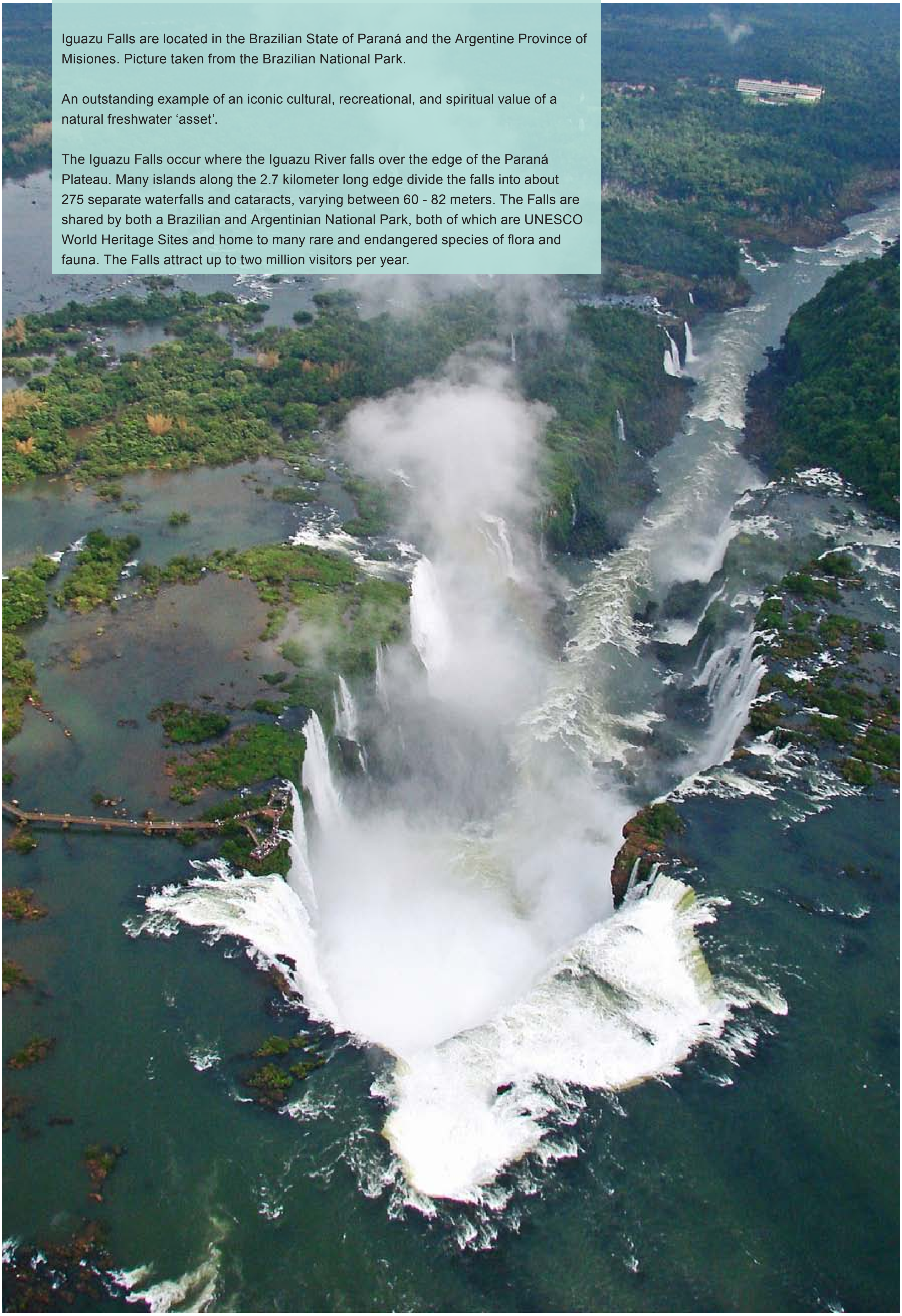
- Recognize responsibility in shaping a sustainable world and take the initiative accordingly
- Participate actively in stakeholder consultations during freshwater prioritization assessments/processes
- Support the implementation of the legal framework on freshwater areas of conservation value
- Act as a guardian of freshwater areas of conservation value by monitoring their integrity

WWF's global experiences show that the identification and prioritization of areas of conservation value is a powerful tool to address river management and water infrastructure development. WWF and partners are applying prioritization approaches around the world, tailoring the methods employed to the diverse requirements, situations, and resources available in individual settings and freshwater systems.

Iguazu Falls are located in the Brazilian State of Paraná and the Argentine Province of Misiones. Picture taken from the Brazilian National Park.

An outstanding example of an iconic cultural, recreational, and spiritual value of a natural freshwater ‘asset’.

The Iguazu Falls occur where the Iguazu River falls over the edge of the Paraná Plateau. Many islands along the 2.7 kilometer long edge divide the falls into about 275 separate waterfalls and cataracts, varying between 60 - 82 meters. The Falls are shared by both a Brazilian and Argentinian National Park, both of which are UNESCO World Heritage Sites and home to many rare and endangered species of flora and fauna. The Falls attract up to two million visitors per year.



# Chapter 1. Introduction

Freshwater ecosystems play a vital role in the lives of humans, providing critical provisioning services, the basis for economic activities, and a wide range of regulating and cultural services. In the face of development, human population growth, and increasing competition between freshwater uses and users, development must be carefully planned such that the services that freshwater ecosystems provide are maintained and that irreplaceable ecosystems and species are not lost. There is a need to identify those areas that must remain intact and actively protected as **"No-Go"** areas. In order to guide river basin management and also dams and other water infrastructure development towards a sustainable and balanced outcome, stakeholders – involved planners, decision makers, regulators, developers, financiers, and affected communities – must be aware of the implications and impacts of infrastructure development on freshwater ecosystems.

**Sustainable development must be carefully planned such that the vital services that freshwater ecosystems provide are maintained and that irreplaceable ecosystems and species are not lost.**

This publication, intended for any and all stakeholders involved with freshwater management, provides an overview to the identification of priorities for freshwater conservation in the face of water infrastructure development. Case studies show how setting priorities can be a valuable tool not only for conservation NGOs' own agendas, but also for all parts of society explicitly involved in or influencing decision-making processes regarding freshwater systems. It is important to note that this is a complicated and often regionally specific issue with no one fits-all approach; rather there are a variety of approaches and methodologies to fit the situation (please see Annex 2 for selected resources).

This publication will discuss:

- Why the identification and prioritization of "areas of conservation value" is needed
- How this can be done effectively, even under a number of constraints (e.g. scarcity of data, lack of institutional capacity, etc.)
- Which outputs can be produced
- How to effectively integrate this knowledge into river basin planning and relevant decision-making processes

Source of Oum Er Rbia River, Morocco’s longest river, rising in the Middle Atlas mountains and flowing generally westward to the Atlantic Ocean near Azemmour. Although the River is not navigable, it is perennial and torrential, in addition to being a major source of hydroelectric power and irrigation: dams on the river include Afourer, Kasba Zidania, Im Fout, Daourat, Sidi Saïd Maâchou, and Bine.

# Chapter 2.
# The Need for Setting Priorities for Freshwater Conservation

**Of the world's total water, only 2.5 % is freshwater, and a mere 0.3 % of that amount exists as wetlands, lakes and rivers.**

**The Value of Freshwater Ecosystems**
Of the world's total water, only 2.5 % is freshwater, and a mere 0.3 % of that amount exists as wetlands, lakes and rivers (Stiassny et al., 1999). Thus, freshwater species are confined to 0.01 % of the world's available water. Yet, diversity of these systems is high, with 40 % of all known fish species occurring in this tiny portion that makes up freshwater ecosystems (Lévêque et al., 2008). Moreover, all species on earth depend on clean freshwater that comes from functioning freshwater ecosystems.

Freshwater ecosystems play a vital role in the lives of humans, providing drinking and irrigation water, a source for food and energy, and an economic basis (most economic activities depend on reliable and good quality water availability). However, freshwater systems not only provide **provisioning services**, but also less obvious, yet fundamentally crucial **regulating services**, such as water purification, groundwater stock balancing and feeding, salinity prevention, flood mitigation, sediment transport and retention. Moreover, society derives a huge variety of **cultural services** ranging from recreational opportunities to aesthetic and spiritual values (e. g., rivers and their landscapes being icons of cultural and religious heritage) (Vörösmarty et al., 2005; Finlayson & D'Cruz, 2005).

Underlying these provisioning and regulating services are the supporting functions of freshwater ecosystems, which play a vital role in nutrient cycling, primary production, habitat provision, and biodiversity maintenance (Gomez-Baggethun & De Groot, 2010). Intact freshwater ecosystems provide some of the largest ecosystem contributions to human welfare (WWF, 2006); the Millennium Ecosystem Assessment calculated wetlands to have a value of US$15 trillion in 1997 (MEA, 2005). These services and their natural capital depend on healthy rivers and basins.

**Why are Priorities for Freshwater Conservation Needed?**
**Integrated basin-wide planning** is required to determine the best possible options for a basin's sustainable utilization and development. Any decision-maker bearing the responsibility of planning for or managing inland water bodies will benefit from good knowledge about the area's water-related assets (e. g. water abundance, hydropower potential, nutrient and sediment retention, drinking, cooling, water processing supply availability, or ecosystem services in general). Therefore, from the basin manager's perspective, it is most useful to have timely and reliable indication of areas of high conservation value within the basin. Ultimately, the prioritization of areas of high conservation value will be the basis for negotiations and final trade-off agreements. Conservationists and wetland managers also benefit from the identification of freshwater conservation priorities, which help guide decisions on where to focus their work and limited resources.

**Threats to Freshwater Ecosystems from Water Infrastructure Development**
River systems around the world are under strong development pressure, especially in light of the world's growing population and current lack of access to clean water, food, and energy (Engel et al., 2011; UN Millennium Project, 2002). Often, significant quantities of water are taken from one river system and transferred into another in large-scale inter basin water transfer schemes (Pittock et al., 2009). For hydropower generation, storage dams, water diversions, and run-of-the-river dams are built, while small hydropower schemes, often considered benign, tend to occur in large numbers in river basins with heavy cumulative impact (WWF, 2006). Of the world's 177 largest rivers, only a third remain free-flowing and only 21 rivers longer than 1,000 kilo-

meters retain a direct connection to the sea (WWF, 2006). It is, however, not only the few remaining free-flowing rivers that are threatened, infrastructure developments are planned on river systems of all types.

Water infrastructure is planned and built for either single-or multi-purpose human use, including water abstractions (mainly for agricultural and urban consumption), hydropower, navigation, or flood protection. Hydropower development in particular is being scaled up to meet national energy demands as it is often considered an indispensable component of a renewable energy mix in the face of climate change. However, this development boom is particularly hazardous to freshwater ecosystems if not conducted in a sustainable manner.

**Water infrastructure can alter river flows, river and coastal morphology, connectivity, and water quality.**

The benefits gained by water infrastructure often come at significant environmental costs. Traditionally operated storage dams can significantly alter downstream **river flows** to a more or less constant flow, or flow releases may follow the daily or even hourly pattern of peak energy demand. Water abstractions and inter-basin transfers also change the flow regime. A river's natural flow dynamics maintain and support key ecological processes and vital life-cycle stages, thus alterations can significantly change an ecosystem or its functioning (Poff et al., 1997). Many seasonal floods and flood pulses provide fish spawning habitats, trigger and enable spawning and migration patterns, and provide nutrients and conditions for floodplain vegetation to exist. Moreover, river estuaries and deltas are sensitive to salt water intrusion, which may increase substantially if the freshwater flow quantity and pattern is altered. Loss of fertile land and potable groundwater may result in those often densely populated and heavily cultivated areas. In this way, a single storage dam can affect the entire downstream river all the way to the sea.

River Mura between Slovenia and Croatia

Flow pulses and flood patterns also physically shape the river's bed, banks, and floodplains by collecting, transporting, and depositing sediment (Church, 2002). Both bed load and suspended load fundamentally shape the river and thus its flood characteristics all the way down to the river's mouth. The alteration of sediment loads due to loss of flood pulses, over-extraction of water, or severed sediment connectivity may lead to heavily altered river characteristics, which can result in increased flood levels during already high flood events with devastating effects. Also, sediment might not reach the river deltas anymore, making these vulnerable to soil loss, coastal erosion, and storm flooding from the sea. Such long-term effects of infrastructure on **river and coastal morphology** are often underestimated or even completely overlooked during planning processes and cost-benefit-analyses of new dams or other water infrastructure projects.

Savage Rapids Dam near Grants Pass, Oregon

Dams and other water infrastructure also affect freshwater ecosystem **connectivity** as rivers become disconnected from their floodplains and wetlands, which impacts riparian habitats. Dams and weirs create physical barriers for the movement of aquatic organisms (Ward, 1998). Even installed fish ladders can only be partially effective in restoring fish migration as these ladders are a mitigation measure for a limited number of species (Porcher & Travade, 2002); less capable fish and benthos organisms are often incapable of passing these structures in sufficient numbers. This applies also to small hydro schemes, which are often considered benign but exert significant cumulative impacts due to their occurrence in frequently large numbers.

Dams and their operations also influence **water quality**. Water released from a dam's reservoir can be either too warm or too cold for native species, depending on the depth at which the water is withdrawn and the season. Among many other chemical and physical parameters are dissolved oxygen, pH, dissolved and undissolved organic and inorganic elements. By turning originally flowing waters into stagnant reservoirs, the chemical and nutrient composition fundamentally changes.

**Planning for Sustainable Solutions**

River basin (or regional) planning needs to be an integrative process to find sustainable solutions that respect conservation priorities under adherence of the precautionary principle,[1] while sustainably supplying societal needs for water, energy, and food.

Given that water is an essential resource, aquatic ecosystems require protection so that they can continue to provide goods and services to people both now and into the future.

Given that water is an essential resource, aquatic ecosystems require protection so that they can continue to provide goods and services to people both now and into the future. Multiple uses and users all compete for the same resource, but not all uses are necessarily mutually exclusive. Therefore, it is possible and indispensable that planning approaches allocate water resources to a sound and sustainable mix of uses; thereby providing for the long-term resilience of the aquatic ecosystems that provide the foundation for all water-related services.

A conservation plan for a river or lake basin of interest that identifies areas for conservation within the basin would be initially completed. A subsequent assessment would then determine which areas within the basin should be off-limit "No-Go" areas to certain activities because of the impacts they would have on priority areas.

In order to guide development and allocate water resources to their highest-value use in a sustainable manner, all involved planners, decision makers, regulators, developers, financiers, and the affected communities should be aware of all possible effects and impacts to existing freshwater ecosystems. **Holistic integrated basin-wide planning** is required to determine the best possible options for development and a basin's utilization. While planning at the basin-scale is sensible and well defined, other planning units may prove useful as well. There may be political boundaries that cover more than one basin (e.g. large countries with multiple river systems, or regions where neighboring countries utilize and manage water resources together) or situations in which merely sub-basins of larger watersheds are encompassed.

Barrage de Roselend, Savoy, France

The first step in implementing a basin (or wider) approach is a complete and thorough needs assessment. Such an assessment will determine if the need (e.g. energy requirement or water storage for agriculture) at hand can be met best through infrastructure (e.g. a dam) or if there are other alternatives, such as wind power, energy conservation, water-saving practices, or crop changes that could be implemented instead and possibly offer more societal benefits.

