STRP
Scientific and Technical Review Panel

Briefing Note

Number 1, February 2012

Ramsar Convention on Wetlands

Ramsar STRP working group.
Photo: Ramsar Secretariat.

Introduction to the Briefing Notes series

Welcome to the Ramsar Convention's Scientific and Technical Briefing Notes series. This series is prepared and produced by the Scientific and Technical Review Panel (STRP) of the Ramsar Convention on Wetlands (Ramsar, Iran, 1971). Briefing Notes enable the STRP to rapidly share relevant, credible and interesting scientific and technical information and advice on wetlands with a broad audience.

About the STRP and Ramsar's scientific and technical work programme

A key role of the Scientific and Technical Review Panel (STRP) is to provide scientific and technical advice and support for the implementation of the Ramsar Convention on Wetlands by responding to requests from Contracting Parties, Ramsar Site managers, and the Secretariat on issues related to the wise use of wetlands and the designation and management of Wetlands of International Importance (Ramsar Sites). Requests for such support may be formally communicated to the STRP in Resolutions of the Conference of Contracting Parties (COP) or through decisions of the Standing Committee; alternatively, urgent or less formal requests may be communicated to the STRP on an *ad hoc* basis through the Secretariat for immediate consideration.

The work programme of the STRP is broad and diverse, covering several Thematic Work Areas. The range and number of Thematic Work Areas that is being considered by the STRP at any particular time depends on the priorities and needs of the Convention, particularly the needs of those responsible for Convention implementation such as Ramsar Administrative Authorities and Ramsar Site managers. Work priorities for the STRP are decided every three years at each Conference of the Contracting Parties.

Larger tasks and projects within the STRP work programme often run over several years. Such larger projects can involve, for example, the preparation of scientific and technical guidance for the Convention on aspects of wetland management. Generally this guidance would be formally adopted by the Convention through Resolutions of the COP.

Another example of a larger task is the collation and synthesis of large amounts of data to prepare global or regional status and trends reports related to wetlands. Many collaborating organizations, wetland scientists, and policy experts can be involved in such a larger STRP project, and often there are repeated consultations with end users to design, test, and finalize a product.

The STRP pursues a number of avenues through which to formally communicate its findings, advice, recommendations, and guidance to its various audiences. These include:

Download PDF at www.ramsar.org/bn/bn1.pdf

Purpose of this BN

The purpose of this Briefing Note is to introduce the scientific and technical Briefing Note series by providing an overview of the purpose of the series, the target audiences, and the types of topics to be addressed. The document also provides information on how Briefing Notes are prepared, reviewed and published, as well as where to find all of the Notes in the series.

Related documents and information

Information about the STRP, including its *modus operandi,* membership, current work plan and newsletters can be found at www.ramsar.org/STRP-main.

A full list of of current Ramsar Briefing Notes can be found www.ramsar.org/BN.

Author

Heather MacKay
STRP Chair 2009-2012
See end page for author details.

The head table at a recent STRP meeting at the Secretariat facilities. ***Photo: Ramsar Secretariat***

- preparation of scientific and technical guidance documents, which may be annexed to draft Resolutions and submitted by the Standing Committee to the COP for consideration and adoption;
- preparation of COP Information Papers containing background and supporting information for scientific and technical guidance documents;
- presentation of regular reports on STRP activities, progress and opinions to the COP and to the Standing Committee of the Convention;
- preparation of internal reports and memos in response to requests for *ad hoc* advice;
- publication of Ramsar Technical Reports, which generally provide substantial scientific detail and depth on a range of specific wetland-related topics; and
- publication of STRP Briefing Notes, which are the subject of this document.

What is the purpose of STRP Briefing Notes?

Briefing Notes were introduced in the 2009-2012 cycle as another category among the STRP's products. Their primary purpose is to enable the STRP to rapidly share relevant, credible and interesting scientific and technical information on wetlands with a relatively broad audience. The intention of publishing in an organized series is to ensure easier and longer-term access to this information for future reference.

Briefing Notes are not intended to provide formal guidance related to Convention implementation. They are usually shorter than Ramsar Technical Reports, being either a true "note" of perhaps 2 to 5 pages, or alternatively a longer information document of around 5 to 15 pages. While Briefing Notes are reviewed by the STRP for scientific correctness, they are generally presented in less technical language than the Ramsar Technical Reports in order to make them more accessible to a wide audience.

The STRP uses Briefing Notes to:

- share information on current STRP work in progress, particularly where work is part of a longer STRP task which might be proceeding in phases over several years;
- share STRP views on an emerging issue of importance or urgency for the Convention in the future, or of general interest, or
- bring relevant scientific and technical information related to wetlands to the attention of Contracting Parties, wetland managers, and policy makers, without necessarily being limited to the schedule of COPs for dissemination of such information.

What can be covered in Briefing Notes?

A broad range of topics and issues can be covered in Briefing Notes, although generally the content would be relevant in some way to current STRP work priorities or to current and future implementation of the Convention. As examples, Briefing Notes might provide:

- a report or update on the results of initial scoping of a larger STRP task, including characterization of end users or target audiences for the final scientific product, terms of reference for technical work to be carried out, and results of exploratory review of scientific literature;
- an annotated bibliography of current scientific references and useful information on an issue of general interest to the Ramsar Convention, such as water resources management;
- a thematic collation of STRP work and Ramsar documents produced to date on a specific topic or issue, such as invasive alien species;
- a review and synthesis of relevant scientific information on an issue of specific interest to the Ramsar Convention, such as the potential impacts of sea level rise on coastal wetlands;

- advice and recommendations from the STRP on an emerging and/or urgent issue relevant to the Convention, such as the status of and responses to Highly Pathogenic Avian Influenza (HPAI);
- background and supporting information for a scientific or technical draft Resolution which is being submitted to the COP for consideration (in which case the Briefing Note might also be assigned a COP Information Document number in order to identify it in the package of documents for a specific COP).

What is the status of a Briefing Note vis-à-vis the Convention's "official" documentation?

Briefing Notes are part of Ramsar's suite of communication products and as such they are facilitated by and issued through the Ramsar Secretariat. Briefing Notes are not adopted or otherwise approved by the Contracting Parties of the Convention, but the information and advice contained in a Briefing Note might support or lead to a formal decision on that topic or another Convention document which is then adopted or endorsed by the Parties. Each Briefing Note carries a standard disclaimer to highlight that the views contained in the document are those of the authors and the STRP and do not represent an officially-adopted view of the Ramsar Convention or its Secretariat.

Who prepares Briefing Notes and how are they reviewed?

Briefing Notes can be issued at any time in the STRP work cycle. Their preparation and publication are not constrained to fit within COP schedules or other internal Convention administrative cycles.

STRP members in the field. ***Photo: Ramsar Secretariat.***

Who are the target audiences for STRP Briefing Notes?

Depending on the content and focus of any particular Briefing Note, target audiences might include:

- Ramsar's Contracting Parties;
- Ramsar Site managers and managers of other wetlands, including those wetlands with or without some other form of protected area designation;
- Wetland scientists, instructors and students;
- Wetland CEPA (Communication, Education, Participation and Awareness) practitioners;
- Other scientific organizations interested in wetlands or in ecology more generally;
- Interested civil society organizations and members of the public.

The preparation of a Briefing Note will usually be agreed and initiated by the STRP, either at a meeting or workshop of the full Panel or through electronic discussion via the STRP Support Service. The rationale, objectives, target audience, scope and content of a particular Briefing Note, once agreed, will be included in the STRP work programme and authors will be assigned to prepare the text.

Not only the appointed STRP members are involved in discussing a Briefing Note, however; wherever relevant and possible, people within the supporting STRP network are encouraged to contribute their views and expertise, including representatives of STRP observer organizations, STRP National Focal Points, and invited experts.

Authors of Briefing Notes could be Panel members, or they could be members of a working group established for a specific STRP task. On occasion, the STRP might commission a Briefing Note from an invited expert outside the Ramsar networks, if the necessary expertise is not available within the STRP's scientific networks or in the current Panel.

Working drafts of Briefing Notes are generally circulated within STRP networks for comments and to obtain further inputs. Once the authors have prepared a final draft, the Briefing Note is reviewed internally by STRP members, who

provide their review comments to the authors. The final content of a Briefing Note is approved and signed off by a small internal editorial panel comprising the STRP Chair and the responsible Thematic Work Area lead or task lead, assisted by the Convention's Deputy Secretary General. The Ramsar Secretariat under-takes the editorial check and final layout, and then releases the final Briefing Note.

Current scientific and technical Briefing Notes can be viewed or downloaded at http://www.ramsar.org/BN.

Where are current Briefing Notes published and how can I access them?

Briefing Notes are published in English in electronic (PDF) format. When resources permit, they will be published also in French and Spanish (the other official languages of the Ramsar Convention) and in printed form. A full list of current Briefing Notes and all those available for download is available from the Ramsar Secretariat and on the Ramsar website www.ramsar.org/BN.

The lifespan of Briefing Notes will vary, depending upon the content and topic of each. In cases where a Briefing Note's content may be completely superseded by new work, the original Briefing Note will be retired or withdrawn and this will be noted in the list. The original Briefing Note will be archived and will remain available on request from the Secretariat.

In some cases, a Briefing Note may be updated with new information and issued in a revised version. This too will be noted in the list and in the revised Briefing Note in order for readers to follow the "paper trail" as a topic or issue is developed further.