If through this assessment process, a genuine need for dams or other water infrastructure is identified, then it is time to assess the basin. Some of the questions to address are: what are the freshwater conservation values of this basin, where are the "No-Go" and priority areas located, and how can impacts to aquatic ecosystems and species be minimized? From this starting point, other questions will need to eventually be addressed: What sites are critical to maintain in as natural a state as possible in order to ensure ecosystem services? What is the hydrological situation and how is it likely to develop under climate change?

1 Adapted from the Preamble to the Convention on Biological Diversity (UN, 1992): 'Where there are threats of serious or irreversible social or environmental damage, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent such damage.' The precautionary approach means that when there is some doubt as to the presence of a high conservation value, the precautionary assumption is that the value is present. Incomplete information shall not be used as a justification for actions that may negatively affect an attribute of areas of high conservation value.

Sockeye salmons migrating up the Adams River to spawn. British Columbia, Canada

Salmon are typically anadromous fish: they are born in freshwater, migrate to the ocean, then return to freshwater to reproduce. Dams and poor water quality are major obstacles for the migrating salmon. The annual salmon run season is a remarkable, iconic event for rivers: salmon-catching bears of North America are an icon of wilderness and nature, whilst sport fishers regard this as the major date of the year. Many indigenous peoples' cultural values are connected to this event as well.

# Chapter 3. Setting Priorities for Freshwater Conservation: Planning Principles, Methodology and Outputs

Planning for freshwater conservation is a relatively nascent field as compared to terrestrial planning. Several papers have been published that lay out a set of agreed-upon principles (summarized below) for setting freshwater conservation priorities (Higgins, 2003; Nel et al., 2008). There is also burgeoning literature with examples of freshwater conservation planning (e. g., Hermoso et al., 2009; Linke et al., 2008; e. g., Linke et al., 2007; Moilanen et al., 2008; Nel et al., 2007; Thieme et al., 2007; Linke et al., 2011).

Prioritization approaches and methodologies will vary based on data quality, type, and resolution; target habitats, species, and functions; and overall project goals; however, some general principles (as described below) should be included in almost any freshwater conservation plan or prioritization process.

**Freshwater Planning Principles**

*Principles and text that follows adapted from Nel et al., 2008, which cites Abell et al., 2002; Higgins, 2003; Fitzsimons & Robertson, 2005; and Roux et al., 2006 as primary sources.*

**1. Plan for representation of freshwater biodiversity**

- Delineate freshwater systems and their associated catchments/sub-catchments
- Map biodiversity surrogates (e. g. species data, modeled species distributions or ecosystem types)

The goal of this part of the process is to ensure the **representation** of the full variety of biodiversity in a planning region. Thus, decisions are made regarding which surrogates (e. g., taxonomic groups, ecosystem types) will be used to represent the full suite of biodiversity, the characteristics of those groups that will be incorporated into the priority setting process (e. g., richness, endemism, threatened species, representation of unique system types), and the scale of the planning unit at which these characteristics will be delineated (e. g., river reach, small sub-basin). Data availability, quality, type, and resolution often drive many of these decisions. There is no best surrogate. The decision on which surrogates to use will depend on many factors including what data are available and what resources there are for data analysis (e. g., spatial modeling) and for the collection of new data (Margules & Pressey, 2000). Sometimes, species occurrence data are used; more often species distributions are modeled based on occurrences. A common approach uses both coarse- and fine-filter targets. **Coarse-filter targets** are ecosystem types or environmental domains that, if conserved, will capture many common species and communities; whereas, **fine-filter targets** include those species or communities that are rare, endangered, occur locally, or are migratory (Groves, 2003). It is worth emphasizing that, when possible, it is important to plan for the validation of species or ecosystem type models by collecting field data or vetting for expert review to test the accuracy of the models.

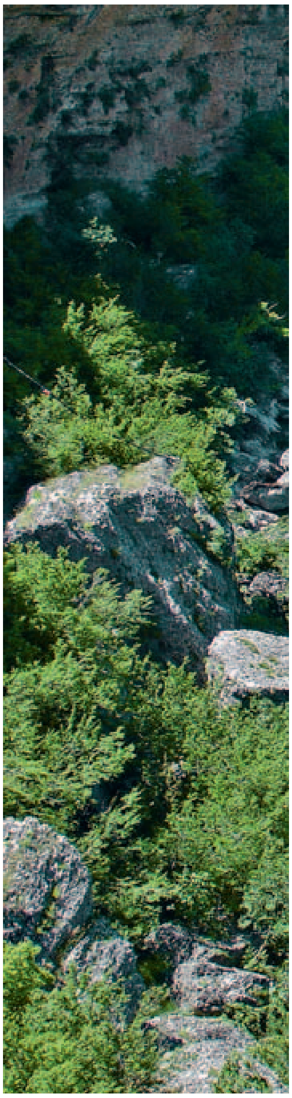
## 2. Set quantitative conservation goals

- For biodiversity surrogates (e. g., species, ecosystem types, species assemblages)

**Setting quantitative conservation goals** is a defining characteristic of systematic conservation planning. Quantitative goals allow for the explicit evaluation of whether or not a certain set of priority areas meets the goals (e. g., see Box 1 and 2). It also facilitates the design of spatially efficient conservation areas by providing a quantitative means for evaluating complementarity of candidate areas. **Complementarity** of an area is defined as the contribution it makes to conservation goals not yet achieved in the existing set of conservation areas.

Examples of conservation goals are requiring inclusion of a certain number of occurrences of a particular river type, number of hectares of a specific wetland type, or number of occurrences of a species in the final set of priority areas. Ideally, goals are defined based on minimum viable species population sizes or minimum habitat requirements that allow the persistence of a species. In reality, conservation goals are often subjectively defined because such information is limited.

River Tara, Montenegro

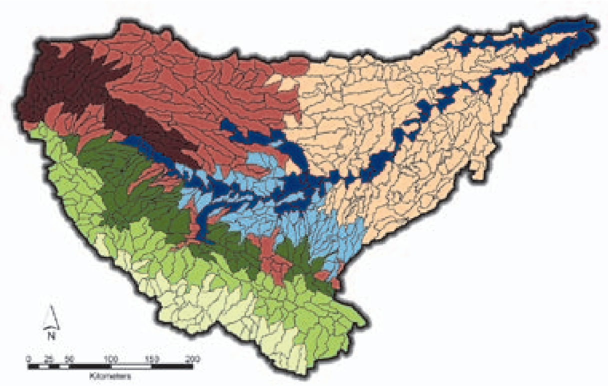


**Box 1. An example of a freshwater conservation plan for a data poor region in a remote Amazonian catchment** (after Thieme et al., 2007).

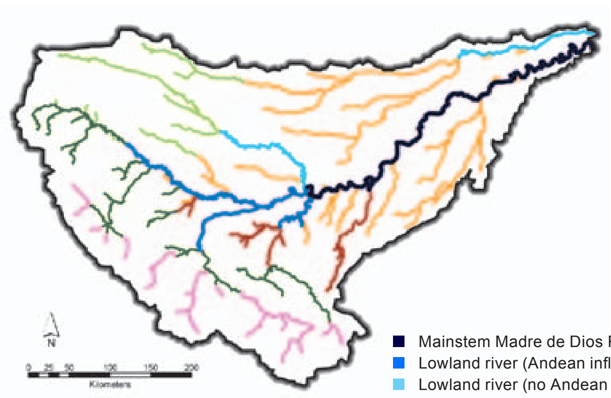
Aerial view of a winding river, Amazon rainforest, Loreto region, Peru

Physically-defined river and floodplain types were derived using a hierarchy of available data that describe hydro-geomorphological characteristics of streams (e.g. elevation, modeled surface runoff, geology). For each of these 22 system types, goals were set at 20 % of the total extent. In meeting goals, choices were guided by rules to maximize complementarity and connectivity, to choose the most intact systems, and to align with terrestrial conservation priority areas and existing protected areas. The final integrated conservation plan differentiates between areas that may require different management strategies: Level I areas are relatively intact and a range of protection mechanisms can be employed; Level II areas coincide with indigenous territories where conservation will depend on collaboration with indigenous groups; and Level III areas experience high use and thus require active threat mitigation to meet conservation needs.

- Pass-through basin
- Lowland wet tropical forest
- Lowland dry tropical forest
- Mid-elevation tropical forest
- Mid-elevation bamboo forest
- Mid-elevation montane forest
- High-elevation montane forest
- High-elevation grass- and shrubland

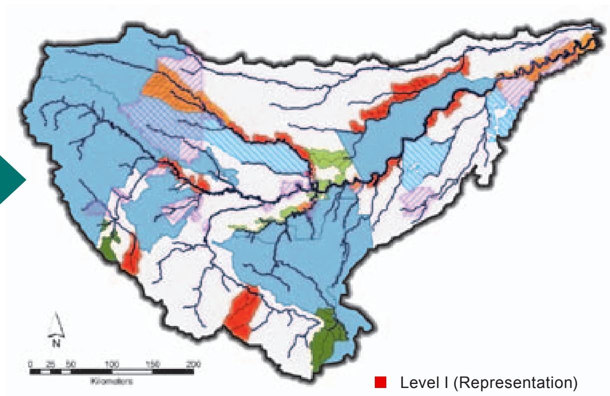


Inputs to hydrogeomorphological classification



- Mainstem Madre de Dios River
- Lowland river (Andean influence)
- Lowland river (no Andean influence)
- Lowland stream (Andean influence)
- Lowland stream (no Andean influence)
- Mid-elevation stream (Andean influence)
- Mid-elevation stream (no Andean influence)
- High-elevation stream (entirely Andean)

Targets for Representation + Rules



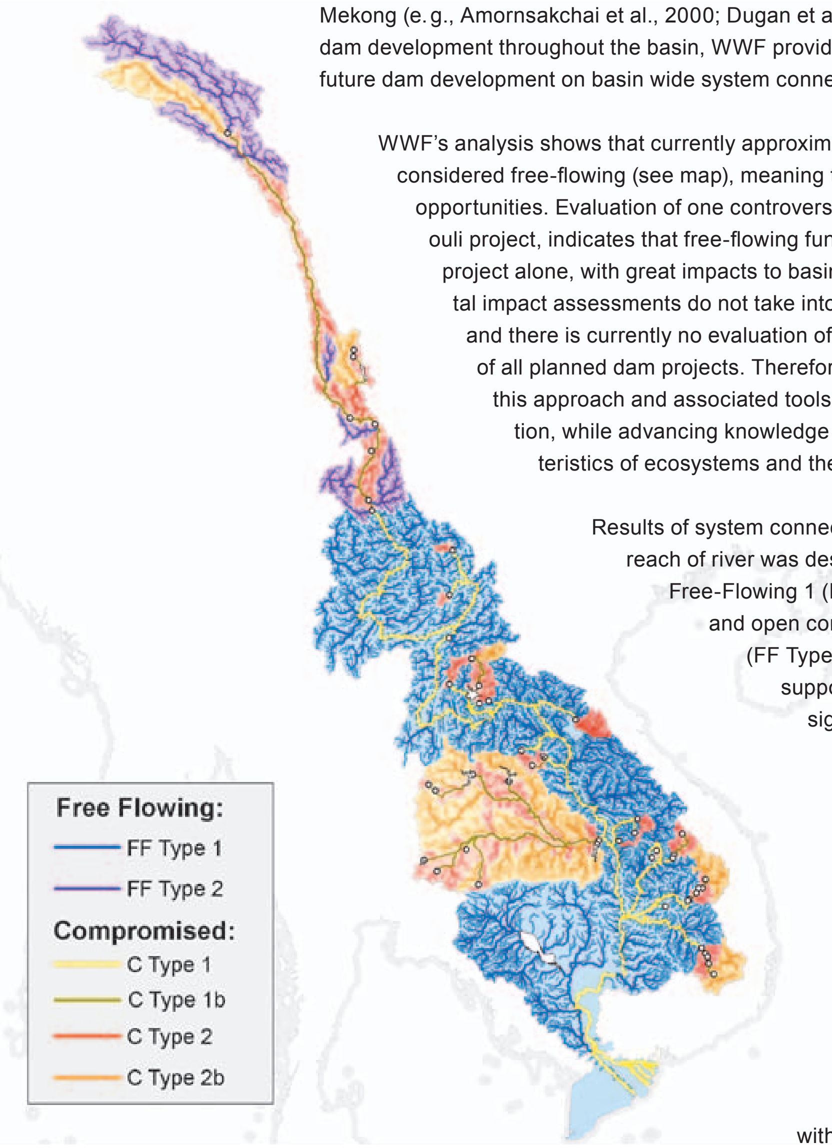
- Level I (Representation)
- Level II (Connectivity)
- Level III (Representation)
- Level III (Connectivity)
- Protected areas
- Indigenous territories
- Terrestrial priority areas
- Major rivers

**Box 2. Mekong River – Quantification and Visualization of River System Connectivity and Free-flowing Characteristics**

Mekong's Khone Falls, Champasak Province in southern Laos. The planned Don Sahong Hydropower Project would dam the main fish migration channel Hoo Sahong. Migratory fish are an important component of fish stocks in the Mekong; this fishery, the most productive inland fishery in the world, provides protein and income for millions of people in the lower Mekong Basin. The Mekong also provides a home for the second-highest number of fish species after the Amazon.

The Mekong, a unique and extremely diverse river system, sustains the daily food supply of approximately 50 million people. The key drivers behind this exceptional productivity are the natural connectivity and variability of flows, which are drivers of basin-wide fish migration. Based on a new approach founded on the WWF HydroSHEDS tools and data, WWF defined a way to quantify and visualize river system connectivity and free-flowing characteristics of the basin and its river systems. Results show that a large part of the Mekong Basin is no longer free-flowing; many systems are effectively ‚locked' behind dams. Various studies have indicated that the loss of connectivity has had negative impacts to fisheries production in various sub-basins of the Mekong (e. g., Amornsakchai et al., 2000; Dugan et al., 2010). Given extensive plans for further dam development throughout the basin, WWF provides an approach to evaluate the impacts of future dam development on basin wide system connectivity and freshwater ecosystems.

WWF's analysis shows that currently approximately 60 % of the basin can still be considered free-flowing (see map), meaning that there still are significant conservation opportunities. Evaluation of one controversial main stream dam in Laos, the Xayabouli project, indicates that free-flowing functionality could be reduced by 20 % by this project alone, with great impacts to basin wide fish migration. Current environmental impact assessments do not take into account large-scale impacts of projects and there is currently no evaluation of the combined impacts of the development of all planned dam projects. Therefore, WWF suggests further development of this approach and associated tools that allow for basin-level impact evaluation, while advancing knowledge of the importance of free-flowing characteristics of ecosystems and the services they provide that benefit people.




Results of system connectivity analysis for the Mekong Basin. Each reach of river was designated as one of the following types: Free-Flowing 1 (FF Type 1): no significant dams upstream and open connectivity to delta/sea, Free-Flowing 2 (FF Type 2): river system upstream of dam that supports river of 100 kilometers length without significant dams upstream, AND remains connected to main stem, Compromised 1 (C Type 1): river system with significant dam upstream, Compromised 1-b (C Type 1b): river system with significant dam upstream AND upstream of a dam, Compromised 2 (C Type 2): river system upstream of dam NOT supporting river of 100 kilometers length without significant dams upstream, or Compromised 2-b (C Type 2b): river system upstream of dam that supports river of 100 kilometers length without significant dams upstream.

### 3. Evaluate current impacts and future threats

- Use field-based ecological integrity data when available
- Use data on existing water use
- Supplement with remotely sensed and mapped land cover data

During the selection of priority areas, current impacts and future threats are incorporated into the process in order to guide selection toward areas in good condition or those that can be restored (see Box 4 in Chapter 4). Areas under high threat levels may also be prioritized if they contain highly imperiled species and are a remaining stronghold for the species. It is during this part of the process in which the current and future effects of climate change should be considered (Matthews et al., 2011). Many freshwater ecosystems are already beginning to see changes in flow regime as a result of shifts in precipitation timing, extreme events, and snowpack shifts (IPCC, 2008); additionally, species and ecosystem distributions may shift with changes in climate, such that priorities may need to be adjusted to plan for overall system resilience.

Ideally, data on the ecological integrity of conservation planning units would come from field-collected data (e. g., biological assessments, water quality assessments); however, as with other ecological data, widespread and even coverage is often limited. Thus, mapping ecological integrity for conservation planning is largely dependent on the use of land cover data, existing data on land and water use, and expert knowledge as proxies for ecological integrity, supplemented with available site-based data whenever possible.

### 4. Plan for persistence

- Incorporate connectivity and other factors that favor persistence

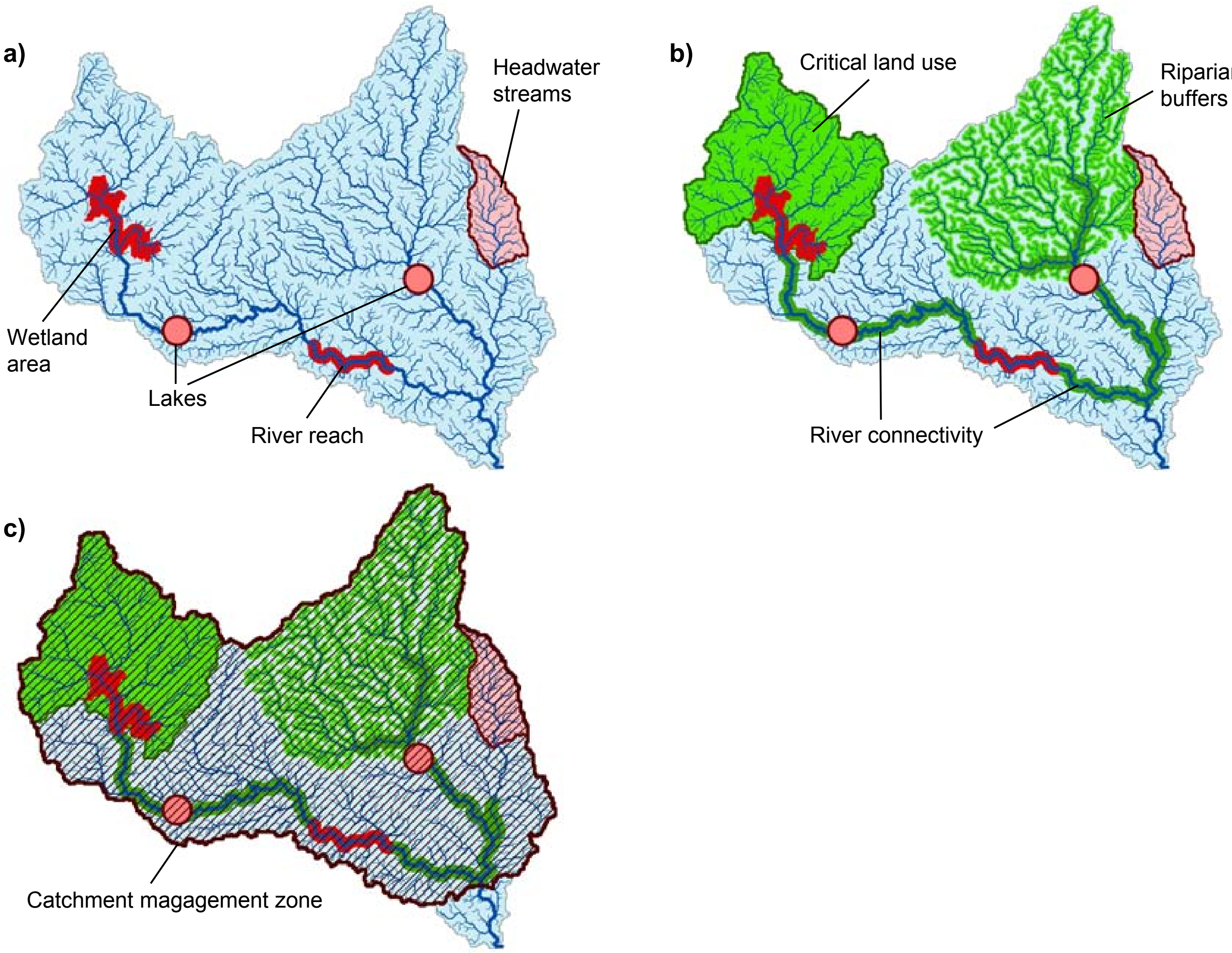
**Persistence** requires maintenance of the natural processes that support and generate biodiversity. For freshwater systems, this largely means incorporating natural processes related to longitudinal, lateral, and vertical connectivity into conservation plans (Nel et al., 2008). Other variables, such as size of conservation areas, replication, and alignment of boundaries (for example, with watersheds) also contribute to the long-term ability of biodiversity to persist in conservation areas. Quantitative goals should be set for connectivity, minimum size or other design criteria (Margules & Pressey, 2000).

**Connectivity** of stream systems adds a particular challenge to freshwater conservation planning. Given its fundamental role in the maintenance of aquatic ecosystems through sustaining key ecosystem processes (e. g., flow regime, species movements); an effort should be made to prioritize those remaining systems or basins that retain high levels of natural connectivity. Several different approaches have been used (e. g., see Box 1 and 2 and Moilanen et al., 2008; Esselman and Allan, 2011; Linke et al., 2008; Heiner et al., 2011; Nel et al., 2011; and Hermoso et al., 2011).

**Box 3. Proposed nesting zoning scheme for freshwater protection zones.**
(after Abell et al., 2007)

Aerial view of a section of the Juruena River between Sao Gabriel and Sao Lucas Rapids, Juruena National Park, Brazil

Proposed zoning for freshwater protection: (a) freshwater focal areas, such as particular river reaches, lakes, headwater streams, or wetlands supporting focal species, populations, or communities; (b) critical management zones, such as river reaches connecting key habitats or upstream riparian areas, whose integrity will be essential to the function of freshwater focal areas; and (c) a catchment management zone, covering the entire catchment upstream of the most downstream freshwater focal area or critical management zone, and within which integrated catchment management principles would be applied. (Source: Abell et al., 2007)



Lake Skadar, Montenegro and Albania

Lake Skadar is a critical wintering and staging site for migratory birds and European waterfowl and the western most nesting site for the Dalmatian pelican; in all, more than 280 species of birds have been recorded here, as well as 50 species of fish.

One of the main characteristics of Lake Skadar is the seasonal variability of its water level due to inflow from the Moraca River, on which a cascade of hydropower dams are planned.

**5. Design a conservation area network that minimizes threats, maximizes representation, and incorporates connectivity and other factors that favor persistence**

- Design for spatial efficiency
- Design for cost efficiency
- Interpret within the context of multiple use zones
- Integrate terrestrial and freshwater conservation plans

Multiple criteria inform the design of a conservation area network, including the representation of biodiversity features, incorporation of design issues that maximize ecological integrity and promote persistence of biodiversity, consideration of socio-economic opportunities and constraints in the region, and alignment with other conservation and planning initiatives (Nel et al., 2008).

Historically, conservation plans were derived from the overlap of areas of importance for multiple criteria. In recent years, decision support software (DSS) has allowed for spatially explicit analyses that aid in meeting multiple criteria and selecting possible portfolios of freshwater priority areas (see Annex 2 for links to several DSS). The use of software in design and negotiation of priority area portfolios has the distinct advantage of generating multiple solution sets that meet quantitative conservation goals and the ability to rapidly update possible solution sets as new data come available or particular decisions are made. Expert assessments can also be incorporated into computerized analyses of spatial data to take advantage of the on-the-ground knowledge that experts possess.

An additional recent advance in freshwater conservation planning has been the conceptualization of nested zoning for freshwater systems that recognizes the inherent hierarchical nature of river and lake basins (Abell et al., 2007). This proposed system of zoning recognizes three types of zones:

- Freshwater focal areas are those locations that support a specific freshwater feature that requires protection (e.g., breeding grounds, hotspot for species endemism)
- Critical management zones are those places whose management is essential to maintaining the functionality of a focal area (e.g., active management of the riparian zone upstream of a spawning site)
- Catchment management zone is the entire upstream catchment of a critical management zone in which best practice catchment management principles would be applied (Box 3)

**6. Plan for effective and sustained implementation**

- Identify clear objectives and the target audience for the plan
- Identify and involve key stakeholders (see section below for more detail on stakeholder involvement and ensuring sustained implementation)
- Assess social, economic and institutional contexts
- Promote cooperation across all political boundaries and sectoral interests
- Develop a shared long-term regional vision and strategy at the catchment scale
- Consider desired output/outcome of planning process to help shape methodology chosen

**Effective and Sustained Management – Policy and Stakeholder Engagement**
Policy and stakeholder engagement is a key component of a prioritization process. Indeed, scientific soundness is insufficient to ensure the use and adoption of the prioritization outcome without the endorsement by a critical mass of stakeholders, including eventual buy-in from key policy- and decision-makers. Since such an exercise is likely to impact land use planning and sectoral policies, the latter will need to integrate the outcomes in relevant plans and policies and potentially into existing legal frameworks.

The larger the base, the greater the legitimacy conferred to the prioritization process and the greater the support that can be expected due to a higher degree of acceptance and stronger feeling of public ownership.

The nature of the stakeholders and the extent of their involvement depends however on a number of factors – notably the political context and institutional setting at the relevant scale (usually at the national, regional, or basin level).

**Stakeholder Identification and Selection**
Identifying stakeholders can be difficult since a stakeholder is simply any group or individual who is interested in, affected by, or can affect an activity or process (UNEP, 2005; IHA, 2010). Even if it is not possible to include representatives from all stakeholder groups in the assessment, it is key to include stakeholder groups that can strongly influence the eventual implementation of the outcome or that will be significantly affected by the proposed plan.

Depending on the political context, the stakeholder base may be very large or it may be kept to a minimal amount of official decision-makers (such as, water authorities, energy utilities, relevant ministries, etc.) or a very narrow leadership. The larger the base, the greater the legitimacy conferred to the prioritization process and the greater the support that can be expected due to a higher degree of acceptance and stronger feeling of public ownership (see Table 1).

**Table 1:** Pros and cons of different sized stakeholder bases

| Stakeholder base | Pros | Cons |
|---|---|---|
| **Large** | Strong public acceptance and/or endorsement by decision-makers | Time-consuming, cumbersome process |
| | Political legitimacy | Potential "watering down" of outcome due to need to achieve consensus |
| | Feeling of ownership by local stakeholders | Risk of not achieving overall consensus if very polarized views prevail |
| | Higher degree and quality of actual implementation | |
| **Limited** | Less time-consuming process | Public acceptance depending on sound choice of stakeholders involved |
| | Consensus easily achieved, especially if polarized views are kept out of the discussions | All stakeholder needs potentially not reflected |
| | Higher degree and quality of actual implementation | Potential failure in identifying interesting alternatives |
| | Less "noise" made, less visibility given to the issue | Uninvolved stakeholders may fiercely oppose plans |
| **None** | "Quick and dirty" process | High risk of raising objection and fueling opposition |
| | Allows a technocratic, top-down approach | Risk of low buy-in from key stakeholders/ decision-makers |
| | Preferred option in highly hierarchal institutional setting | Risk of non-implementation |
| | | Potentially reduced transparency in the process |

It is important to stress that much also depends on the initiator of such an assessment – for example, a non-governmental organization (NGO) will generally follow a bottom-up stakeholder involvement approach while a public authority often takes a top-down approach. Participation at the grassroots level is not sufficient alone as the central government must reciprocate initiatives – combining top-down and bottom-up approaches – for effectiveness and sustainability. Effective citizen 'voice' – the 'demand side' of the equation – needs to be met by 'supply-side' state responsiveness, which in turn will reinforce and foster more citizen engagement in a virtuous cycle. Institutional responsiveness is defined here as the achievement of congruence between community preferences and public policies such that activities of the institution are valued by the public (UN ECA, 2004).

When it comes to the selection and the definition of the stakeholder group to be addressed, the relevant geographic scale will have to be determined. This will usually overlap with the scale chosen for the assessment (e.g. river basin, region, or country). However, it could also be decided that stakeholders external to the region (e.g. international organizations) should be consulted or that focus should be given primarily to the immediately affected local communities. A good balance will be of paramount importance to soundly reflect the situation and key influences.

For these reasons, it is crucial to conduct a proper stakeholder analysis that identifies the main players and the type and degree of their influence on the process (see Table 2).

**Table 2:** Type and level of influence – blue-highlighted boxes indicate the commonly observed level of influence for each type of stakeholder.

| Level of Influence | None | Low | Medium | High |
|---|---|---|---|---|
| Supranational or international institution (e.g. EU, UN) | | | ■ | ■ |
| National government | | | | ■ |
| Regional government | | | ■ | |
| Public administration/utility (e.g. water, environment energy) | | | ■ | |
| Local authorities | | | ■ | |
| Users upstream* | ■ | ■ | ■ | |
| Users downstream* (incl. coastal communities) | ■ | ■ | ■ | |
| Academic/research Institutions | | | ■ | |
| Private sector | | | ■ | ■ |
| Religious/cultural entities | ■ | ■ | | |
| Civil society (NGOs, interest groups) | ■ | ■ | | |
| * Upstream or downstream users could be farmers, fishermen, loggers, indigenous people, etc. | | | | |

Particular **stakeholder categories** need different degrees of attention and approaches. In the case of a prioritization exercise, it is likely that three types of stakeholders will be key:

- **Policy- and decision-makers**: their buy-in (or not) is most likely to have the highest impact on the assessment's successful outcome as an official endorsement and potential integration in public plans or policies

- **Academic institutions**: their involvement will add scientific legitimacy to the assessment

- **Affected communities**: their engagement from the start will increase ownership of long-term plans and improve chances for the successful implementation of plans

**Method and Stage of Stakeholder Involvement**
Since all stakeholders cannot and should not be deeply involved all of the time, there will be varying methods, levels, and periods of participation. The four main types of interaction with stakeholders, according to an increasing degree of involvement, are (FAO Informal Working Group on Participatory Approaches & Methods):

- Providing Information – a one-way flow of general information to keep people informed about developments

- Consultation – a two-way flow of more specific information where views are considered in decision-making

- Collaboration – two-way communication where stakeholders assume greater control over decision-making in partnership with the donor/lead agency

- Empowerment – two-way communication where primary control of decisions is entrusted to the stakeholders, often after capacity-building efforts have taken place to make this possible and in accordance with donor's financial and reporting requirements

After assessing the type and timing of stakeholder involvement, a number of appropriate tools (listed in Table 3 below) will have to be selected at specific stages of the prioritization process to enhance involvement and make it efficient.