Acknowledgements

Rebecca Lee (STRP member 2009-2012), and Monica Zavagli, Dwight Peck, Nick Davidson and Sandra Hails (all of the Ramsar Secretariat) provided much advice and assistance in developing the Briefing Note concept, generating ideas for layout, and reviewing this Note. Their support and enthusiasm are gratefully acknowledged.

Briefing Notes series

This series is prepared by the Ramsar Convention's Scientific and Technical Review Panel (STRP) in order to share relevant, credible and interesting scientific and technical information on wetlands with a broad audience. Briefing Notes are reviewed internally by STRP members and a small internal editorial panel, comprised of the STRP Chair and the responsible Thematic Work Area lead or task lead, assisted by the Convention's Deputy Secretary General.

Briefing Notes are published by the Ramsar Convention Secretariat in English in electronic (PDF) format. When resources permit, they will be published in French and Spanish as well (the other official languages of the Ramsar Convention) and in printed form.

A full list of current Briefing Notes can be found at www.ramsar.org/BN. Information about the STRP can be found at: www.ramsar.org/STRP-main/. For more information about Briefing Notes or to request information on how to correspond with their authors, please contact the Ramsar Secretariat at strp@ramsar.org.

Author: Heather MacKay, STRP Chair 2009-2012; Director, FHB Consulting Services, 1610B Grover Street, Lynden WA 98264, USA. heather@fhb3.com.

Citation: MacKay, H. 2012. *Introduction to the Ramsar Briefing Notes series.* Ramsar Scientific and Technical Briefing Note no. 1. Gland, Switzerland: Ramsar Convention Secretariat.

The Convention on Wetlands (Ramsar, Iran, 1971) – called the Ramsar Convention – is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance and to plan for the "wise use", or sustainable use, of all of the wetlands in their territories.

Ramsar Convention Secretariat
Rue Mauverney 28
CH-1196 Gland, Switzerland
Tel.: +41 22 999 0170
Fax: +41 22 999 0169
E-Mail: ramsar@ramsar.org
Website: www.ramsar.org

STRP
Scientific and Technical Review Panel

Briefing Note

Number 2, February 2012

Ramsar Convention on Wetlands

Wetlands and water storage: current and future trends and issues

Purpose of this BN

The objectives of this Briefing Note are: to bring relevant issues related to water storage to the attention of Contracting Parties and to help them understand the implications for wetlands; to provide additional information to supplement Ramsar's existing guidance on these issues; and to offer recommendations for responding to these issues at global, national and river basin levels.

Background

In the STRP work plan for 2009-2012, task 7.4 in Thematic Work Area 6 (Wetlands and Water Resources Management) includes a review of the role of wetlands in water storage and preparation of a technical report on wetlands and water storage interactions (including dams and groundwater) to support the implementation of Ramsar Resolutions concerning water-related guidance (see Ramsar Wise Use Handbook 8, 4th edition, 2011). At its mid-term workshops in 2010, the STRP requested the preparation of a Briefing Note on this topic in order to provide further and updated information.

Author

Mike Acreman, STRP Thematic Work Area Lead for Water Resources 2009-2012

It is clear that in all regions of the world there will be continued growth in the demand for reliable supplies of water for climate change adaptation, food security, water security, human and economic development. In an increasingly unpredictable global environment, providing effective options for water storage will be an important aspect of meeting that demand. Both large and small dams are likely to be suggested as potential solutions for increasing surface water storage, but as Ramsar Contracting Parties have recognized in several Resolutions, dams can have both negative and positive implications for wetlands and wetland ecosystem services. In this Note, the STRP provides an overview of the implications for wetlands of current issues and trends related to potential growth in demand for surface water storage capacity.

Key messages and recommendations

- Growth in demand for water storage is expected to increase significantly in the near future, in particular as more countries begin to implement policies for climate change adaptation. After a relatively quiet period in terms of new dam construction in the years after the World Commission on Dams final report in 2000, construction of new dams and expansion and refurbishment of older dams can be expected to increase in future in order to meet at least some of the increased demand for water storage.
- Wetlands and wetland ecosystem services can be negatively impacted by dams and other water storage infrastructure, but some types of wetlands can play valuable roles as "natural infrastructure" and can provide water storage capacity under certain conditions.
- The Ramsar Convention has adopted several Resolutions which provide guidance on dealing with the impacts on wetlands of water infrastructure such as dams. That suite of guidance remains valid and useful, and Contracting Parties are urged to implement its recommendations.
- The STRP has offered the following additional recommendations for the Convention:
  - provide sound scientific justification for the water storage functions and capabilities of different wetland types;
  - define a clear Ramsar message on wetlands and water storage issues, and use the right language to ensure understanding; and
  - identify the most important target audiences for that message and develop focused strategies for communicating relevant wetland information to these audiences.

Download PDF at www.ramsar.org/bn/bn2.pdf

Why is water storage needed?

Water is essential for most aspects of our lives including drinking, washing and cooking, growing food, supporting industry, and producing energy (Gleick 1993). People also benefit further from water through its maintenance of ecosystems that provide additional goods and services (Acreman 2003) – now commonly referred to as "ecosystem services" (MA 2005).

Water is delivered to the Earth's surface through precipitation, which varies around the world and over different time scales. Precipitation is very seasonal in monsoon regions, the Indian sub-continent, and much of Africa. Inter-annual variability also occurs, driven by large-scale phenomena such as the El Niño-Southern Oscillation (ENSO), which can create floods and droughts on a 3 to 8 year cycle (Adhikari *et al*. 2010). Decadal persistence is also a feature of past records; in the early 1980s the Sahel experienced drought and starvation, but by August 1988 floods ravaged the same region.

Although agricultural demand for water is often seasonal, demand for household water, power generation, and industrial water use tends to be constant through the year. Storage of water in times of plenty, for use in times of scarcity, is essential because any gap between the demand and supply of water will have wide-ranging implications including crop failure, thirst, power cuts, loss of transport links, and degradation of ecosystem services.

Hydrological variability affects economic growth

Rainfall variability can significantly impact on economic growth (Brown & Lall 2006). Kenya suffered a 16% fall in its gross domestic product (GDP) as a result of the 1998-2000 drought and an 11% drop in GDP due to 1997-1998 floods, partly because the country was unable to store and distribute water efficiently for irrigation and hydropower production (Economic Commission for Africa 2008). The Comprehensive Assessment of Water Management in Agriculture (Molden 2007) concluded that 20% of the world's population lives in areas of physical water scarcity.

Water is stored in many components of the hydrological cycle: in the atmosphere, such as in cloud forests, in soils, in underground aquifers, rivers, lakes and other wetlands. Groundwater is the largest store of unfrozen fresh water and it currently provides the majority of water used in the world. For example, in Africa, 60% of the population live in rural areas and depend on small-scale groundwater supplies (Calow *et al*. 2009). In many areas of the world groundwater is replenished by rainfall soaking slowly into the ground, which can take many months. So groundwater has the potential to provide water over a number of years and hence to buffer availability of water resources through both seasonal and multi-year variations in rainfall and major droughts.

The potential for groundwater to meet water demands

Groundwater is often preferred by farmers for crop irrigation as they have direct control over the resource. Yet over-exploitation (where withdrawal exceeds long term recharge), often for short-term gain, has led to lowering of the water table and significant problems in China, Mediterranean Europe, and India. In northern China, for example, there were 2.6 million wells at the end of 1997, resulting in the water table falling 42 meters in 30 years (Brown 2000). Over much of sub-Saharan Africa, hard crystalline rocks bear only limited groundwater potential.

Where water entered an aquifer in the distant past and is not currently being recharged, it is often described as 'fossil water' (Abd El Samie & Sadek 2001), and its exploitation is termed 'groundwater mining.' As with mineral resources such as oil, fossil water is an exploitable resource with a finite life. For example, the groundwater in the Kufra and Sirte basins in Libya was last replenished during a wetter period several millennia ago, but the resource is vast, has been exploited to irrigate crops for the last 30 years, and will continue to provide water for several decades to come (Wright *et al*. 1982).

How and why is demand for water and water storage changing?

The debate over water storage has intensified in recent years due to global and regional economic, demographic and climate changes, which in turn affect the timing, location and extent of water demands and hence the need for increased or new water storage options.

Demographic and social changes affecting water demand

The world's population is expected to rise from the current 7 billion to 9 billion by the year 2042 (DESAPD 2006), generating greater demands for food from irrigated agriculture and for clean safe drinking water. Irrigation already accounts for more than 70% of all water abstracted, yet water for food security is an increasingly critical issue (Hanjra & Qureshi 2010).

Despite progress towards the Millennium Development Goals (MDGs), almost 900 million people still lack access to safe drinking water. Efforts by governments and agencies to expand access to water for basic human needs will undoubtedly require reliable sources of water (Sullivan *et al.* 2003).

Regional policies for achieving food security will increasingly become issues of global significance. Some countries such as Kuwait and Saudi Arabia are buying land for food production in other countries (e.g., Sudan, Pakistan), which creates new demands on water resources and new political issues.

Will social changes lead to water conflicts?

More than half of all people now live in urban areas and most future population growth is expected to take place in cities (UNFPA 2007). Over the next 30 years, the populations of African and Asian cities are expected to double, posing particular problems for water supply. Changes in diets, for example from vegetables to meat in China, may also have an impact, though recent increases in meat demand have been met by national production (Ray 2008).

Some commentators have expressed concerns that during the next 25 years competition for water will be a catalyst for conflicts in many regions as countries fight for access to increasingly scarce resources (Mason *et al*. 2007). However, to date, the numbers of direct conflicts over shared waters remain low, and other commentators see water resources issues as a catalyst for cooperation (e.g., Grey & Sadoff 2007).

Climate changes affecting water demand

Intensification of the hydrological cycle will increase rainfall variability and more extreme floods and droughts (Meehl et al. 2007, Burke *et al* 2006). Highly populated regions adjacent to the Himalayan and Andean mountain ranges are considered particularly vulnerable to the impacts of glacier retreat (Barnett *et al.* 2005). In marginal recharge areas, groundwater storage may become non-renewable. Major land use change can also affect large scale atmospheric cycles, for example Amazonian deforestation is likely to change rainfall patterns in Mediterranean Europe (Gedney *et al.* 2006). This growing unpredictability of water availability is increasing the need for additional water storage.

Economic changes affecting water demand

Over the summer of 2008 oil prices rose from $30 to $140 per barrel, giving further impetus for development of renewable energy sources, such as hydropower, biofuels and wind energy, that do not use fossil fuels (although the financial and economic crisis led to a 2% fall in global energy demand in 2009 (IEA 2010)). Some countries, such as those in Latin America, are already heavily reliant upon hydropower (Millan 1999). Hydropower can be generated by run-of-river schemes that have limited impact on river flows. However, the most productive hydropower stations are associated with large dams, which alter river flows significantly. A detailed discussion of the possible implications for wetlands of energy policies, plans and activities can be found in a new Ramsar Technical Report (Anderson & MacKay in prep.), which has been prepared in support of the Draft Resolution for COP11 (DR10) on "Wetlands and energy issues" (Ramsar Convention 2012).

The complex links between water infrastructure, water security and economic development

In general, access to water infrastructure tends to be lowest in those parts of the world where water insecurity risks are highest (UNDP 2006). Why this should be so is not always clear. Grey & Sadoff (2007) claimed that many of the world's wealthiest nations also have achieved the highest water security through investment in water storage schemes. However, direct cause-effect relationships are not clear: national wealth may enable extensive water storage, or alternatively water storage may be the source of such national wealth.

Economic prosperity does not necessarily depend on investment in water infrastructure, if natural storage, such as groundwater, is available and a country's economy is not reliant on water demanding sectors. Many Middle Eastern states, such as Saudi Arabia and United Arab Emirates, have had sufficient groundwater for domestic use and have relied on income from oil sales to obtain food produced in other countries; but they are also now leasing land in Africa to grow their food, e.g., in Ethiopia (Economist 2009). However, as fossil groundwater and oil reserves become depleted, these economics may change. Furthermore, water security in many rural areas will continue to be limited by access rather than physical availability for the foreseeable future (Sullivan *et al*. 2003).

Less obvious costs and benefits of infrastructure development may not be revealed in national economic statistics such as GDP or the UN gini coefficient (Gini 1912). For example, hydropower generation at the Manantali dam in Mali has led to better electricity supplies to ur-

Water infrastructure and wealth

The USA invested heavily in multi-purpose dams starting in the 1930s with the Tennessee Valley Authority. The Hoover and Glen Canyon dams on the Colorado River supported economic development of southwest USA. Many European states have invested available wealth in dam construction; for example, for hydropower in Norway and Switzerland and for irrigated agriculture in Spain. In Australia, water infrastructure, particularly in the Murray-Darling basin, has been instrumental in industrial growth and development of agriculture and livestock production.

There are clear examples of countries which experience high hydrological variability but have limited water storage and less successful economies, such as Ethiopia and Yemen. Ethiopia has only 165 million m^3 of water storage per capita (including the new Tekeze dam on the Atbara River) compared to 4,500 million m^3 in Australia, a country with a very similarly variable climate. Less than 6% of Ethiopia's irrigable land is under irrigation, whilst in neighbouring Sudan 14% of the land is under irrigation (FAO 1987).

ban areas in Senegal, Mali and Mauritania, but there has been little electrification in rural areas and rural people have suffered loss of other important ecosystem services such as fisheries due to alterations to the river flow regime downstream of the dam (Acreman 1996).

Some argue that major water resources projects stimulate broad regional economic growth which has significant direct and indirect benefits to poor people, through generating employment and improving services such as roads and healthcare, whilst some organisations focus on appropriate local technologies (e.g., treadle pumps) that do less for GDP, but more for direct local community poverty alleviation amongst the very poorest people. The World Bank is supporting a focus on national economic growth as a top-down mechanism to pull people out of poverty rather than a bottom-up local livelihoods approach.

Potential for growth in surface water storage capacity

Whilst China and India, in particular, have major ongoing programmes of dam development, most developing countries have exploited little of the potential for infrastructure-based surface water storage; Asia, Africa and Latin America have only developed 22%, 7% and 33% of their potential hydropower, respectively (IHA 2008). In Africa, 94% of agriculture is rain-fed. The Commission for Africa (2005) highlighted the severe poverty and lack of economic growth in many parts of Africa and recommended investment in infrastructure (including water storage) to double the area of irrigated land.

Are dams the solution to the storage challenge?

Many large dams have brought significant social and economic benefits. The broad links between infrastructure development (including dams), increased agricultural productivity and economic growth have been documented (Hussain & Hanjra 2004, Hanjra *et al*. 2009). However, largely because of the adverse environmental and social impacts that they can bring about, large dams are controversial.

During the past few decades, there has been an increasing awareness that large-scale "hard" engineering, such as dams, can be an inflexible approach to water management with costs, both direct and indirect, in some cases outweighing benefits. The World Commission on Dams (WCD 2000a) concluded that dams have made an important and significant contribution to human development, but the social and environmental costs have, in too many cases, been unacceptable and often unnecessary. This has led directly to a period of reduced activity in dam building as the implications of the Commission's report were debated.

Additional concerns regarding the impacts of dams have been raised in recent years. For example, high emissions of methane (CH_4) have been recorded at shallow, plateau-type tropical reservoirs where the natural carbon cycle is most productive (Delmas 2005), although deep water reservoirs at similar low latitudes tend to exhibit lower emissions. A desk-study of greenhouse gas (GHG) emissions from creation of hydropower reservoirs in India (World Bank 2007) concluded that emissions would be low, because India's reservoirs are to a large extent located in regions where natural conditions restrict processes that give rise to methane emissions.

More water evaporates from reservoirs than is consumed by humans (UNEP 2008) and hydropower generation in the USA consumes more water per KWatt than fossil fuel generation does (Torcellini *et al.* 2003).

Because dams provide significant water storage capability, they can be multi-functional, for example, by playing a significant role in reducing floods downstream. The Three Gorges dam on the Yangtze generates hydro-

Dams: good and bad

During the Dams and Development Project (the UNEP follow-up to the WCD), the International Rivers Network (IRN) followed the progress of several dams to see if WCD processes were implemented. They concluded that major projects, such as dams at Bui (Ghana), Lom Pangar (Cameroon), Epupa (Namibia), Bakun (Malaysia) and Mphanda Nkuwa (Mozambique) have not followed WCD guidelines. However, there is no complementary global information collection from governments or dam associations with which to compare the IRN findings.

In contrast, there are many examples of dam developments demonstrating good practice against sustainability criteria. For example, the 50 MW Bumbuna project in Sierra Leone is seen as a good model of local community benefit sharing, where a Trust has been set up, supported by the World Bank and with a multi-stakeholder board, which has empowered local communities in deciding on how the funds are used. Issues and experience with dams since 2000 have recently been reviewed by Moore et *al.* 2010.

power, but it is also designed to reduce the frequency of major downstream flooding from once every 10 years to once every 100 years, and it saved many hundreds of lives in 2010. Whilst the USA has over 1000 dams purely for flood management and a further 1000 multipurpose dams that include flood management, none of the Indian dams registered in the ICOLD World Register of Dams (http://www.icold-cigb.net/GB/World_register/world_register.asp) has a flood control function, as India has not particularly favoured flood control by regulation, preferring to use levees instead.

There are numerous examples of positive benefits of dams. In Cameroon, the Waza dam is operated to inundate the Logone floodplain, with releases made to optimise ecosystem services such as fisheries, flood recession agriculture, and post-flood livestock grazing (Loth 2004). It could be argued that storage of water in the dam offers security against droughts and large floods, which would be less optimal for the floodplain. Dams create a water body which can have many characteristics of natural lakes, including valuable fish and bird species. Indeed, quite a few reservoirs have been designated as Ramsar Sites, such as Rutland Water in UK, often for their waterbird populations, although these are generally less diverse and more dominated by common species than are equivalent natural lakes (Davidson & Delany 1999).

The positive and negative socio-economic and environmental impacts of dams are well-known and can be mitigated, whilst the impacts of alternative water storage options are relatively unknown (Alhassan 2009). Pressures on water resources, including climate change as well as increasing demands for flood protection, food and energy, will inevitably lead to more dams being built.

Reducing the impacts of dams on wetland ecosystems

The International Hydropower Association continues to be an influential organisation. IHA has, for example, worked with WWF to produce sustainability guidelines (IHA 2004) and an assessment protocol for hydro dams (IHA, 2006). The World Bank has produced criteria for assessing likely adverse environmental impacts of dams (Ledec & Quintero 2003) and has also adopted the concept of environmental flows as part of its safeguards policy for water infrastructure (Brown & King 2003, Acreman 2003) that must be followed to secure Bank loans.

In fact, recent water laws in several countries include environmental flow requirements to maintain the ecosystem services of rivers and associated wetlands downstream, for example, in Costa Rica (Jiménez *et al*. 2005, Le Quesne *et al.* 2010), South Africa (Rowlston & Palmer 2002), and Tanzania (Acreman *et al.* 2006). There have been many regional initiatives, such as in the Mekong, and studies of individual dams. Yet implementation of environmental flows remains elusive due to limited information on trade-offs (Acreman & McCartney 2000) and lack of political will to change historical water rights, to take back water currently used for public supply, agriculture and industry, and in some cases to pay compensation. Designing in or retro fitting large gates and spillways to allow managed flood releases can be very expensive.