**Table 3:** Participatory tools suitable for the prioritization principles

| Prioritization principle | Tools |
|---|---|
| 1. Plan for effective and sustained implementation | • Stakeholder analysis to understand the direct and indirect groups affected and plan who is going to participate how<br>• Development of a stakeholder conflict grid<br>• Consultation and analysis of relevant framework needs to make sure that the plan is in line with objectives<br>• Discussion with authorities and policy-makers for buy-in (ideally at ministerial level)<br>• Seeking and getting public support<br>• Parliament voting or referendum |
| 2. Plan for representation of freshwater biodiversity | • Participatory data-gathering additional to experts' work<br>• Tools that help understand the local situation and bring it into the picture |
| 3. Set quantitative conservation goals | • Stakeholder round-tables and joint decision-making whenever possible |
| 4. Evaluate current impacts and future threats | • Participatory data-gathering additional to experts' work<br>• Tools that help understand the local situation and bring it into the picture |
| 5. Plan for persistence | • Participatory data-gathering additional to experts' work<br>• Tools that help understand the local situation and bring it into the picture |
| 6. Design a conservation area network | • Public information<br>• Stakeholder consultation (e.g. round-tables, internet, workshops, etc.)<br>• Participatory evaluation and joint decision-making |

### Degree of Empowerment and Decision-Making Processes

If the degree of involvement reaches the level of participatory decision-making and empowerment, then the level of agreement necessary to finalize a decision (known as a **decision rule**) will need to be decided. The range of possible decision rules varies from unanimous agreement or consensus to unilateral decision-making through various majority thresholds.

### Prioritization Planning Outputs

Although outputs are often not considered at the beginning of a complex process (such as a prioritization exercise), it is actually very important to determine this during the initial planning phase in order to guide the methodology chosen.

The most important driving force towards the selection of the output is the "relevance" of the action, or what is the intended purpose of the exercise and who should use it. The type of either technical or political output to produce must hence be driven by the limitations imposed by the end users who must be able to operate, consult, and ideally, update it.

It may seem unnecessary to state that the output greatly depends on time and resources available, yet it is useful to remind project planners to reflect on whether the time and resources available allow the objective to be achieved. In other words, it may be unwise to embark on a prioritization process if the time and resources available prevent the expectations and needs of the final users to be met. It is worthwhile engaging in a dialogue with end users to scope out all possible alternatives and check whether there is one that optimally matches available resources with needs. It may also prove extremely helpful to engage an advisor experienced with the various potential outputs.

### Technical Outputs

Technical outputs of the prioritization process can be presented in numerous forms (Table 4), but the type of output is decided by the intended audience and use of the information presented.

**Table 4:** A list of potential physical outputs highlighting the main pros and cons

| Technical Output | Pros | Cons |
|---|---|---|
| Paper map | • Tangible, valid and durable document | • Cannot be dynamically updated |
| Electronic map and associated software | • Dynamic / can be updated<br>• Easy to share with others / disseminate | • Requires hardware/ software and capacity to use it |
| Decision Support System | • Dynamic / can be updated | • Complex design<br>• Expensive<br>• Depending on the tool, may be difficult to use<br>• Requires hardware/ software and capacity to use it |
| Report | • Easy to produce | • Information potentially not presented in manner that facilitates decision-making |

**Policy Outputs**
Depending on the level of the decision-making applied – e. g. grassroots or higher political – and the extent of the political actors' involvement, the result of the assessment could be used as a:

- Tool for fostering **consensus and mutual trust** among key stakeholders when used in an inclusive manner
- **Lobbying tool** used by NGOs, academic institutions and/or local communities to exert pressure on the higher political spheres, e. g. regional or national -level, to improve or review their current plans or policies in terms of freshwater resources management/land use planning
- **Basis for policy instruments**, e. g. political declaration, adopted at higher political levels to further influence policies, e. g. at ministerial level
- Draft law or decree that can be included in the **legislative process**; particularly if discussed in the Parliament, it can be integrated into the existing legal or regulatory framework

Kravice Waterfalls in Bosnia-Herzegovina

Aerial view of a winding river, Amazon rainforest, Loreto region, Peru.

Peru and Brazil signed an energy cooperation agreement for over 7,200 MW through the construction of large dams in the Peruvian Amazon and transmission lines to Brazil. The projects Inambari, Paquitzapango, Tambo 40, Tambo 60, and Mainique 1 are located in four river basins of the central and southern Peruvian piedmont. The projects affect areas of high biodiversity, indigenous communities, and ancestral territories.

# Chapter 4. WWF Case Studies on Setting Priorities for Freshwater Conservation

In the various regions where WWF works, the combination of science and policy considerations has been translated differently in freshwater land use planning approaches as illustrated below. Each case study will review the objectives, methodology, stakeholder involvement, outputs, challenges, impacts achieved, and next steps (see Annex 1 for summary table).

## 1. Amazon – Hydrological Information System for Amazon River Assessments (HIS-ARA)

**Objectives:**
Main Objectives:
- Identify a set of priority conservation areas that could guarantee the existence of a functional & resilient sample of Amazon biome biodiversity based on the principles of representation, irreplaceability, functionality, flexibility, vulnerability, and connectivity
- Identify the Amazon Rivers that need to remain free-flowing in order for the natural flow regimes (the pulse) of the overall Amazon system to be maintained
- Support the development of strategies to guarantee our regional conservation targets[2]

Secondary objectives:
- Identify biodiversity protection gaps
- Identify vulnerability areas
- Generate information and assessment methodologies for decision makers

**Methodology**: The analysis followed a Systematic Conservation Planning approach, which involves a cost/benefit analysis that counterweights the biodiversity representativeness, biological importance (irreplaceability) and vulnerability and conservation opportunities of a given area to determine its inclusion (or not) in a protected area system (Margules & Pressey, 2007).

To identify a given area's ecological importance, terrestrial ecological systems and the drainage ecological units developed by WWF (based on Hydrosheds[3]) as a surrogate for the Amazon ecosystems biodiversity were used. A protection goal of at least 30 % for each landscape/aquascape was defined as a representation target.

The cost layer for the terrestrial ecosystems was a deforestation probability model developed by the Amazon Institute of Research – IPAM. This model utilizes data from road, cities, economic demands and governance to infer potential expansion of economic activities in the Amazon and the consequent risk of natural vegetation conversion. For aquatic systems, an Ecological Risk Index (ERI) was calculated using data of different anthropogenic threats and its potential impacts on the aquatic ecosystems (see Box 4). As an opportunity layer, the datasets of indigenous territories and sustainable use areas were used.

The optimization (cost/benefit) analysis was performed using the software tool Marxan. The overall process is summarized in Figure 1[4].

2 Diversity of terrestrial and aquatic ecological systems; natural flow regimes that maintain aquatic connectivity and dictate the pulse of the largest river basin on the planet; and, global and regional climate regulator role of the Amazon biome

3 http://hydrosheds.cr.usgs.gov/

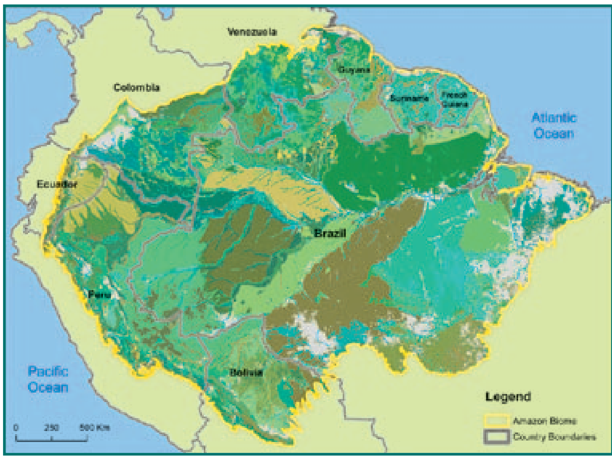
4 Animation of the model described, HIS ARA (English): http://www.youtube.com/watch?v=rJsYURZuFvk

## Box 4. Ecological Risk Index (ERI)

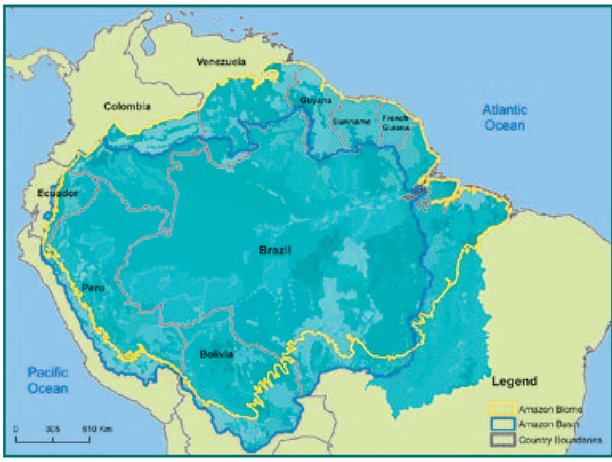
Ecological Risk Index (ERI) provides a protocol for assessing the impacts of anthropogenic stressors on the ecological integrity of watersheds (Mattson & Angermeier, 2007). By combining the frequency of various land uses with estimates of their potential effect on any biotic driver (i.e., flow regime, physical habitat, water quality, energy sources, and biotic interactions), the ERI provides a synthetic measure of the impact of human activities on freshwater ecosystems. The calculation of the ERI for each threat (ERI-T) includes a sensitivity score to account for different responses of diverse landscapes and aquascapes to a similar threat. The Composite Ecological Risk Index (ERI-C) for each sub-basin is then obtained from the integration of all of the ERI-T scores for that sub-basin.

In the Amazon Basin, WWF compiled spatial information on anthropogenic activities that potentially threaten the status of aquatic biodiversity and freshwater ecosystem processes. This information is organized into a spatially explicit hydrological information system. The ERI-C for sub-basins across the entire Amazon River Basin was calculated and then used as a "cost" layer in the application of the systematic conservation planning tools (see Amazon case study).

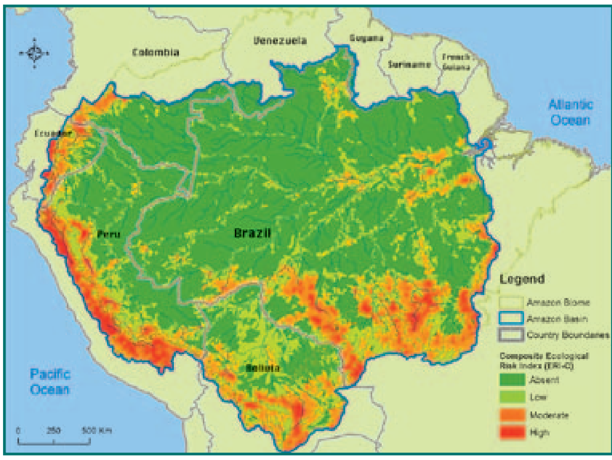
The results show that the major threats to freshwater ecosystems in the Amazon Basin are in the Andean Region and its Piedmont, as well as the "arc of deforestation" in Brazil. Emerging threats along major highway projects and the Amazon main stem are also evident (see Figure 1, the ERI is third from top).



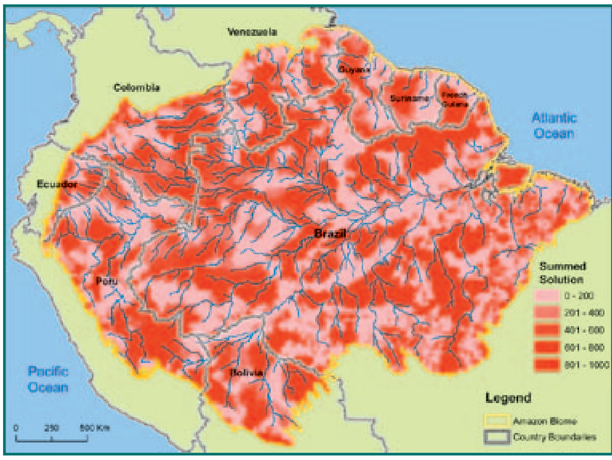
Terrestrial Ecological Systems (Josse et al., 2003)



Aquatic Habitat Types (WWF, 2008)



Ecological Risk Index (WWF, 2009)



Conservation Opportunities: Protected Areas & Indigenous Lands

**Figure 1:** Steps in the optimization (cost/benefit) analysis using the Marxan systematic conservation planning tool

Data Input Habitat

Data Input Habitat

1st Iteration:
Save at least 30 % of each habitat

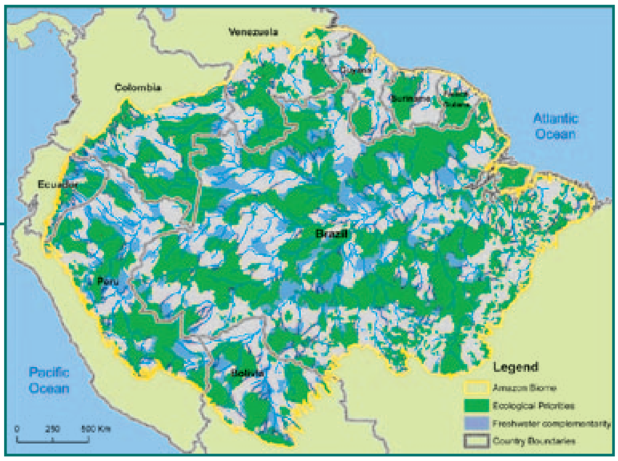
**MARXAN**

2nd Iteration:
Save at least 15 % of each habitat

Data Input Cost

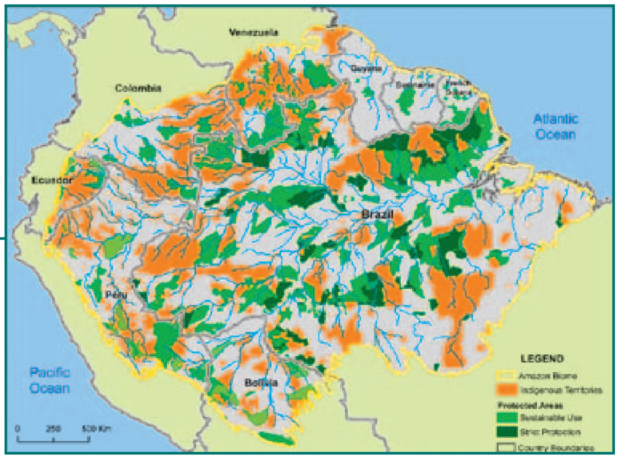
Data Input Cost

Output




Preferred Solution. Area necessary to preserve at least 30 % of each habitat type

Output




Irreplaceability Score estimated by number of times selected

**Stakeholder Involvement process used**: Since early 2010, HIS-ARA was presented and discussed with dozens of key stakeholders from governments, industry and civil society, affected by the advancement of the hydropower frontier into the Amazon in Bolivia, Brazil and Peru.

**Outputs**: Set of assessments that identify priority areas, gaps in the current protected areas systems, vulnerabilities, areas denominated by irreplaceable scores, potential land designation conflicts, and Amazon rivers needed to maintain connectivity of priority areas to the main stem – the Amazon River. These and similar analysis' could be used by decision makers to support their land use and development plans and to coordinate large-scale conservation actions (see Figure 2).