Achieving appropriate water quality is also a key challenge of environmental flows. The temperature of re-

Ramsar's existing guidance addresses ways to plan for and manage the impacts of dams on wetland ecosystems:

- Resolution VIII.1 (*World Commission on Dams*);
- Handbook 9, 4th edition (*River basin management*);
- Handbook 10, 4th edition (*Allocation and management of water for maintaining the ecological functions of wetlands*);
- Handbook 11, 4th edition (*Managing groundwater*);
- Handbook 16, 4th edition (*Impact assessment*).

leased water may be different from natural water, especially if the reservoir is deep. The water may also contain noxious substances, such as hydrogen sulphide (Petts 1984). In addition, extra storage may be required to retain sufficient water for the releases in addition to other requirements of the dam, particularly if the system is to be future climate-proofed. Convincing justifications will be needed to attract additional investment funds for these adaptations even though they can help to reduce the impacts of dams on wetland ecosystems.

Can wetlands provide realistic water storage alternatives?

There have been many scientific studies that demonstrate the key role of wetlands in the hydrological cycle and the resultant high economic values of wetlands as water infrastructure (Emerton & Bos 2004). However, the manner in which this role has been described has led to generalisations that suggest that all wetlands perform all functions and deliver the same services and values to the same degree.

Not all wetlands store water

In part, misunderstandings arise because the term "wetlands" (according to the Ramsar Convention) covers a wide range of habitat types from coral reefs to underground lakes and it has been mistakenly assumed that functions and services that exist in one wetland type occur equally in all types (see Bullock & Acreman 2003).

For example, it is widely quoted that "wetlands act like a sponge", soaking up water during rainfall (thus reducing flood risk) and releasing it slowly during dry periods (thus augmenting low flows). In some wetlands the soil water table level rises and falls seasonally; this is called the hydro-period (Mitsch & Gosselink 2007). Rises in water table signify uptake of water into storage; falls in the water table denote evacuation of water from storage.

It is true that wetlands can reduce floods if storage is available, for example when heavy rainfall coincides with a low water table level and water can be taken rapidly into storage. But in many headwater wetlands, soils are saturated for most of the time, which means that they have little available storage; indeed headwater wetlands are often termed 'contributing areas' by hydrologists because they tend to generate flood runoff, rapidly shedding water. But much also depends on the management of such wetlands, and actions such as reversing drainage and re-vegetating denuded areas can significantly reduce flood runoff.

Floodplains on the other hand often have large aboveground storage capacity, and there are many examples of floodplains significantly reducing flood risk downstream (Acreman *et al*. 2003). Wetlands with a large hydroperiod thus are able to store considerable water. Storage capacity also depends on soil type because saturated soils can contain anything from between 20% and 80% water.

It has long been recognised that vegetated wetlands, such as the Sudd (Hurst 1933), evaporate large volumes of water that can exceed evaporation rates from open water bodies such as reservoirs, because of the larger leaf area of wetland plants (Blaney & Muckel 1955). However, in some cases evaporated water is recycled locally through local weather systems. Evaporation from wetlands in the inner Niger delta is responsible for generating local rainfall that sustains grazing land in surrounding drylands (Taylor 2009). Similar analysis of the Sudd suggests that rainfall induced from evaporation is small in relation to the scale of the entire Nile catchment area (Mohamed *et al*. 2005), but it may be quite significant locally.

Yet for a storage option to be viable, storing a sufficient quantity of water is not enough: the water stored must also be of adequate quality. Some wetlands also perform important water quality functions. For example, the Nakivubo papyrus swamp in Uganda receives semi-treated sewage effluent and highly polluted storm water from Kampala (Kansiime & Nalubega 1999). During the passage of the effluent through the wetland, sewage is absorbed and the concentrations of pollutants are considerably reduced, such that water can be abstracted nearby for the public water supply. Ecosystem services vary significantly between wetlands: wetland ecosystems can be easily overloaded by pollutants, and their tolerance is often not known.

An alternative option for utilizing the storage capability of wetlands is to enhance natural storage by creating artificial wetlands to perform hydrological functions. For example, managed aquifer recharge is practised widely in India (CGWB 2005) where millions of small structures capture monsoonal rainfall on the surface and allow it to infiltrate into the often low storage capacity basement aquifers. In the Shiquma scheme, north of the Gaza Strip, a small dam has been constructed to create a reservoir which holds flood water. The water is then pumped to large depressions (infiltration basins) in the sand dunes near the coast where it percolates into the ground to recharge the dune aquifer. Tanks have been the main source of irrigation in many parts of India for

Water storage issues cross political and ecological boundaries

Economic development is increasingly seen as a river basin scale issue. For example, if Ethiopia develops consumptive uses, such as irrigation, it may have hydrological implications for Sudan and Egypt. Although hydropower is a non-consumptive use of water and may only change the timing of flows, this can have positive or negative effects: reducing wet season flows and increasing dry season flows as a result of hydropower operations may benefit irrigation in Sudan. Furthermore, storing water upstream where evaporation losses are lower makes more sense than storing it downstream. But whatever the infrastructural developments, the real issue is building trust between the riparian states in shared river basins. The Nile Basin Initiative supported by the World Bank is promoting sharing of benefits from water rather than sharing the water itself (Sadoff & Grey 2002).

Even if the water courses are not transboundary, the benefits may be – e.g., hydropower energy may be exported across national boundaries. Nepal has hydropower potential that exceeds internal demand, but large-scale hydropower projects, such as the 70 MW Middle Marsyangdi Hydro Project, are feasible in Nepal only when India is prepared to buy power at commercial rates and to share the benefits accrued (WECS 2002). In the Democratic Republic of Congo, two hydropower dams (Inga I and II) exist on the Congo River with a combined capacity of 1775 MW (IWPDC 2008). There now plans for new dams Inga III (4320 MW) and Grand Inga (40 GW), which will be the world's largest hydropower scheme, with transmission lines proposed to Egypt, Nigeria and Southern Africa. Energy security will depend on regional political stability.

centuries. These are low, earthen bunds constructed across a shallow valley, creating storage to hold the monsoon rainwater.

Wetlands can be managed in order to maximise water storage but this could compromise other ecosystem services, such agricultural production (Acreman *et al*. 2001) – presenting a trade-off in services. So incentive mechanisms such as payments from those who benefit need to be found (Smith *et al*. 2006).

Integrated planning with combined surface and groundwater management and use is likely to be the best strategy for coping with future rainfall variability (McCartney & Smakhtin 2010). For example, combinations of small and large reservoirs were particularly effective for providing water for irrigation in southern Sri Lanka (Keller *et al*. 2000).

The science underpinning the storage ability of wetlands needs to be reviewed and clear supportable conclusions defined that are honest about what each type of wetland can and cannot do in terms of providing viable water storage options. Convincing water managers, who often have an engineering background, is part of the challenge, so terminology is particularly important. Use of a term such as 'natural infrastructure' is likely to be more effective in achieving understanding than employing ecological language such as 'biodiversity', 'ecosystems', or 'ecosystem services'.

Who influences decisions on water storage?

River basin authorities are being created in many regions, either within national boundaries, such as the seven authorities established in Tanzania, or transboundary authorities, such as the Mekong River Commission. The concept of Integrated Water Resources Management and the development of river basin plans are being emphasized as key to achieving water-related Millennium Development Goals, an approach that is supported by the Global Water Partnership. River basin authorities are increasingly becoming focal points for decisions concerning water allocation and infrastructure development and management. In some parts of the world, economic integration or coordination bodies are playing significant roles in water management and water infrastructure, and are being reinforced by the donor community. The Common Market for Eastern and Southern Africa (COMESA), the Southern African Development Community (SADC), the United Nations Economic Commission for Africa (ECA), and the Economic Community of West African States (ECOWAS) are examples of bodies which function in this way, to varying degrees.

Funders of large infrastructure can also strongly influence decisions on water and water storage. In recent years there has been significant diversification of the institutional framework for funding large infrastructure.

- Multilateral banks have come back into development of dams after a 10-15 year lull following the World Commission on Dams report; however, al-

though these banks often lead the study phase, they do not necessarily fund the actual investment. The World Bank is now only involved in 5% of dams in developing countries, and, though the Bank applies environmental safeguards policies, these can only be effective for dams which it supports.

- Bilateral funding agencies tend to avoid supporting dam development with the exception of Agence Francaise de Développement, which has expressed interest in funding dam development in central and west Africa.
- Export credit agencies can provide support if the World Bank safeguards are met.
- The role of the multilateral banks has increasingly been taken over by private or sovereign investment organizations, some of which have few, if any, conditionalities. Governments wanting to build dams are increasingly able to "shop around" among groups of potential funders/donors, or to put together their own internal financing packages without reference to others.

Who is funding dam development?

After the World Bank turned down a request for funding the Tucuruí Dam in Brazil, which plans to generate 8370 MW and provide navigation, funding was instead procured by Eletronorte and Brazilian institutions such as Eletrobrás, BNH, Banco do Brasil, Caixa Econômica Federal and FINAME (WCD 2000b). Of the 19 dams planned for the main stem of Mekong in Cambodia, Laos, Thailand and China, most are funded by provincial power companies and Chinese banks. Chinese financing is involved in 59 dams in Burma (though some are on hold or shelved) including the Tasang Dam (7100 MW) on the Salween River, costing $9 billion and funded by the China Power Investment Co (Burma Rivers Network 2008). The Gulf Funds and Islamic Development Bank have also emerged as key financiers of dams.