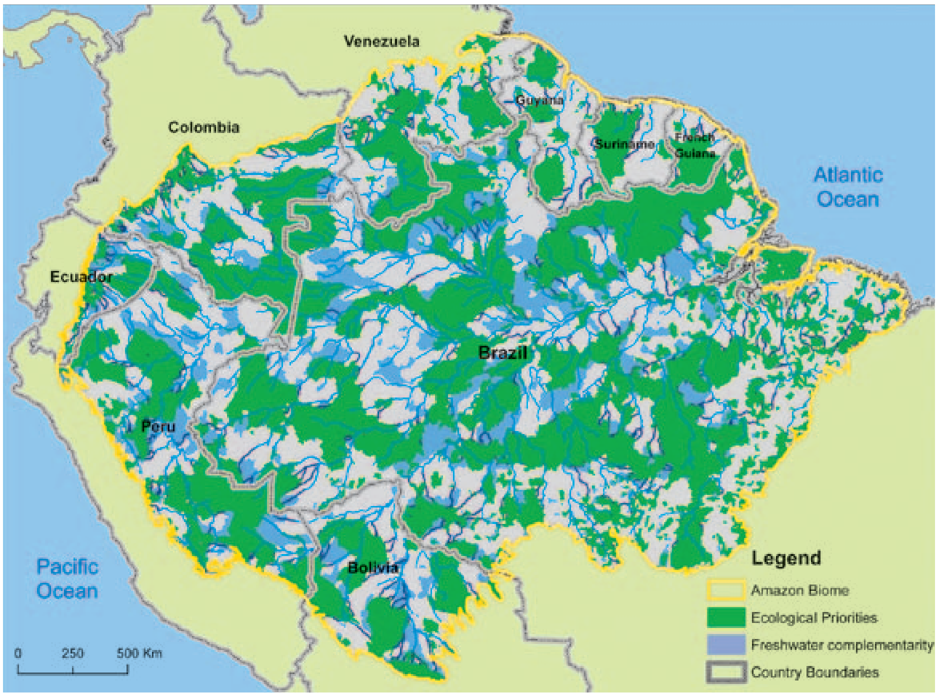



**Figure 2:** Priority areas in the Amazon biome based on WWF's HIS-ARA 2011 assessment

**Impact achieved**: The results of HIS-ARA are being used by WWF to guide the deployment of the Living Amazon Initiative's[5] transformational strategies on shifting the paradigm of development, land planning and free flowing rivers, and to help the engagement of the main stakeholders affected by these processes. WWF is also promoting this kind of analysis among national governments. The Brazilian government is already using it to define priority areas for biodiversity protection and to promote dialog between hydropower development and conservation in specific Amazon basins. Likewise, there is an international initiative to create an integrated Pan-Amazonian Protected Area System based on the same methodology.

There is an increasing level of consciousness and convergence among key stakeholders that planning of development projects in the Amazon must be based on basin-wide and cumulative-wise assessments, and in light of this, Amazon rivers must be part of the decision process if they are to remain free-flowing and provide their valuable resources and services. By working with the national authorities, financial institutions, and private sector, WWF expects to have an impact on the future hydropower blueprint for the Amazon Basin and the overall energy pathways of the emerging economies in the region.

**Next Steps**: Next steps include a joint effort by the energy and conservation decision-makers within the Brazilian government to produce a conservation strategy for the Tapajos River basin since this is the most important basin for the country's hydropower development in the next 10–15 years[6]. Likewise, assessments of other basins to be considered for hydropower development shall now incorporate the idea of systematic conservation planning early in the process.

5 The Living Amazon Initiative, launched in 2008, is WWF's integrated conservation approach for the Amazon (www.panda.org/amazon)

6 Short movie on Tapajós River, Brazil, which is being considered for hydropower development (English): http://www.youtube.com/watch?v=slUAEXuuDJs

## 2. Austria – National Eco-Master Plan

**Objectives**: Provide a basis for future decisions on the feasibility of utilizing the remaining free-flowing river stretches ("No-Go" and "Go" areas) in Austria.

The Eco-Master Plan is also intended as a contribution to the EU Water Framework Directive's (WFD) 7 implementation as there is little strategic and integrated planning for new hydropower plants in Austria.

The energy industry is planning significant expansion of hydropower on Austrian rivers. However, appropriate data for selecting the relevant river stretches and a strategic/integrated planning approach is missing despite the recommendations developed in the WFD Common Implementation Strategy's framework.

**Methodology**: The WWF Eco-Master Plan evaluated the potential for protection and restoration of Austria's 53 largest rivers (catchment area > 500 kilometers²) with a total length of 5,447 kilometers based on the following four criteria:

- Ecological status (status assessment following the WFD)
- Morphological status (following the WFD)
- Stretches located within protected areas (international, national, EU)
- Uninterrupted, free flowing river stretches

| Conservation Value | Ecological status | Protected Area | Morphological status | Length of free-flowing river stretch |
|---|---|---|---|---|
| **Very High** | Class I & II | River stretch located in PA | Class I & II | Rhithron > 25 km<br>Potamon > 50 km |
| **Limited** | Class III & IV | | Class III & IV | Rhithron > 5 km<br>Potamon > 10 km |
| **Low** | Class V | No protection status | Class V | Length smaller |

**Table 5.** Weighting of criteria used: very high potential for protection (green); limited potential for protection (yellow); low potential for protection (red); Class I = high; Class II = good; Class III = moderate; Class VI = poor; Class V = bad (following the WFD)

7 see http://ec.europa.eu/environment/water/water-framework/index_en.html for further information

**Stakeholder Involvement process used**: The study was carried out in co-operation with the University of Vienna's Department of Hydrobiology and Water Management.

**Output**: Analysis of 53 rivers with catchment area > 500 kilometers$^2$:

- Dammed river stretches: 1,667 kilometers (31 %)
- Ecological Status Class I and II: 1,224 kilometers (22 %)
- Stretches located within protected areas: 936 kilometers (17 %)
- Morphological Status Class I and II: 636 kilometers (12 %)
- Uninterrupted, free flowing river stretches: 373 kilometers (67 %)
- Ecological Status Class III with low security: 146 kilometers (3 %)
- Limited potential for protection: 324 kilometers (6 %)
- Minor potential for protection: 135 kilometers (2 %)

River Lech in Austria. Ecological improvement by river bed widening

WWF conclusions and recommendations (see Figure 3)

- Stretches with ecological status I and II should be declared for protection and excluded from further energy management plans in line with the Water Framework Directive's "no deterioration" principle

- Stretches in protected areas should be preserved and also excluded from further energy management plans

- Stretches with morphological status I and II and long uninterrupted free-flowing river stretches should be excluded from further energy management plans due to their high potential for restoration

- Stretches with ecological status III with low security should be further evaluated due to the lack of data available

- Stretches with a medium potential for protection are open for integrated use

- Stretches with low potential for protection are potential sites for future energy use

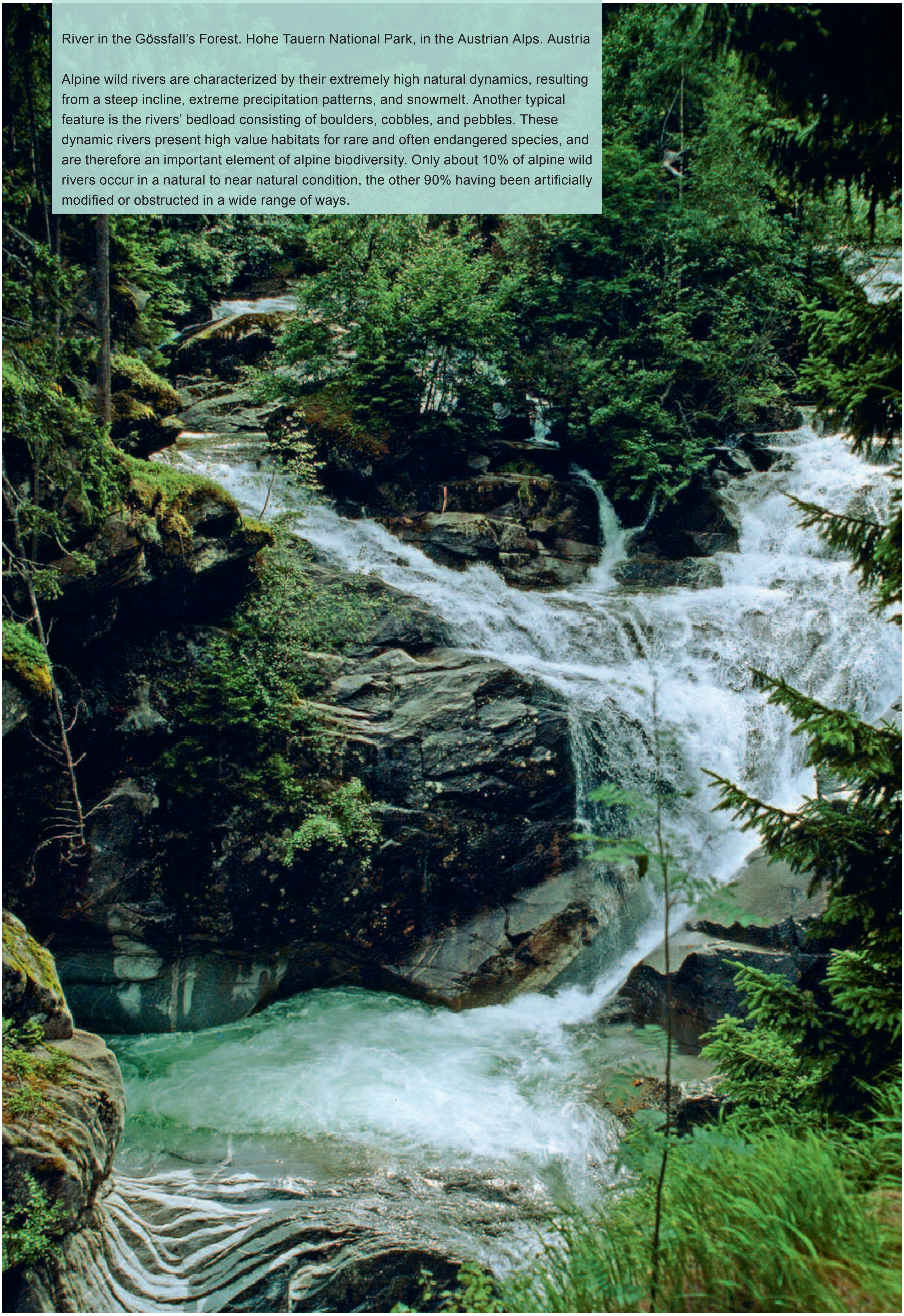
**Challenges met**: Austria lacks a systematic approach in implementing new hydropower facilities; therefore, a large number of new hydropower projects are planned in ecologically sensitive locations. The challenge for WWF was to create a basic tool to preserve ecologically important river stretches and support the hydropower sector with clear messages of "No-Go" areas.

**Impact achieved**: WWF made clear where "No-Go" areas for further hydropower facilities in Austria are. Hydropower planners and politicians already use the Eco-Master Plan when discussing new project locations. By spring 2011, WWF presented a more detailed Eco-Master Plan that dealt with more than 2,800 rivers in Austria.

**Figure 3:** Map of Austria's free-flowing rivers.

River in the Gössfall's Forest. Hohe Tauern National Park, in the Austrian Alps. Austria

Alpine wild rivers are characterized by their extremely high natural dynamics, resulting from a steep incline, extreme precipitation patterns, and snowmelt. Another typical feature is the rivers' bedload consisting of boulders, cobbles, and pebbles. These dynamic rivers present high value habitats for rare and often endangered species, and are therefore an important element of alpine biodiversity. Only about 10% of alpine wild rivers occur in a natural to near natural condition, the other 90% having been artificially modified or obstructed in a wide range of ways.



## 3. China – Central and Lower Yangtze River & Lake Eco-region Conservation Planning

**Objective**: Internal assessment to identify conservation targets (flagship species, priority habitats, and key ecological processes) and priorities in the Central and Lower Yangtze River and Lake Eco-region and develop conservation strategies and actions.

The key threats to freshwater ecosystems in the area are levees and embankments built for flood control, dams in upstream areas, pollution, unsustainable fishing (overfishing, unsustainable fish farming, using electricity and small nets), habitat modification (wetlands reclamation), dredging and sand collection, and hunting.

**Methodology**: The key technical guidelines for this planning was *A Sourcebook for Conducting Biological Assessments and Developing Biodiversity Visions for Ecoregion Conservation, Volume II: Freshwater Ecoregion* (Abell et al., 2002).

Due to the lack of available systematic data on biodiversity at the species, habitat, and ecosystem level, an alternative and practical planning methodology was employed, namely a knowledge-based planning exercise. More than 100 experts (expertise areas covered botany, ecology, aquatic ecology, zoology, theology, ornithology, fishery, freshwater dolphins, etc) were invited to participate in the planning process. Key steps of the planning were:

- Initially and as recommended by the criteria of eco-regional planning, 15 focal species were selected based on the knowledge and information provided by the experts

- Experts were then asked to draw the distribution areas for each of the focal species on larger scale maps

- Each of the distribution maps were then digitalized, modified with high resolution of DEM data, and overlaid using GIS. Priority areas with denser distribution of focal species were identified (see Figure 4)

- In addition, other representative habitats, if not covered by those priority areas, were also identified using criteria specified in the Sourcebook

The planning took about 1.5 years due to organizing three planning workshops for the experts and the GIS analysis between the meetings.
During the planning, key technical capacities included:

- A leading conservation planning expert who knew the eco-region planning methodologies and was able to advise on necessary adjustments to the methodology according to the local situation and data availability

- A GIS expert who prepared large scale maps and conducted related GIS analysis

- A good facilitator who managed the planning and project implementation process was also key for delivering timely results

**Stakeholder Involvement process used**: The partners involved in the conservation planning were researchers from institutes and universities, managers and officials from related government departments and nature reserves, and other conservation organizations.

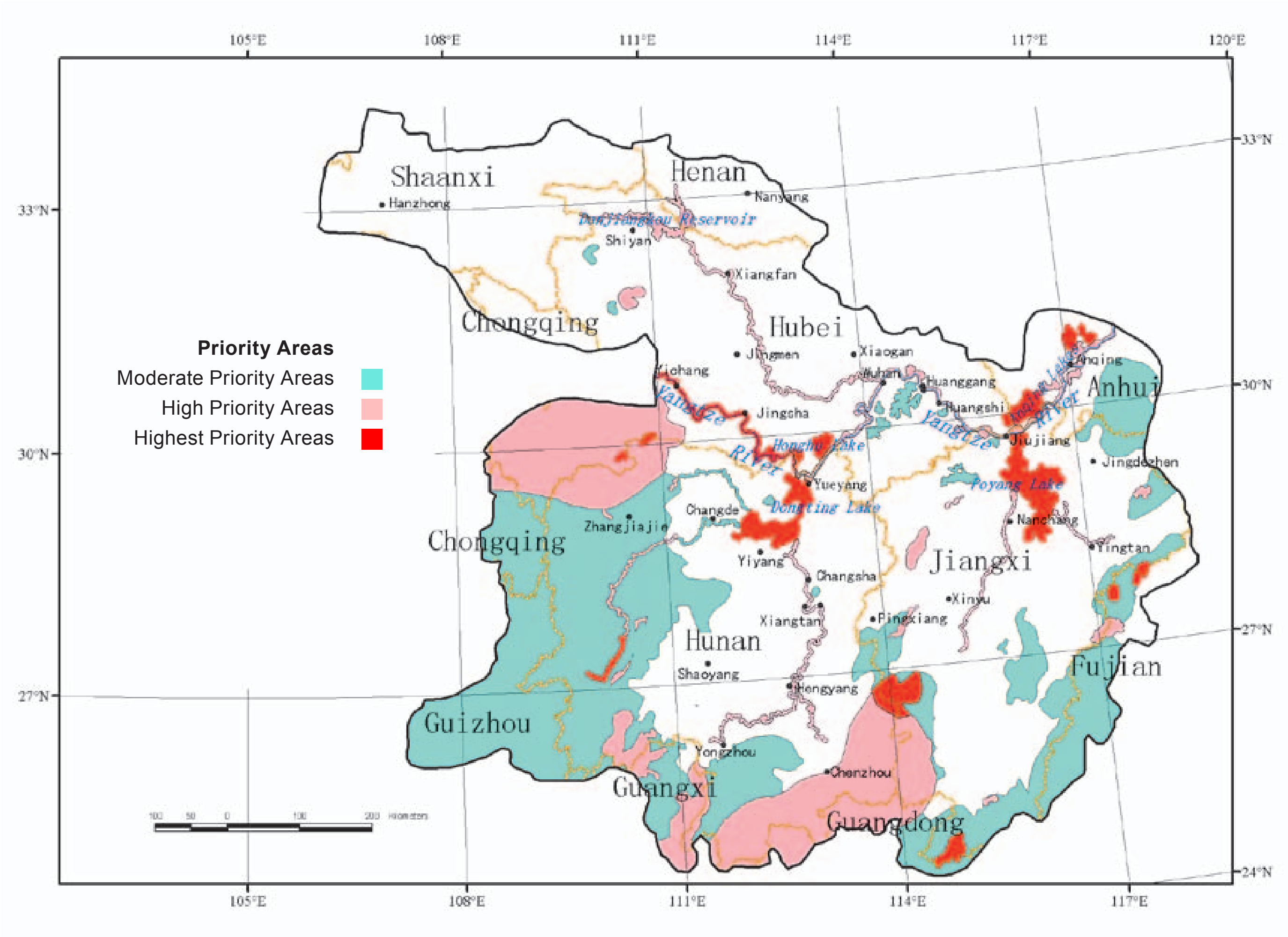



**Figure 4:** Distribution of Priority Areas in Yangtze River and Lake Ecoregion

**Output**: An Eco-region Planning Report that includes an overview of the eco-region, flagship species and key threats to them, conservation priority areas, eco-region conservation vision and objectives, opportunities, recommended conservation actions, and 19 related maps.