Responding to changing water storage issues: recommendations for the Ramsar Convention

Provide sound scientific justification for the water storage functions and capabilities of different wetland types

There is a need to:

- review the scientific basis for quantifying storage functions of different types of wetlands, and
- ensure there is a clear audit trail from policy-relevant statements back to scientific papers and reports.

This will enable Ramsar to build a strong case for the extent to which wetlands can provide water storage, regulate water flows, and provide existing water resources through their natural infrastructure, and for how this capability varies between wetland types and geographical locations. This needs to be taken into consideration in any future development of linked guidance on evaluating ecosystem services.

Define a clear Ramsar message on wetlands and water storage issues, and use the right language to ensure understanding

Ramsar should define a clear message on water storage issues and future trends as these affect wetlands, using language appropriate to the target audience. All sectors have their own language. The ecological community has developed a number of concepts, such as the ecosystem approach and ecosystem services, which are still being debated even within that community. If water engineers are the target audience for advocacy, it is better to use concepts such as "natural infrastructure" which they will understand better than "ecosystem services".

Likewise, although 'environmental flows' is becoming everyday language in the conservation community, it is a new and baffling concept to many outside that community. After many years (decades) of development and awareness building, environmental impact assessment, for all its faults, has become widely understood and accepted (however well or badly EIAs may eventually be done). River basin authorities operate through approaches such as IWRM or IRBM, and thus Ramsar guidance needs to be translated into the language used in these approaches.

Identify the most important target audiences for this message and develop focused strategies for communicating relevant wetlands information to these audiences

Priority target groups:

- Those involved, directly or indirectly, with global water policy processes, including the Global Water Partnership, World Water Council, FAO, UNEP,

UNDP and WMO. Engaging with this group provides the opportunity to promote the role of wetlands in water issues at a high strategic level, particularly when addressing major issues of climate change adaptation and mitigation, food security, and responses to major events such as floods and droughts. Wetlands need to be incorporated into international policy statements, decisions, and action programmes on water and infrastructure, including briefings for government delegations to relevant international meetings. This is particularly important in implementing the *Changwon Declaration on wetlands and human well-being* (Ramsar Resolution X.3, 2008) which indicates action steps for how to deliver some of the world's most critical environmental sustainability goals.

- National government environmental departments and agencies, which are often politically weak and do not lead the key processes of planning and decision-making in relation to water storage, though they are often statutory consultees. The Ramsar Convention already provides guidance to support focal ministries in becoming involved in the water management and planning process.

- Subnational and international river basin authorities. Increasingly water and infrastructure planning, which is likely often to be transboundary, will be part of the activities of river basin authorities.

- Strategic planning institutions. In particular the wetland community needs to participate in planning for water storage in processes where storage options are being considered for strategic energy planning (hydropower and others), water supply planning (especially urban and agricultural), transport, and flood control. Additional guidance may be needed, such as on co-management.

- Energy sector institutions. Interaction should also be increased with organisations associated with the energy industry, such as the International Hydropower Association (IHA). The IHA is currently working with WWF to produce sustainability guidelines (IHA 2004) and an assessment protocol for hydropower dams (IHA 2006).

- Private sector institutions. The private sector, particularly banks and power companies, is becoming more influential and offers sources of funding for dams throughout the world. Private sector entities that are significant water users will generally have an interest in protecting their water supplies, for example in the beverage industry, and can influence both wetlands and water resources management.

References

Abd El Samie, S. & Sadek, M. 2001. Groundwater recharge and flow in the Lower Cretaceous Nubian Sandstone aquifer in the Sinai Peninsula, using isotopic techniques and hydrochemistry. *Hydrogeology Journal* 9: 378-389.

Acreman, M.C. 2001. Ethical aspects of water and ecosystems. *Water Policy Journal* 3: 257-265.

Acreman, M.C. 1996. Environmental effects of hydroelectric power generation in Africa and the potential for artificial floods. *Water and Environment Journal* 10: 429-435.

Acreman, M.C. 2003. *Case studies of managed flood releases. Environmental Flow Assessment Part III.* World Bank Water Resources and Environmental Management Best Practice Brief No 8. World Bank, Washington DC.

Acreman, M.C. & McCartney, M.P. 2000. Framework guidelines for managed flood releases from reservoirs to maintain downstream ecosystems and dependent livelihoods. International Workshop on Development and Management of Floodplains and Wetlands. Beijing, China 5-8 September, 2000. 155-164.

Acreman, M.C., Booker, D.J. & Riddington, R. 2003. Hydrological impacts of floodplain restoration: a case study of the river Cherwell, UK. *Hydrology and Earth System Sciences* 7,1, 75-86.

Acreman, M.C., King, J., Hirji, R., Sarunday, W., Mutayoba, W. 2006. Capacity building to undertake environmental flow assessments in Tanzania. *Proceedings of the International Conference on River Basin Management, Morogoro, Tanzania, March 2005*. Sokoine University, Morogoro. Available at: www.iwmi.cgiar.org/Research_Impacts/Research_Themes/BasinWaterManagement/RIPARWIN/Outputs.aspx.

Adhikari, S., Liyanarachchi, S., Chandimala, J., Nawaratne, B.K., Yahiya, Z., Bandara, R. & Zubair, L. 2010. Rainfall prediction based on the relationship between rainfall and El Niño Southern Oscillation (ENSO). *Journal of the National Science Foundation* 38, 4.

Alhassan, H.S. 2009. Butterflies vs hydropower: reflections on large dams in contemporary Africa. *Water Alternatives* 2, 1, 148-160.

Anderson A. & MacKay H.M. 2012 (in prep). Wetlands and energy issues: a review of the possible implications of

policies, plans and activities in the energy sector for the wise use of wetlands. Ramsar Technical Report, Ramsar Convention on Wetlands.

Barnett, T.P., Adam, J.C. & Lettenmaier, D.P. 2005. Potential impacts of a warming climate on water availability in snow-dominated regions. *Nature* 438 7066, 303-309.

Blaney, H.F. & Muckel, D.C. 1955. Evaporation and evapotransipiration investigations in the San Francisco Bay area. *Trans. Am. Geophys. Un*. 36, 813-820.

Brown, C. & King, J. 2003. Environmental flow: concepts and methods. Water Resources and Environment, Technical Note C1. World Bank, Washington D.C., USA.

Brown, C. & Lall, U. 2006. Water and economic development: the role of variability and a framework for resilience. *Natural Resources Forum* 30, 306-317.

Brown, L. R. 2000. *Population Growth Sentencing Millions to Hydrological Poverty*. Worldwatch Institute Issue Alert. June 21, 2000.

Bullock, A. & Acreman, M.C. 2003. The role of wetlands in the hydrological cycle. *Hydrology and Earth System Sciences* 7,3, 75-86.

Burke, E.J., S.J. Brown & N. Christidis. 2006. Modelling the recent evolution of global drought and projections for the 21st century with the Hadley Centre climate model. *J. Hydrometeorol.,* 7, 1113-1125.

Burma Rivers Network. 2008. Tasang dam: www.burmariversnetwork.org/dam-projects

Calow, R. C., MacDonald, A. M., Nicol, A. L. and Robins, N. S. 2010. Ground Water Security and Drought in Africa: Linking Availability, Access, and Demand. *Ground Water* 48, 246–256.

Central Groundwater Board 2005. *Water resources of India*. Ministry of Water Resources, Government of India.

Commission for Africa. 2005. *Our common interest*. Commission for Africa. www.commissionforafrica.info/

Davidson, N.C. & Delany, S. 1999. *Biodiversity impacts of large dams: waterbirds.* Appendix to: McAllister, D.E., Craig, J., Davidson, N. & Seddon, M. *Large dam impacts on freshwater biodiversity.* Report from IUCN – The World Conservation Union to the World Commission on Dams.

Delmas, R. 2005. Long term greenhouse gas emissions from the hydroelectric reservoir of Petit Saut (French Guiana) and potential impacts. *Global Warming and Hydroelectric Reservoirs,* CDD 363.73874, 117-124.

Department of Economic and Social Affairs Population Division. 2006. *World population prospects*. United Nations. pp. 37-42. www.un.org/esa/population/publications/wpp2006/WPP2006.

Economic Commission for Africa. 2008. *Africa Review Report on drought and desertification* Economic Commission for Africa, Addis Ababa.

Economist. 2009. Buying land abroad. Outsourcing's third wave. *Economist* May 2009.

Emerton, L. & Bos, E. 2004. *Value: counting ecosystems as water infrastructure.* Water and Nature Initiative, IUCN – The World Conservation Union.

Food and Agriculture Organization of the United Nations 1987. *Irrigated areas in Africa: extent and distribution*. FAO report AGL/MISC13/87. Rome 127 p. + map.

Gedney, N., Cox, P.M., Betts, R.A., Boucher, O., Huntingford, C. & Stott, P.A. 2006. Detection of a direct carbon dioxide effect in continental river runoff records. *Nature* 439: 835–838.

Gini, C. 1912.Variabilità e mutabilità *(Variability and Mutability)*, C. Cuppini, Bologna, 156 pages. [Reprinted in *Memorie di metodologica statistica* (ed. Pizetti E, Salvemini, T). Rome: Libreria Eredi Virgilio Veschi (1955).]

Gleick, P.H., ed. 1993. *Water in crisis: a guide to the world's fresh water resources*. Oxford University Press, Oxford.