**Impact achieved**: The planning process helped WWF develop its conservation strategy (conservation targets and priority areas, conservation vision and objectives, and conservation action plan), leverage technical support for conservation planning at such a large scale where there is normally a lack of systematic biodiversity monitoring data, and build partnerships with experts and their institutions.

**Next Steps**: Following such an eco-regional conservation plan, WWF has been implementing conservation projects in the eco-region and has since invested more than €10 million. So far, key conservation objectives developed in this plan have been partially or fully achieved, e. g. operating the Three Gorges Dam to meet environmental needs of this eco-region, restoring the floodplain lakes with the Yangtze mainstream, establishing wetlands conservation network, and setting up the Yangtze Forum as a platform to promote Integrated River Basin Management (IRBM).

## 4. India – Identifying Ecologically Critical Areas in Himalayan River Basins

**Objective**: Develop a methodology that would identify high priority ecological areas, which could guarantee the functional and resilient sample of unique ecosystems within the Kali River Basin in the Eastern Himalayan region.

In the wake of a large number of hydropower projects proposed in the Eastern Himalayan region, the proposed methodology would help to identify river stretches that are critical for maintaining the river basin's ecological integrity.
**Methodology**: Focusing on one of the key aspects of sustainable hydropower development – the identification of priority ecological areas for protection. Based on the principles of representation, functionality, irreplaceability and vulnerability, the methodology includes identifying both freshwater and terrestrial ecosystems.

In the context of freshwater ecosystems, the primary goal was to ensure the 'maintenance of key ecosystem functions of the basin', with the objective of ensuring:

- Maintenance of sustainable examples of each species assemblage within the basin
- Maintenance of sustainable populations of all important species within the basin
- Protection of high priority ecological sites
- Maintenance of key abiotic processes within the basin, in particular flows and sediment transport

The assessment is designed to address the following criteria:

- Representativity: sufficient freshwater habitats to maintain a sustainable population of each characteristic species assemblages within the basin
- Irreplaceable and important sites: particularly important river stretches, on the basis of irreplaceability, high priority or existing protected status, and priority terrestrial habitats that would be impacted by hydropower development
- Connectivity: representative lateral and longitudinal connectivity within the basin to permit migration and provide refuge, adaptation, and resilience
- Priority species: particular life cycle requirement of important species

**Method of integration**: Identification of critical and high priority places were undertaken by integrating the four criteria assessed above. As anticipated, significant overlap existed between the requirements to meet each of the criteria and the identified critical and high priority sites were able to meet several of the objectives. Integration was undertaken at a specialist expert workshop.

In the absence of systematic data on biodiversity at the species, habitat, and ecosystem level, a knowledge-based planning exercise involving Mahseer, an endangered species and reasonably well documented species in the region was chosen for the study.

**Stakeholder Involvement process used**: The team involved WWF staff, independent researchers, a GIS team, university faculty, officials from related government departments, and staff of other conservation organizations.

**Outputs**: A report titled, ‘Identifying ecologically critical areas in Himalayan River Basin: A pilot study of the Kali River Basin’ that provides a detailed description of the Kali River basin, the status of hydropower development (existing and planned) in the basin, irreplaceable and important sites based on primary and secondary data identified, integrated GIS maps showing priority areas (free flowing rivers), and a concluding chapter with recommendations on the limitations suggestions (see Figure 5).


**Figure 5:** Ecologically critical sub-basins and river stretches in the Kali River Basin.

River stretches proposed for protection along Ecologically Critical Areas
Existing Terrestrial Protected Areas
Areas with special floral taxa
Planned dam location
Tanakpur Barrage
International Boundary
Drainage

The methodology and the findings from the study were shared with groups working on hydropower in India. Workshops were held at WWF-Nepal and WWF-Bhutan to share the methodology and the study findings. Interest was expressed by these offices to carry out similar exercises with other layers of information integrated into it (such as cultural).

When governments are making decisions on hydropower development schemes, they can use the output from the study and the methodology. In fact, after presenting the methodology and results to Bhutan's government, WWF was invited to collaborate with Bhutan's National Environment Commission on developing a "No-Go" area at the basin level. WWF is working towards presenting a similar brief to India's government.

**Challenges met**: Field-data for 8 sub-sub-basins and the Kali main-stem (excluding the 4 basins in Nepal) in 4.5 months, mostly on foot in mountainous terrain, was too short of a time-frame.

Further field work to understand levels of intactness and to interview fishermen on aquatic species assemblages was also conducted in the winter, when it was not possible to see and verify specimens of those fish species where there was confusion with vernacular names, which vary frequently.

However, given the data-poor situation, the adopted method in the field was time-efficient and reasonably rigorous.

**Next Steps**: Any exercise to prioritize river ecosystems for conservation in the context of hydro-power development not only requires difficult political negotiations, but also detailed justification, which could only come from detailed studies at the specific basin (such as through the use of stream classification system. Thus, a detailed scientific study of the basin in order to lobby for considering ecological criteria in decision-making on hydropower is the next step.

The study would be more complete had the Nepal basins also been included, as prioritizing them for ecological values would possibly have yielded more depth in zonation. For example, based on existing knowledge of the area, it was felt that Chameliya River in Nepal would make a much better candidate for the second representative glacier-fed sub-basin, but fieldwork could not be conducted there. Entire river basins would need to be covered if recommendations are to be credible for the difficult negotiations ahead; thus a joint study between WWF India and WWF Nepal will be carried out.

The present methodology was pilot tested in a Kali river basin, which is the sub-basin of River Ganga, one of India's biggest rivers. In order to obtain first level identification of critical areas for conservation, this study needs to be scaled up to the basin level.

The partners identified for further collaborations include various ministries at the federal and state level, such as Ministry of Environment and Forest, Ministry of Water Resources, Ministry of Power, financial institutions, and hydropower developers.

The Tehri Dam on the Ganges River, in the state of Uttarakhand, India. The Dam became operational in 2005, and is the 5th largest in the world. It is part of a project in which the Indian government plans to link 37 major rivers through a series of dams and canals to provide drinking water and generate electricity. In the WWF's report 'World's Top 10 Rivers at Risk', the Ganges River has been identified as one of the 10 at risk, due to the water withdrawal.

## 5. Mekong – Rapid Sustainability Assessment Tool (RSAT)

**Objective**: Develop a scorecard tool that provides a basin wide rapid integrative form of assessment for hydropower sustainability and complements existing assessment tools currently in use in the Mekong and globally.

**Methodology**: The Rapid Sustainability Assessment Tool (RSAT) assesses the sustainability of:

- Existing and proposed cascades of hydropower project(s) within a sub-basin
- A sub-basin as a whole that has hydropower potential
- A single hydropower project and its relationship to a sub-basin
- Transboundary issues for basins shared by different countries, where hydropower is already developed or could be developed in future

The RSAT is a flexible tool that can be used to achieve different objectives – it can assess a river basin at any point in time with multiple projects at different stages of development. The different applications of RSAT that were identified during its development are:

- Inform impact assessment studies
- Assist basin planning organizations
- Prioritizing project(s)
- Inform the development of standards for hydropower projects
- Create dialogue between different stakeholders
- Monitor hydropower sustainability performance
- Assist capacity building or training
- Assess transboundary arrangements

RSAT includes two key functions:

- Participatory assessment of Strength, Weakness, Opportunities and Threats (SWOT) for hydropower sustainability in a river basin by multiple stakeholders
- Scoring against a set of sustainability criteria

The RSAT consists of 11 Topics (listed below) and 53 criteria which are considered by the Environmental Considerations for Sustainable Hydropower Development (EC-SHD) partners to be the most important social, environmental, technical, governance and economic aspects of sustainable hydropower development in the Mekong context by contemporary standards.

- Economic development of basin
- Social and cultural well-being in the basin
- Environmental quality of the basin
- Options assessment and alignment with regional plans
- Coordination and optimization of multiple projects in a basin
- Environmental flows and downstream regulation
- Fish passage and fisheries management
- Benefit sharing and financing sustainability measures
- Safety and disaster prevention
- Institutional setting
- Stakeholder engagement and communication

Sampans meet at early morning market in the Mekong Delta, Vietnam.

**Stakeholder Engagement**: The Rapid Sustainability Assessment Tool (RSAT) has been developed by the Environmental Considerations for Sustainable Hydropower Development (ECSHD), a collaboration between the Asian Development Bank (ADB), Mekong River Commission (MRC), and WWF. The ECSHD partners identified the International Hydropower Association's (IHA) Hydropower Sustainability Assessment Protocol as a potential tool that is very useful tool to assess hydropower sustainability for individual projects (IHA, 2010). However, an additional tool that could also address the situation in the Mekong where a basin-wide, multi-stakeholder, integrative approach to sustainability assessment is needed. In 2010, with the assistance of Eco-Asia, and the expertise of Hydro Tasmania, the first draft of RSAT was developed.

The first RSAT trial was with a small group of MRC stakeholders from the Basin Development Program and Environment Program, the Initiative for Sustainable Hydropower, AusAID, and some national and international consultants. The outcomes of the trial were positive; so version 2 of RSAT was developed and further tested with the MRC's Technical Review Group (TRG) over a 3-day workshop. During this workshop, the TRG members used the tool and completed a transboundary assessment of a basin using all eleven topics. This raised the awareness of RSAT and basin wide sustainability issues with the TRG members and provided the opportunity for the TRG to gain ownership of the tool and provide valuable feedback. The key outcomes of the TRG workshop were:

- Technical feedback on the topics and criteria
- TRG endorsement of the RSAT tool
- TRG recommendation that national trials be conducted in each Lower Mekong Basin country to test RSAT in the national context. Each National Mekong Committee nominated a suitable river basin and a trial was initiated in each country

In response to TRG feedback, the third version of RSAT was finalized and presented at the ADB's Annual Water Conference in Manila. The RSAT was posted on MRC's website[8] and liaison with each NMC commenced to organize national RSAT trials.

Aerial of wide Mekong river at dawn with small sandy islets.

8 for further information, http://www.mrcmekong.org/news-and-events/news/innovative-tool-for-mekong-basin-wide-sustainable-hydropower-assessment-launched/

**Output**: The RSAT tool is action oriented and practical. The potential outputs include the following:

- Action plans
- Improve quality of Cumulative Impact Assessments (CIA), Environmental Impact Assessments (EIA), and Strategic Environmental Assessments (SEA)
- Develop common understanding between stakeholders
- Measure sustainability performance
- Identify what needs to be put in place for sustainable hydropower
- Compare suitability/readiness of different basins for hydropower
- Improve consistency of management approaches in a basin (e.g. fish passage, environmental flows)
- Provide support for sustainable projects
- Strengthen capacity

**Challenges met**: RSAT is a complex tool and thus needs time to get stakeholders on board. It is essential that RSAT guides be properly translated to local language so that all stakeholders can fully participate. The scoring statements in particular were found to be very difficult to translate, because they have very precise meanings in English; in all cases it was found that RSAT-3's English is too complex.

Impact achieved: Overall, the feedback from the pilot studies has been very positive. Panel members felt that they had a better understanding of what is required for sustainable hydropower development at the end of pilot trials.

The feedback has also been useful to refine the RSAT, highlighting issues that need to be added or improved.

It is also clear that the RSAT is a very different tool compared to the IHA's sustainability Protocol in that the broader issues of river basin management can be considered along with other developments, such as irrigation and mining; whereas, the Protocol is a tool for assessing the sustainability of individual hydropower projects at different stages of development.

**Next Steps**: The outcome of these pilot trials will lead to the further development of the RSAT and its application in real situations, which will lead to greater stakeholder commitment to the findings and recommendations. Partners are also exploring opportunities to apply the tool beyond the Mekong region.

## 6. Mexico – Identification of Potential Water Reserves in Mexico

**Objective**: Identify Mexican watersheds that meet conditions (high biological richness and conservation values, availability of water, and low pressure from water users) to declare them as water reserves with the purpose of ensuring flows for ecological protection, including conservation or restoration of vital ecosystems, as stated in the National Water Law.