Grey, D. & Sadoff , C. W. 2007. Sink or swim? Water security for growth and development. *Water Policy* 9: 545–571.

Hanjra, M.A., Ferede, T., Gutta, D.G. 2009. Pathways to breaking the poverty trap in Ethiopia: investments in agricultural water, education and markets. *Agricultural Water Management,* 96, 11, 2-11.

Hurst, H.E. 1933. The Sudd region of the Nile. *J. Roy. Soc. Arts* 81, 721-736.

Hanjra, M.A. & Qureshi, M.E. 2010. Global water crisis and future food security in an era of climate change. *Food Policy* 35, 365-377.

Hussain, I. & Hanjra, M.A. 2004. Irrigation and poverty alleviation: review of the empirical evidence, *Irrigation and Drainage* 53**,** 1, 1–15.

IEA. 2010. World Energy Outlook 2010. International Energy Agency, Paris. www.iea.org/weo/2010.asp

International Hydropower Association. 2004. *Sustainability guidelines*. International Hydropower Association, London.

International Hydropower Association. 2006. *Sustainability assessment protocol*. International Hydropower Association, London.

International Hydropower Association. 2008. *Hydropower: making a significant contribution worldwide*. International Hydropower Association, London

International Water Power & Dam Construction. 2008. www.waterpowermagazine.com/.

Jiménez, J. A., Calvo J., Pizarro F. & González E. 2005. *Conceptualisation of Environmental Flows in Costa Rica. Preliminary Determination for the Tempisque River.* San José, Costa Rica: IUCN.

Kansiime, F. & Nalubega, M. 1999. *Wastewater treatment by a natural wetland: the Nakivubo swamp, Uganda: processes and implications*. PhD dissertation, IHE Delft, The Netherlands

Keller, A., Sakthivadivel, R. & Seckler, D. 2000. *Water scarcity and the role of storage in development*. IWMI Research Report 39. IWMI, Colombo.

Ledec, G. & Quintero, J.D. 2003. *Good dams and bad dams: environmental criteria for site selection of hydroelectric projects*. World Bank Latin America and Caribbean Region Sustainable Development Working Paper 16. Washington, D.C.

Le Quesne, T., Kendy, E., & Weston, D. 2010. The implementation challenge: taking stock of government policies to protect and restore environmental flows. WWF-UK and The Nature Conservancy.

Loth, P. 2004. *The return of the water: restoring the Waza-Logone floodplain in Cameroon*. IUCN, Gland , Switzerland. 153 pp

Mason, S., Hagmann, T., Bichsel, C., Ludi, E., Arsano, Y. 2007. Linkages between sub-national and international water conflicts: the Eastern Nile Basin. In: Brauch H.G., Grin J. et al. (eds), *Facing global environmental change: environmental, human, energy, food, health and water security concepts*, Berlin, Springer-Verlag.

McCartney, M. & Smakhtin, V. 2010. Water storage in an era of climate change. IWMI Blue Paper. IWMI, Colombo.

Meehl, G.A., Stocker, T.F., Collins, W.D., Friedlingstein, P., Gaye, A.T., Gregory, J.M., Kitch, A., Knutti, R., Murphy, J.M., Noda, A., Raper, S.C.B., Watteron, I.G., Weaver, A.J. & Zhuo, Z.-C. 2007. Global Climate Projections. In: *Climate Change 2007: the physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

Millan, J. 1999. *The future of large dams in Latin America and the Caribbean*. Inter-American Development Bank Energy Strategy. IDB, Washington, D.C.

Millennium Ecosystem Assessment. 2005. *Ecosystems and human well-being*. Island Press, Washington, D.C.

Mitsch, W.J., and J.G. Gosselink. 2007. Wetlands, 4th ed., John Wiley & Sons, Inc., New York

Mohamed, Y.A., van den Hurk, B.J.J.M., Savenije, H.H.G. &. Bastiaanssen W.G.M. 2005. Impact of the Sudd wetland on the Nile hydroclimatology, *Water Resour. Res.* 41, W08420.

Molden, D., ed. 2007. *The Comprehensive assessment of water management in agriculture*. Earthscan, London, IWMI, Colombo

Moore, D., Dore, J., Gyawali, D. 2010. The World Commission on Dams +10; revisiting the large dam controvery. *Water Alternatives* 3, 2. 3-13. www.water-alternatives.org

Petts, G.E. 1984. *Impounded rivers: perspectives for ecological management*. John Wiley and Sons, Chichester, 326 pp.

Ray, D.E. 2008. Data show that China's more meat-based diet is not the cause of ballooned international corn prices? Agricultural Policy Analysis Center, University of Tennessee, article 48. www.agpolicy.org/weekpdf/408.

Ramsar Convention. 2012. Draft Resolution XI.10 (Wetlands and energy issues) prepared for the 11th meeting of the Conference of the Contracting Parties. www.ramsar.org/pdf/cop11/doc/cop11-dr10-e-energy.pdf.

Rowlston, W.S. & Palmer, C.G. 2002. Processes in the development of resource protection provisions on South African Water Law. *Proceedings of the International Conference on Environmental Flows for River Systems*, Cape Town, March 2002.

Sadoff, C.W., Grey, D. 2002. Beyond the river: the benefits of cooperation on international rievrs. *Water Policy* 4, 389-403

Smith, M., de Groot, D., Bergkamp, G. 2006. *Pay-establishing payment for watershed services*. IUCN, Gland, Switzerland. 109 pp.

Sullivan, C.A., Meigh, J.R., Giacomello, A.M., Fediw, T., Lawrence, P., Samad, M. Mlote, S., Hutton, C., Allan, J.A.,

Schulze, R.E., Dlamini, D.J.M., Cosgrove, W., Delli Priscoli, J., Gleick, P., Smout, I., Cobbing, J., Calow, R., Hunt, C., Hussain, A., Acreman, M.C., King, J., Malomo, S., Tate, E.L., O'Regan, D., Milner, S., Steyl, I. 2003. The Water Poverty Index: Development and application at the community scale. *Natural Resources Forum* 27, 3, 25-41.

Taylor, C.M. 2009. Feedbacks on convection from an African wetland. *Geophysical Research Letters* 37, L05406.

Torcellini, P., Long, N. & Judkoff, R. 2003. *Consumptive water use for US power production.* National Renewable Energy Laboratory Technical report 550-33905.

United Nations Development Programme. 2006. *Human development report*. Macmillan, New York.

United Nations Environment Programme. 2008. *An overview of the state of the world's fresh and marine waters*. Second edition. UNEP, Nairobi.

United Nations Population Fund. 2007. *State of world population: peering into the dawn of an urban millennium*. www.unfpa.org

Water & Energy Commission Secretariat. 2002. *Water resources strategy.* His Majesty's Government of Nepal, Kathmandu.

World Bank. 2007. *Review of greenhouse gas emissions from the creation of hydropower reservoirs in India*. World Bank, Washington, DC

World Commission on Dams. 2000a. *Dams and development*. Earthscan, London.

World Commission on Dams. 2000b. *Tucuruí Hydropower Complex Brazil.* WCD case study www.dams.org/docs/kbase/studies/csbrmain.pdf.

Wright, E.P., Benfield, A.C., Edmunds, W.M. & Kitching, R. 1982. Hydrogeology of the Kufra and Sirte basins, eastern Libya. *Quarterly Journal of Engineering Geology & Hydrogeology* 15, 2, 83-103.

Briefing Notes series

This series is prepared by the Ramsar Convention's Scientific and Technical Review Panel (STRP) in order to share relevant, credible and interesting scientific and technical information on wetlands with a broad audience. Briefing Notes are reviewed internally by STRP members and a small internal editorial panel, comprised of the STRP Chair and the responsible Thematic Work Area lead or task lead, assisted by the Convention's Deputy Secretary General.

Briefing Notes are published by the Ramsar Convention Secretariat in English in electronic (PDF) format. When resources permit, they will be published in French and Spanish as well (the other official languages of the Ramsar Convention) and in printed form.

A full list of current Briefing Notes can be found at www.ramsar.org/BN. Information about the STRP can be found at: www.ramsar.org/STRP-main/. For more information about Briefing Notes or to request information on how to correspond with their authors, please contact the Ramsar Secretariat at strp@ramsar.org.

Author: Dr Mike Acreman, Head of hydro-ecology and wetlands, Centre for Ecology and Hydrology, UK (man@ceh.ac.uk).

Citation: Acreman, M. C. 2012. *Wetlands and water storage: current and future trends and issues.* Ramsar Scientific and Technical Briefing Note no. 2. Gland, Switzerland: Ramsar Convention Secretariat.

The Convention on Wetlands (Ramsar, Iran, 1971) – called the Ramsar Convention – is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance and to plan for the "wise use", or sustainable use, of all of the wetlands in their territories.

Ramsar Convention Secretariat
Rue Mauverney 28
CH-1196 Gland, Switzerland
Tel.: +41 22 999 0170
Fax: +41 22 999 0169
E-Mail: ramsar@ramsar.org
Website: www.ramsar.org

STRP
Scientific and Technical Review Panel

Briefing Note

Number 3, April 2012

Ramsar Convention on Wetlands

Purpose of this BN

This Briefing Note provides supporting information to Draft Resolution XI.9, An Integrated Framework and guidelines for avoiding, mitigating and compensating for wetland losses, developed by the STRP in response to Resolution X.10 (2008). It is important to note, however, that the selection of examples is not intended to represent endorsement or any comment on the level of implementation on the ground but simply to demonstrate the widespread adoption of the avoid-mitigate-compensate approach in all the Ramsar regions.