**Methodology**:
A national database with seven core variables (see below) and 46 secondary variables were used to assess 728 watersheds considered as water management units by CONAGUA (Mexico's National Commission of Water)

- A feasibility analysis was developed based on the conditions of the following seven core variables
  Positive conditions:
  - Surface water availability and low pressure
  - Conservation importance (Natural Protected Areas, Ramsar sites, and a gap analysis for freshwater priorities conservation)
  - Current water extraction legal ban

  Negative conditions:
  - Presence of water infrastructure
  - Irrigation districts
  - Overexploited aquifers
  - Population density

- The analysis was conducted through a weighted assessment

- The weighted watersheds were classified into three different feasibility categories as potential water reserves

- The result was compared with the representation of hydrological zones, terrestrial and freshwater eco-regions, Natural Protected Areas and Ramsar sites, current water allocations, and future water use

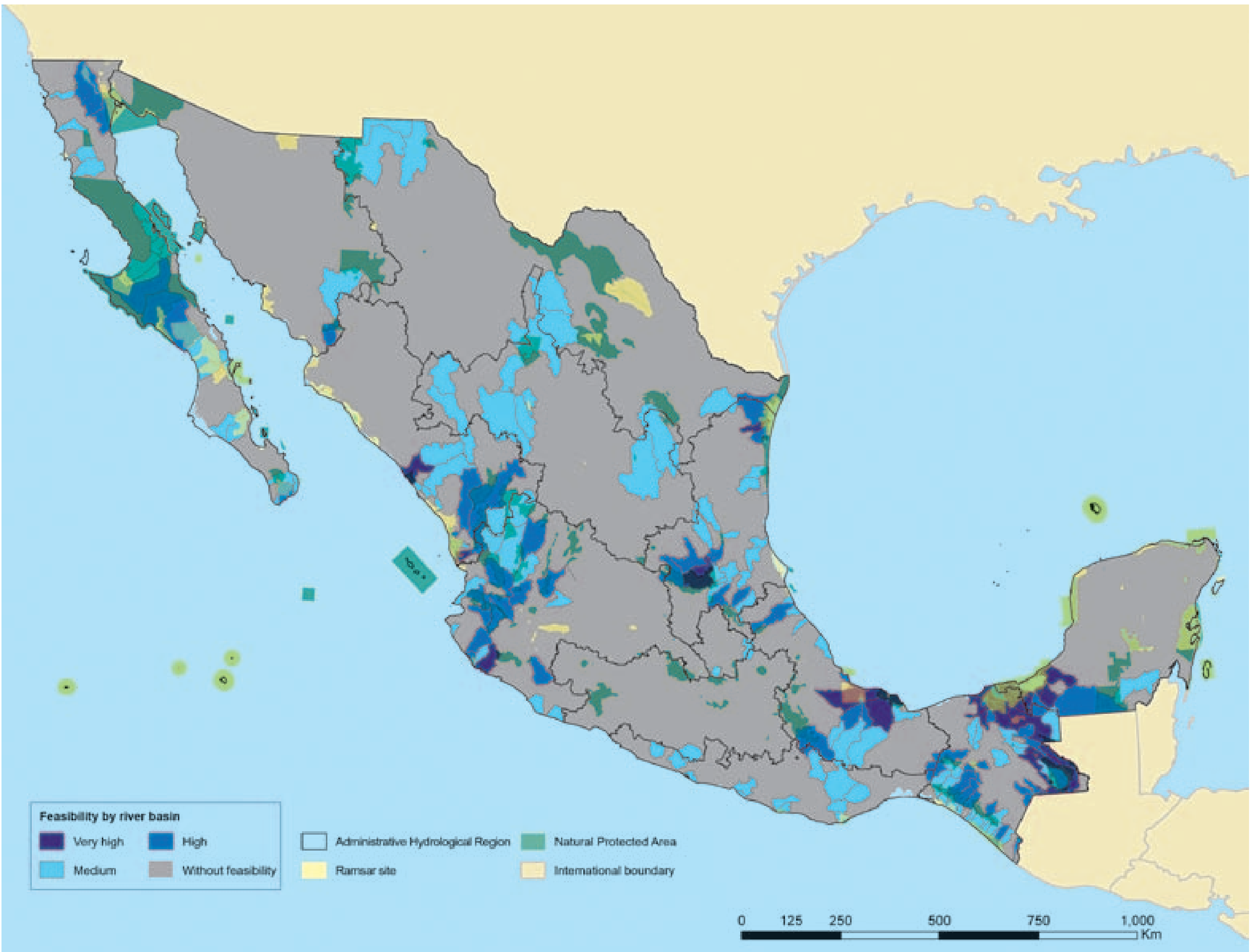
**Stakeholder involvement**:
- The analysis was jointly developed with The National Commission of Water (CONAGUA), which is the Mexican Agency in charge of water management and administration and a leader in the regional dialogue on water and climate change in Latin America

- This analysis is the result of the work that WWF and the Fundación Gonzalo Río Arronte I.A.P. have been doing over the past seven years to determine environmental flow requirements, and implementation feasibility in three pilot river basins: the Conchos River in the Chihuahua State and Chihuahuan Desert, Copalita-Zimatán-Huatulco Rivers in Oaxaca State, and San Pedro Mezquital River that connects the Chihuahuan Desert with the Gulf of California

- Inter-American Development Bank has agreed to fund the implementation of a national water reserves program and replicate its experiences in Latin America

**Output**:
The study identified 189 out of 728 river basins under different feasibility categories where water reserves could be established according to the National Water Law (see Figure 6).
19 – Very high
54 – High
116 – Medium
Proportion in terms of type of basin: 103 (54 %) Inland, and 86 (46 %) Coastal
A Geographical Information System (GIS) for the whole country with 7 core variables (such as water availability and pressure, and high conservation values), congregating 46 sub-variables

**Figure 6.** Feasibility (Very High, High, Medium, not Feasible) of protecting Mexico's water basins as water reserves.




**Challenges met**: The main challenge met was to create a productive and confident relationship with the National Water Commission, which made it possible to discuss water management from an environmental perspective and how a water reserve is not a restrictive concept but a safeguarding tool to preserve a water cycle's environmental goods and services.

Another challenge was to work out different data sources and formats to integrate in a national GIS, which has been recognized as one of the main achievements of this process.

**Impacts achieved**:

- Government acceptance of establishing a sustainable limit on water availability, which fosters the principle of saving water and managing the demand placed on this resource, and thus reducing risk from water scarcity and conflicts

- A National Water Reserves Program in the planning stage (year 1) of its implementation over the next four years as a public and private initiative with the participation of civil society and academic sectors

**Potential impacts of the National Water Reserves Program**:

- Guarantee the connectivity of the entire basin and the conservation of ecosystems and maintenance of environmental services such as storing, conducting and supplying water, improving water quality, and protection from extreme events

- Introduction of integrated planning and management of both subterranean and surface water, especially in regions with little surface water, such as in northern Mexico

- Preservation or controlled release of peak flows to prevent the interruption of river channels, general occupation of riverbeds, and as a consequence, diminish the risk against extreme events

- Reinforcement of the strategy for the conservation of the nation's most important ecosystems and their environmental benefits: 97 Natural Protected Areas, 55 Ramsar sites, and an additional 78,500 kilometers2 of river basins that do not have any form of legal protection currently

- Representation of all types of hydrological zones and the majority of terrestrial eco-regions and freshwater ecosystems in order to prevent water shortages and guarantee the resilience of ecosystems and society (11,405,652 inhabitants involved in the basins); thereby, creating a dedicated strategy to adapt to the impacts of climate change

- Consolidation of Mexico's leadership in the field of water management and climate change

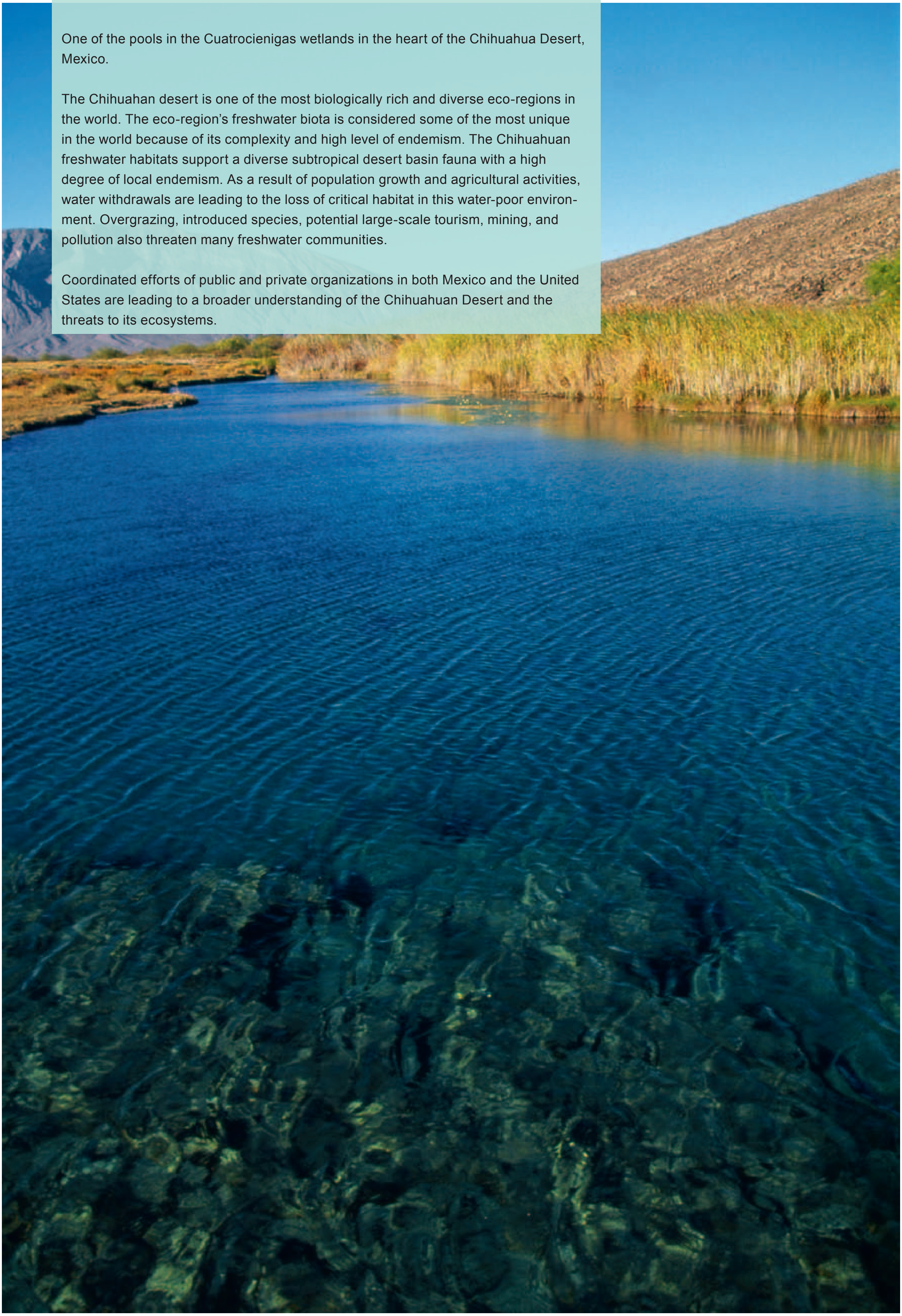
**Next steps**:

- To establish the National Water Reserves Program over the next several years

- Announce the first water reserves by March 2012 (World Water day)

- In the last quarter of 2011 and all of 2012, begin pilot projects of water reserves to support the design of the Program, focusing on the potential water reserves already identified

- Strengthen Mexico's public and private sectors' capacities specifically in the fields of eco-hydrology, legal, and socioeconomic issues when creating water reserves



One of the pools in the Cuatrocienigas wetlands in the heart of the Chihuahua Desert, Mexico.

The Chihuahan desert is one of the most biologically rich and diverse eco-regions in the world. The eco-region's freshwater biota is considered some of the most unique in the world because of its complexity and high level of endemism. The Chihuahuan freshwater habitats support a diverse subtropical desert basin fauna with a high degree of local endemism. As a result of population growth and agricultural activities, water withdrawals are leading to the loss of critical habitat in this water-poor environment. Overgrazing, introduced species, potential large-scale tourism, mining, and pollution also threaten many freshwater communities.

Coordinated efforts of public and private organizations in both Mexico and the United States are leading to a broader understanding of the Chihuahuan Desert and the threats to its ecosystems.

# Chapter 5. Conclusions – Key findings from the Case Studies and Recommendations

Rapidly developing infrastructure has led to the need for priority area conservation to ensure important freshwater ecosystems can be efficiently protected, as shown by the case studies presented in the previous chapter. In addition, such prioritization processes were also found to be useful to encourage sound management of all rivers within the basin, regardless of their priority level, in the context of an IRBM approach, such as in China, Mexico, and the Mekong.

The main characteristics of the most successful approaches were:

- Good balance between scientific work (e. g. sound methodology, involvement of experts, or thorough data analysis) and practical considerations (resource availability, access to data, timing, etc.)

- Involvement of key stakeholders (such as, water agencies, national government, local communities) from the earliest possible stages to increase ownership and to secure public acceptance and effective buy-in from decision-makers

- Using the river basin as a minimum scale, even if this implies working in a transboundary context (e. g. Amazon, Mekong)

- Sustained advocacy work at higher political levels

Challenges were both scientific in nature, such as the lack of data or data aggregation; and practical, such as difficult access to field sites (e. g. mountainous areas in India, forest cover in the Amazon), little funding or time available (e. g. India case); as well as political, including lack of political buy-in, mistrust between stakeholder groups (e. g. Mexico case), and conflicting interests over water use.

In most cases, a scientific assessment was the initial purpose and often led to a more exhaustive stakeholder dialogue over water use. However, the ultimate goal was in many cases the institutionalization of a priority area status (e. g. for Mexico the "water reserves", for Austria the official listing of "No-Go" rivers) through a high-level political process or integration into the legal framework.

There is a considerable implementation gap between recognition of the freshwater assets within a basin and application of this knowledge in practice. Critically important natural assets are increasingly under threat from unsustainable development. A plethora of multilateral and national agreements and commitments exist that recognize biodiversity and natural ecosystems' inherent value. However, few are effectively implemented. Thus, there is thus a need for more concerted action to ensure that such commitments become practice. This could be encouraged through more effective inter-institutional coordination across sectors, adequate funding, and clear commitment at the highest political level.

Therefore, when engaging in a prioritization plan, WWF recommends that:
**National or regional authorities in charge of water management:**

- Conduct assessments identifying freshwater areas of conservation value at the appropriate scale (including transboundary)
- Inform relevant stakeholders and involve them in freshwater prioritization assessments/processes at an early stage and obtain public acceptance
- Ensure that identified freshwater areas of conservation value obtain a legally-binding status
- Ensure enforcement of the legal and regulatory framework on priority freshwater conservation areas
- Require Strategic Environmental Assessments for river basins and/or infrastructure development according to internationally recognized standards, the precautionary principle, and under full consideration of environmental services
- Regularly monitor the integrity of freshwater areas of conservation value to update conservation status and adjust management, as needed

**Private sector:**

- Adopt the precautionary principle in its approach to infrastructure development
- Recognize responsibility towards sustainable development and the conservation of critically important natural assets
- Comply with the mandatory provisions for freshwater areas of conservation value in planning procedures and approval processes
- Foresee appropriate mitigation and/or compensation measures where adverse impacts of projects cannot be avoided
- Be transparent and inclusive in project development plans

**Civil society:**

- Recognize responsibility in shaping a sustainable world and take the initiative accordingly
- Participate actively in stakeholder consultations during freshwater prioritization assessments/processes
- Support the implementation of the legal framework on freshwater areas of conservation value
- Act as a guardian of freshwater areas of conservation value by monitoring their integrity

In conclusion, WWF's global experiences show that the identification and prioritization of areas of conservation value is a powerful tool to address river management and water infrastructure development. WWF and partners are applying prioritization approaches around the world, tailoring the methods employed to the diverse requirements, situations, and resources available in individual settings and freshwater systems.

**Acronyms**

| | |
|---|---|
| ADB | Asian Development Bank |
| AusAID | Australian Development Aid Agency |
| CIA | Cumulative Impact Assessments |
| CONAGUA | National Water Commission (Comisión Nacional del Agua) |
| DEM | Digital Elevation Model |
| DSS | Decision Support Software or System |
| ECSHD | Environmental Considerations for Sustainable Hydropower Development |
| EIA | Environmental Impact Assessments |
| ERI | Ecological Risk Index |
| ERI – T | Ecological Risk Index Threat |
| ERI – C | Composite Ecological Risk Index |
| FAO | Food and Agriculture Organization (of the United Nations) |
| GIS | Geographic Information System |
| HIS-ARA | Hydrological Information System for Amazon River Assessments |
| IADB | Inter-American Development Bank |
| IHA | International Hydropower Association |
| IPAM | Instituto de Pesquisa Ambiental da Amazônia (Amazon Institute of Research) |
| IPCC | Intergovernmental Panel on Climate Change |
| IRBM | Integrated River Basin Management |
| IWRM | Integrated Water Resources Management |
| MEA | Millennium Ecosystem Assessment |
| MRC | Mekong River Commission |
| NMC | National Mekong Committee |
| NGO | Non-Governmental Organization |
| RSAT | Rapid Sustainability Assessment Tool |
| SEA | Strategic Environmental Assessments |
| SWOT | Strength, Weakness, Opportunities and Threats |
| TRG | Technical Review Group |
| UNECA | United Nations Economic Commission for Africa |
| UNEP | United Nations Environment Programme |
| WFD | Water Framework Directive (EU) |
| WWF | World Wide Fund for Nature |

## Glossary

**Coarse-filter Target** – A conservation target (nearly always an ecosystem type or ecological system) that, if conserved, is expected to capture many common species and communities and ecological processes, as well as, represent a given level and scale of biological organization.