Background

Resolution X.10 calls for the development of "guidance in mitigation of and compensation for losses of wetland area and wetland values, in the context of Resolution X.16 on A Framework for processes of detecting, reporting and responding to change in wetland ecological character." The research for this Briefing Note was conducted by the Institute for Biodiversity Law and Policy, Stetson University College of Law, USA.

Authors

Prof. Royal C. Gardner, STRP Invited Expert 2009-2012; Marcela Bonells, Erin Okuno, Juan Manuel Zarama. Further information on the last page.

Avoiding, mitigating, and compensating for loss and degradation of wetlands in national laws and policies

Ramsar Draft Resolution XI.9 reaffirms the Contracting Parties' commitment to avoiding negative impacts on the ecological character of Ramsar Sites and other wetlands as the primary step in any wetland management approach. Ramsar Draft Resolution XI.9 also states that if such avoidance is not feasible, appropriate mitigation and/or compensation actions should be implemented as far as possible. This Briefing Note provides examples of the variety of approaches that Contracting Parties have taken in adopting the "avoid-mitigate-compensate" sequence in laws and policies throughout the Ramsar regions.

Key messages and recommendations

The avoid-mitigate-compensate sequence is an important tool for maintaining the ecological character of wetlands, and it is not a novel or radical approach. There are a number of Resolutions and Recommendations already adopted by the Ramsar Conference of the Parties (COP) that recognize the three-stage approach to avoiding, mitigating (or minimizing), and compensating for residual wetland losses. These official documents emphasize the need to avoid wetland losses as an imperative.

A variety of national laws and policies are currently in place throughout the Ramsar regions which already recognize this approach in different forms, ranging from wetland-specific and biodiversity-related laws and policies to more general environmental impact assessment instruments.

While not all of these Contracting Parties use the precise avoid-mitigate-compensate formulation, they use interchangeable or related terms that are consistent in essence. Moreover, while Parties have adopted different forms of the avoid-mitigate-compensate approach, their approaches generally recognize that the avoidance or prevention of wetland losses is essential, in line with the COP Resolutions and Recommendations.

The examples highlighted in this review describe the various ways in which the avoid-mitigate-compensate sequence has been reflected in national laws and policies. The examples are not exhaustive and are not intended to indicate the level and effectiveness of implementation on the ground.

Introduction

This Briefing Note begins with explanatory definitions of the three terms 'avoidance', 'mitigation', and 'compensation'. It then cites law and policy examples of the avoid-mitigate-compensate approach in each Ramsar region, proceeding

alphabetically. The terms "law and policy" are used in a general sense. They include legislation, such as statutes, acts, decrees, and ordinances; regulations and other rules promulgated by agencies that have the force of law; and policies, which depending on the jurisdiction may also have the force of the law or may merely provide principles or rules that guide a decision-making process.

Many Contracting Parties, recognizing the importance of the conservation and wise use of wetlands, have adopted some form of an avoid-mitigate-compensate approach to wetland loss and degradation. In this context, national, regional, and local laws and policies emphasize that negative wetland impacts should be avoided if at all possible. If such negative impacts cannot be avoided or prevented, actions should be taken to mitigate (minimize or reduce) this wetland loss or degradation. Finally, if wetland loss or degradation remains after such mitigation, actions should be taken to compensate for (i.e., offset) these residual impacts.

RELATED DOCUMENTS

Ramsar Resolutions and Recommendations which recognize the three-stage approach of avoiding, mitigating (or minimizing), and compensating for wetland losses and degradation

- Recommendation 2.3 (1984), Action points for priority attention
- Resolution VII.24 (1999), Compensation for lost wetland habitats and other functions
- Resolution X.12 (2008), Principles for partnerships between the Ramsar Convention and the business sector
- Resolution X.17 (Annex), Environmental Impact Assessment and Strategic Environmental Assessment
- Resolution X.19 (Annex), Wetlands and river basin management
- Resolution X.25, Wetlands and "biofuels"
- Resolution X.26, Wetlands and extractive industries

Relevant Ramsar Publications

- Ramsar Handbook 2, National Wetland Policies (4th edition, 2010)
- Ramsar Handbook 3, Laws and institutions
- Ramsar Handbook 18, Managing wetlands
- Ramsar Handbook 19, Addressing change in wetland ecological character

The avoid-mitigate-compensate approach is not limited to wetlands: while we find this approach in wetland-specific laws and policies, it is also present in many broader water-related laws and policies. Moreover, a number of Contracting Parties have adopted general biodiversity-related laws and policies which encompass wetlands, and these also promote an avoid-mitigate-compensate approach to habitat and species conservation. Finally, many Contracting Parties require an environmental impact assessment (EIA) for certain proposed actions that could affect wetlands, and an avoid-mitigate-compensate approach is a common feature of these EIA laws and policies.

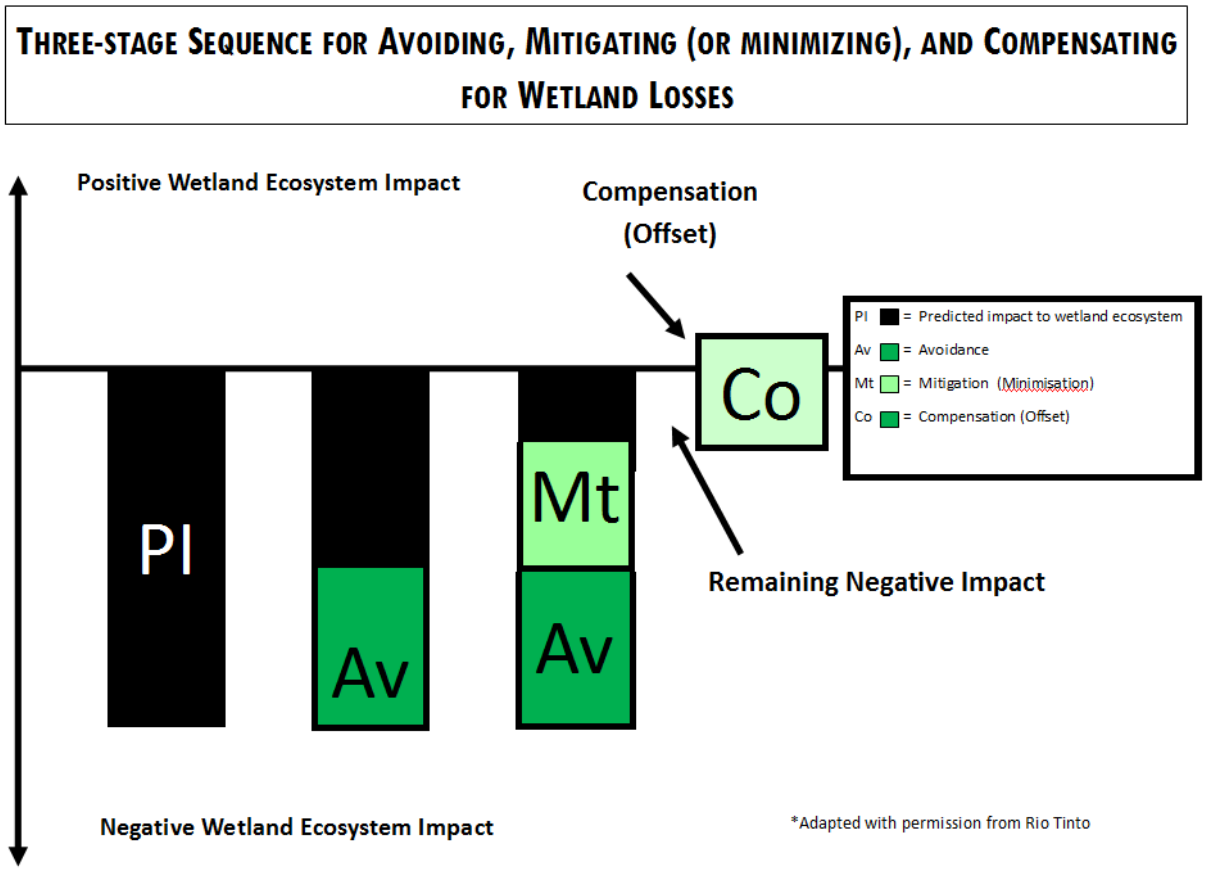
Some Contracting Parties have been influenced and guided by the work of the Business and Biodiversity Offset Program (BBOP), a collaborative program of over 40 companies, financial institutions, governments, and civil society organizations, whose efforts have been recognized in Ramsar Resolution X.12 (2008). The BBOP vision is that "offsets are applied worldwide to achieve no net loss and preferably a net gain of biodiversity relative to development impacts" (Forest Trends, 2012). The use of compensation or offset markets as a tool for achieving no net loss or net gain is an emerging trend in many Parties but is beyond the scope of this Note.

While this Briefing Note offers examples of the avoid-mitigate-compensate approach from all Ramsar regions, it should be reiterated that the examples are illustrative and not exhaustive.

Definitions

It is important to observe from the outset that the terms 'avoid', 'mitigate', and 'compensate' are used in a broad sense. Not every Contracting Party uses this precise formulation; others more closely align with the BBOP definitions and principles. Yet the concepts behind the terms are in essence consistent. For example, 'prevent' is the equivalent of 'avoid', and 'reduce or minimize' fits neatly under the definition of 'mitigate'.

Avoidance: Avoiding wetland impacts involves proactive measures to prevent adverse change in a wetland's ecological character through appropriate regulation, planning or activity design decisions. Examples would include choosing a non-damaging location for a development project, or choosing a "no-project" option when the risks to the maintenance of ecological character are assessed as being too high.