**Complementarity** – The contribution that an additional site would make toward achieving the conservation goals of a spatial conservation plan that have not yet been achieved with the existing set of conservation areas in the plan.

**Connectivity** – The exchange of matter, energy, and biota between different elements of the riverine landscape via the aqueous medium. Connectivity can be longitudinal, lateral, or vertical.

**Continuity** – The ability of a river to let organisms (e. g. fish, macrozoobenthos, water plants, phytoplankton) and sediment pass freely up or down rivers and laterally with the floodplain.

**Conservation Goal** – Within the context of spatial conservation planning, this is the number of replicates of each biodiversity or conservation target that should be accounted for in the final conservation plan in order to allow for the persistence of those targets over time.

**Conservation Target** – An element of biodiversity at a project site, which can be a species, habitat/ecological system, or ecological process that a project has chosen to focus on. Targets are surrogates of the biodiversity of an eco-region, since it would be impossible to assess each component of biodiversity individually even if we knew what all of it was and where it resided. Synonymous with biodiversity target.

**Decision rule** – The rule according to which a decision is taken in a decision-making process, such as elections or consensus building (e. g. simple majority, unanimity rule).

**Ecosystem services** - The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious, and other nonmaterial benefits (MEA, 2005).

- **Provisioning services** – The ecosystem services that describe the material outputs from ecosystems. They include food, water and other resources (TEEB, 2010).
  - Food: Ecosystems provide the conditions for growing food – in wild habitats and in managed agro-ecosystems.
  - Raw materials: Ecosystems provide a great diversity of materials for construction and fuel.
  - Fresh water: Ecosystems provide surface and groundwater.
  - Medicinal resources: Many plants are used as traditional medicines and as input for the pharmaceutical industry.

- **Regulating services** – The services that ecosystems provide by acting as regulators, e. g. regulating the quality of air and soil or by providing flood and disease control (TEEB, 2010).
  - Local climate and air quality regulation: Trees provide shade and remove pollutants from the atmosphere. Forests influence rainfall.
  - Carbon sequestration and storage: As trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues.
  - Moderation of extreme events: Ecosystems and living organisms create buffers against natural hazards such as floods, storms, and landslides.
  - Waste-water treatment: Micro-organisms in soil and in wetlands decompose human and animal waste, as well as many pollutants.
  - Erosion prevention and maintenance of soil fertility: Soil erosion is a key factor in the process of land degradation and desertification.
  - Pollination: Some 87 out of the 115 leading global food crops depend upon animal pollination including important cash crops such as cocoa and coffee.
  - Biological control: Ecosystems are important for regulating pests and vector borne diseases.

- **Supporting service, or habitat service** – Services that underpin almost all other ecosystem services and without which these services' could not occur. Ecosystems provide living spaces for plants or animals; they also maintain a diversity of different breeds of plants and animals (TEEB, 2010).
  - Habitats for species: Habitats provide everything that an individual plant or animal needs to survive. Migratory species need habitats along their migrating routes.
  - Maintenance of genetic diversity: Genetic diversity distinguishes different breeds or races, providing the basis for locally well-adapted cultivars and a gene pool for further developing commercial crops and livestock.

- **Cultural services** – The non-material benefits people obtain from contact with ecosystems; they include aesthetic, spiritual and psychological benefits (TEEB, 2010).
  - Recreation and mental and physical health: The role of natural landscapes and urban green space for maintaining mental and physical health is increasingly being recognized.
  - Tourism: Nature tourism provides considerable economic benefits and is a vital source of income for many countries.
  - Aesthetic appreciation and inspiration for culture, art and design: Language, knowledge and appreciation of the natural environment have been intimately related throughout human history.
  - Spiritual experience and sense of place: Nature is a common element of all major religions; natural landscapes also form local identity and sense of belonging.

**Fine-filter Target** – Species and communities that are not well captured by coarse-filter targets, and require individual attention. Examples of the groups of species and communities that might be fine-filter targets are those that are rare, endangered, occur locally, or are migratory.

**Free flowing river** – WWF defines a free flowing river as any river that flows undisturbed from its source to its mouth, at either the coast, an inland sea or at the confluence with a larger river, without encountering any dams, weirs or barrages and without being hemmed in by dykes or levees. In today's world, such rivers, particularly those that run over long distances, are increasingly rare. In large river systems, distinct stretches of rivers can retain characteristics of a free flowing river despite the presence of water infrastructure upstream or downstream of this stretch (WWF, 2006).

**Geographic scale** – The geographic area used as a basis for determining the scope of a policy, project, or activity. In water resources management, the scale is typically the river basin, but can also be national boundaries.

**Impact** – The effect that a threat has on a conservation target. Also used in this publication as: The effect achieved by the prioritization process/assessment on the ground, notably in changing practices and/or policies (e.g. integration into the national policy or legal framework).

**Integrated River Basin Management (IRBM)** – The process of coordinating conservation, management, and development of water, land, and related resources across sectors within a given river basin in order to maximize the economic and social benefits derived from water resources in an equitable manner while preserving and, where necessary, restoring freshwater ecosystems (Williams, 2003).

**Integrated Water Resources management (IWRM)** – A process that promotes the coordinated development and management of water, land, and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP, 2000).

**"No-Go" area** – Area of conservation value, or its upstream basin, that has been determined to be off-limits for certain activities.

**Objective** – A formal statement detailing a desired outcome of a project such as reducing a critical threat. A good objective meets the criteria of being: outcome oriented, measurable, time limited, specific, and practical.

**Persistence** – The ability of an ecosystem or area to support the viability of conservation targets over the long-term; determined by the ecological processes and habitat conditions that sustain population viability and ecological integrity (Groves, 2003).

**Potamon** – The „portion of a stream that includes the deepest part of the channel and is nearly always defined as lotic. Also applied to that portion of a stream that contains water even if discharge becomes intermittent" (Armantrout, 1998).

**Prioritization** – The process of setting priorities; also referred to as "feasibility categories" (Mexico Case Study) or "potential of protection (Austria Case Study).

**Project** – A set of actions undertaken by a defined group of practitioners – including managers, researchers, community members, or other stakeholders – to achieve defined goals and objectives. Note the difference to the same word but meaning 'infrastructure project' or 'development project'.

**Representation** – (also referred to as 'representativity' in text) Inclusion of occurrences of each community or ecosystem across the environmental gradients in which they occur in a system or portfolio of conservation areas (Groves, 2003).

**River morphology** – The terms river morphology and its synonym fluvial geomorphology are used to describe the shapes of river channels and how they change over time. The morphology of a river channel is a function of a number of processes and environmental conditions, including the composition and erodibility of the bed and banks (e. g., sand, clay, bedrock); vegetation and the rate of plant growth; the availability of sediment; the size and composition of the sediment moving through the channel; the rate of sediment transport through the channel and the rate of deposition on the floodplain, banks, bars, and bed; and regional aggradation or degradation due to subsidence or uplift (http://en.wikipedia.org/wiki/River_morphology).

**Rhithron** – The „reach of stream that extends from the headwaters downstream to where the mean monthly summer temp reaches 20°C, dissolved oxygen levels are always high, flow is fast and turbulent and the bed is composed of rocks or gravel with occasional sandy or silty patches" (Armantrout, 1998).

**Stakeholder** – Any group or individual who is interested in, affected by, or can affect an activity or process. Based on the definitions of UNEP, 2005: "Any group or individual who can affect, or is affected by, an organization or its activities. Also, any individual or group that can help define value propositions for the organization;" and of the Hydropower Sustainability Assessment Protocol (IHA, 2010):"One who is interested in, involved in or affected by the hydropower project and associated activities."

**Stakeholder analysis** – A method used to identify and analyze the role played by stakeholders in a project or activity. Typically takes the form of a grid or table displaying the category of stakeholders and the type and degree of each category's impact or influence.

**Threat** – A human activity that directly or indirectly degrades one or more targets. Typically tied to one or more stakeholders.

- **Critical Threat** – Direct threats that have been prioritized as being the most important to address.

- **Direct Threat** – A human action that immediately degrades one or more biodiversity targets. For example, "logging" or "fishing." Typically tied to one or more stakeholders. Sometimes referred to as a "pressure" or "source of stress." Compare with indirect threat. Enabling Condition – A broad or high-level opportunity within a situation analysis. For example, the legal or policy framework within a country.

- **Indirect Threat** – A factor identified in an analysis of the project situation that is a driver of direct threats. Often an entry point for conservation actions. For example, "logging policies" or "demand for fish." Sometimes called a root cause or underlying cause. Compare with direct threat.

**Annex 1. Analytical table of case studies' methodological approach, outputs, involved stakeholders and impacts**

| Region | Objective | Methodology | |
|---|---|---|---|
| **Amazon** | • Identify priority areas for biodiversity conservation from the terrestrial and aquatic perspective<br>• Create a database and information system to support planners' decision making process<br>• Design a baseline for monitoring of future conservation actions effectiveness and impact | • Areas of ecological priority identification<br>• Hydrological Information System for Amazon River Assessments (HIS/ ARA incl. HydroSHEDS)<br>• Vulnerability assessment (Climazon under construction)<br>• Stakeholder roundtables | |
| **Austria** | • Preserve the few remaining free-flowing rivers in Austria<br>• Take stock and identify assets<br>• Decision-making for conservation priorities<br>• Map free-flowing rivers and installed hydropower | • Criteria following WFD requirements:<br>• Ecological status<br>• Hydromorphology<br>• Protected Areas<br>• Free-flowing stretches<br>• Assessment of hydromorphological status<br>• Mapping of existing and planned hydropower projects<br>• CEN standards | |
| **China** | • Prioritize WWF work | • Definition of 15 targets + representative habitats + connectivity<br>• GIS mapping with different overlays supported by experts | |
| **India** | • Preserve a representative sample of free-flowing rivers<br>• Define "No-Go" rivers | • Pilot on Kali River Basin to be potentially replicated/ up-scaled<br>• Based on one fish species as a proxy<br>• 3 criteria: representativeness, uniqueness, connectivity | |
| **Mekong** | • Build into existing planning tools and processes a set of interventions that will help move the Mekong countries towards adopting an agreed upon decision support system for sustainable hydrop ower development | • Rapid Assessment Tool developed in a partnership between ADB, MRC, WWF, Eco-Asia and Hydro Tasmania<br>• Pilot testing in different sub-basin | |
| **Mexico** | • Identify watersheds that meet the necessary conditions to qualify as "Water Reserves" with the purpose of ensuring ecological flows, notably for freshwater ecosystem conservation or restoration | • National database with primary and secondary variables used for watershed assessment<br>• Feasibility analysis looking at conditions in watersheds, using weighted assessment<br>• Classification of watersheds into 4 categories with respect to qualification as "Water Reserves" | |

| Output | Key Stakeholders | Impact |
|---|---|---|
| • Decision Support System (tool)<br>• Methodology to promote among stakeholders<br>• Ecological Risk Index<br>• Examples of tool applications<br>• Maps | • Government officials, industry, and civil society in Brazil, Bolivia and Peru | • Component of a policy strategy and other WWF Amazon strategies<br>• Dialogue with energy and water authorities in Amazonian countries<br>• Overall strategic tool appreciated by governments (incentive), energy sector, financial institutions and civil society<br>• WWF's added value to sustainable development processes |
| • 3 categories of conservation value<br>• River conservation mapping | • University of Vienna | • Interest from the EU Commission |
| • Overlay map | • Research institutes, universities, government officials, nature reserve managers, other conservation organizations | • Definition of WWF working priorities |
| • Map<br>• Prioritization exercise<br>• Up-scaling of results | • Researchers, GIS specialists, universities, government officials, other conservation organizations | • Interest of government in "No-Go" area designation |
| • Decision support, consensus building, and capacity building tool<br>• Ready to use open source | • ADB, MRC, AusAID, Eco-Asia, Hydro Tasmania, National Mekong Committees | • Improved environmental aspects of proposed hydropower projects at early stages of sector planning<br>• Improved transparency and cooperation<br>• Reduced controversy of environmental aspects of hydropower developments, particularly regarding transboundary impacts |
| • Map with 4 categories of watersheds<br>• GIS system for nation-wide use | • CONAGUA, Fundacion Gonzalo Rio Arronte I.A.P., IADB | • Acceptance by the government of ecological limits to water use<br>• National Water Reserves Program, a private-public initiative in the planning stage and to be implemented over the next 4 years, with support from the IADB |

**Annex 2. Selected Resources**

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**Freshwater Ecoregions of the World** (www.feow.org) provide a coarse-scale freshwater biogeographic unit for conservation planning in aquatic systems.

**High Conservation Value areas** (HCVs). The High Conservation Value Network (www.hcvnetwork.org) defines HCVs as "critical areas in a landscape, which need to be appropriately managed in order to maintain or enhance High Conservation Values. There are six main types of HCV areas, based on the definition originally developed by the Forest Stewardship Council for certification of forest ecosystems, but now increasingly expanded to apply to assessments of other ecosystems." HCV areas have not yet been applied to freshwater, but there is potential to do so.

**HydroSHEDS** is an innovative product that provides hydrographic information in a consistent and comprehensive format for regional and global-scale applications. It offers a suite of geo-referenced data sets, including stream networks, watershed boundaries, drainage directions, and ancillary data layers such as flow accumulations, distances and river topology information. HydroSHEDS provides key data layers to support regional and global watershed analyses, hydrological modeling, and freshwater conservation planning at a quality, resolution and extent. http://hydrosheds.cr.usgs.gov or http://www.worldwildlife.org/science/projects/freshwater/item1991.html

**Integrated Biodiversity Assessment Tool** (IBAT, https://www.ibatforbusiness.org) is a tool developed mainly for terrestrial spatial planning, but currently provides some information that could be useful for integrated river conservation planning at coarse scales.

**IUCN Regional Freshwater Biodiversity Assessments** (http://www.iucn.org/about/work/programmes/species/our_work/about_freshwater/resources_freshwater) provide distribution data at the scale of sub-basins for freshwater species across several taxonomic groups.

**Decision Support Software: Marxan** (http://www.uq.edu.au/marxan/) and **Zonation** (http://www.helsinki.fi/bioscience/consplan/software/Zonation/index.html) are two types of decision support software that are available to assist with freshwater conservation planning.

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## WWF'S CASE STUDIES

show that identification and prioritization processes are powerful tools to address and guide river management and water infrastructure development. WWF and partners are applying prioritization approaches around the world.

## THE WATER-FOOD-ENERGY NEXUS

is creating increasing pressure on freshwater ecosystems. Identification and prioritization of valuable freshwater areas is needed so that vital services of freshwater ecosystems are preserved.

## PRIORITIZATION APPROACHES AND METHODOLOGIES

will vary based on the overall goals, diverse requirements/situations, and resources available in individual settings. Certain general principles should be included in almost any freshwater conservation plan or prioritization process.

## CHARACTERISTICS OF SUCCESSFUL APPROACHES ARE:

- Balance between scientific work and practical considerations
- Involvement of key stakeholders to increase ownership and secure public acceptance and effective buy-in from decision-makers
- Using the river basin as a minimum scale
- Sustained advocacy work at higher political levels

**Why we are here**
To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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