Three-stage Mitigation Sequence Chart: Rio Tinto, 2008. Rio Tinto and biodiversity: Achieving results on the ground. Rio Tinto's Biodiversity Strategy. Available at: http://www.riotinto.com/documents/ReportsPublications/RTBidoversitystrategyfinal.pdf.

Mitigation: Mitigating wetland impacts refers to reactive practical actions that minimize or reduce *in situ* wetland impacts. Examples of mitigation include "changes to the scale, design, location, siting, process, sequencing, phasing, management and/or monitoring of the proposed activity, as well as restoration or rehabilitation of sites" (Ramsar Resolution X.17 annex, para. 23). Mitigation actions can take place anywhere, as long as their effect is realized in the site where change in ecological character is likely. In many cases it may not be appropriate to regard restoration as mitigation, since doing so represents an acknowledgement that impact has already occurred: in such cases the term 'compensation' may be a truer reflection of this kind of response.[1]

Compensation: Compensating for wetland impacts refers to actions that are intended to offset the residual impacts on wetland ecological character that remain after any mitigation has been achieved. An example of compensation would be an off-site wetland restoration or creation project, provided it adds value beyond what would have happened otherwise (i.e., relying on an already-planned benefit would not constitute compensation). Contracting Parties have highlighted the fact that it is preferable to compensate for wetland loss with wetlands of a similar type and in the same local water catchment (Resolution VII.24).

Avoid-mitigate-compensate approaches in Africa

Burkina Faso: The EIA decree (2001) reflects the precautionary principle to prevent damage to the environment as a consequence of human activities. Under this framework, an EIA must identify proposed mitigation or compensation measures, while avoiding or reducing the negative impacts to acceptable levels (Desire, 2007).

Egypt: The document "Guidelines of Principles and Procedures for Environmental Impact Assessment" (2009) describes the EIA process as the "systematic examination of consequences of a proposed project, aiming to prevent, reduce or mitigate negative impacts on the environment, natural resources, health and social elements as well capitalize on impacts of the project."

Ghana: Environmental Assessment Regulations (1999) make an EIA mandatory for undertakings that drain wet-

1 *N.B.* The interpretation of mitigation in this context does not relate to climate change mitigation.

lands. To enable the Environmental Protection Agency to make this assessment, an applicant must submit a report that contains a commitment "to avoid any adverse environmental effects which can be avoided on the implementation of the undertaking … [and] to address unavoidable environmental and health impacts and steps where necessary for their reduction." The report must also suggest "alternatives to the establishment of the undertaking." Ghana's Strategic Environmental Assessment (SEA) Manual (2004) defines mitigation measures as "[m]easures that avoid, reduce, remediate or compensate for the negative impacts of a strategic action."

Namibia: The Environmental Management Act (2007) requires Environmental Assessments for all projects that may "have significant effects on the environment or the use of natural resources." Among the principles of environmental management set forth in the Act are the prevention of damage to the environment and the reduction, limitation, or control of activities causing environmental damage. In practice, this can lead to or encourage an avoid-mitigate-compensate approach. For example, a Strategic Environmental Assessment for the central Namib Uranium Rush (2010) calls for the avoidance, minimization, mitigation/and or restoration of biodiversity impacts, as well as the implementation of biodiversity offsets.

South Africa: The National Biodiversity Framework (2009), which applies to wetlands, expressly discusses an avoid-mitigate-compensate (offset) approach:

> In some cases, following avoidance and mitigation, there is still residual damage to biodiversity as a result of a development. In such cases, if the development is socially and economically sustainable, ecological sustainability may be achieved through a biodiversity offset. A biodiversity offset involves setting aside land in the same or a similar ecosystem elsewhere, at the cost of the developer.

Similarly, at the provincial level, the 2010 draft guidelines on biodiversity offsets in the province of KwaZulu-Natal suggest a sequence of "avoiding, minimizing, repairing or restoring" to address negative biodiversity impacts.

South Africa's National Environmental Management Act No. 107 (1998), which specifically covers wetlands under development pressure, outlines sustainable development principles in an "avoid, minimize, remedy" sequence, whereby negative impacts to biodiversity are "avoided" and unavoidable impacts are "minimised and remedied."

Uganda: Wetland policies and regulations are in accord with an avoid-mitigate-compensate approach. The national Wetland Policy (1995) encourages the avoidance of wetland impacts, stating that there will be "no drainage of wetlands unless more important environmental management requirements supersede" and "[o]nly those uses that have been proved to be nondestructive to wetlands and their surroundings will be allowed and/or encouraged." If a permit is issued to allow development in a wetland, the permit holder shall, within a year after the permit expires, "restore the wetland to as near the state it was as possible immediately before the commencement of the permitted activities" (National Environment Management Authority, 2000).

Avoid-mitigate-compensate approaches in Asia

China: The 1998 Forest Law and the 2002 Forest Vegetation Restoration Fee Levy, Use and Management Provisional Measures require development projects such as mining and construction to be conducted so as to avoid and minimize impacts to forest areas (Bennett, 2009). In addition, to offset any remaining impacts, developers pay a Forest Vegetation Restoration Fee, which forest management authorities "use for afforestation and forest vegetation recovery for an area no less than that taken up by the developer's operations" (Bennett, 2009).

At a local level, the Town Planning Board of Hong Kong adopted a precautionary and "no net loss" approach to protect and conserve the Mai Po and Inner Deep Bay Ramsar Site (Advisory Council on the Environment, 2008). For example, proponents of residential developments within certain zones must

> assess and mitigate all possible adverse environmental impacts arising from the project. In case ecological impacts are identified, mitigation measures to be implemented to ensure that the proposed development would not result in any significant residual impacts, should include, in the order of priority, avoidance of impacts, minimization of impacts, and compensation for loss of ecological functions.

India: Environmental impact assessment notifications are required for development projects that are likely to adversely impact sensitive ecosystems, including wetlands. The EIA and environment management plan

Malua BioBank, located in a conservation area in Sabah, Malaysia, issues biodiversity conservation certificates for the rehabilitation and preservation of critical orangutan habitat. Copyright © JPHTN. Available at: http://www.maluabank.com/gallery.html#.

should address "the prevention, elimination or mitigation of the impact, right from the inception stage of the project" (Notification I, S.O. 85(E), 1992).

Japan: The Environmental Impact Assessment Law (originally enacted in 1997), which requires an EIA for all large-scale projects that may adversely affect the environment, follows an avoid-minimize-compensate sequence (Tanaka, 2008). The Environmental Impact Assessment Guidelines, contained in The Third National Biodiversity Strategy of Japan (2007), make clear that avoiding impacts is the first step, stating that "avoidance and decrease of environmental impact[s]" be given priority, "rather than taking compensatory mitigation by creating an equal environment to the one that would be lost by the project."

Malaysia: The State of Sabah's Environment Protection Enactment (2002) requires an EIA or a proposal for mitigation measures for development projects that may have a significant adverse impact on the environment. A 'mitigation declaration' is defined as "an agreement signed by a person before commencement of any [prescribed] development activity." The law imposes a duty to "avoid, remedy or mitigate any adverse effect on the environment arising from any activity … whether or not such activity is … permitted."

Mongolia: The Law on Environmental Impact Assessment (2001) requires an EIA for development activities that may adversely impact the environment. The EIA must identify potential adverse environmental effects, as well as measures to "minimize and mitigate" them. The environmental protection plan requires consideration of measures to "reduce, mitigate, or eliminate the adverse impacts" identified in the detailed EIA. In addition, the Law on Environmental Protection (1995) establishes that citizens shall have the duty to "prevent adverse environmental impacts and to restore or compensate for any damage or loss in the form of adverse environmental impacts arising from their conduct." The law refers to compensation in the context of natural resources valuation, stating that a resource's "economic value shall form the basis for determining the level of payments and fees for resource use and the amount of compensation payable in the case of adverse environmental impacts and direct damage." Restoration costs may be part of the compensation.

Vietnam: The 2011 decree on "protecting strategic environmental assessment, environmental impact assessment and environmental protection commitment" requires that any strategic environmental assessment report must include "measures to prevent and mitigate adverse environmental impacts."

Avoid-mitigate-compensate approaches in Europe

European Union: The EU has endorsed an avoid-mitigate-compensate approach in several contexts. For example, guidance on Article 6 of the Habitats Directive 92/43/EEC (2000) defines mitigation as "measures aimed at minimising or even cancelling the negative impact of a plan or project, during or after its completion." Guidance on these measures calls for a "hierarchy of preferred options" where avoiding impacts is the highest preference (European Commission, 2001). Where no alternative solutions exist (i.e., where impacts to a Natura 2000 site cannot be avoided) and adverse impacts remain, then "compensatory measures" must be

Approach to mitigation	Preference
Avoid impacts at source	Highest ↑
Reduce impacts at source	
Abate impacts on site	
Abate impacts at receptor	Lowest

European Commission, 2001. Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites: Methodological Guidance on the Provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC. Available at: http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/natura_2000_assess_en.pdf.

Severn Estuary, UK. Example of avoidance of changes to ecological character by government denial of permit for tidal energy project. Copyright: © Severn Estuary Partnership. Available at: http://www.flickr.com/photos/severnestuary/5163687605/.

assessed. Compensatory measures may consist of restoration, creation, enhancement, and/or preservation of habitat.

The Water Framework Directive (2000), which applies to wetlands, directs Member States to adopt legislation that encompasses the concepts of avoiding impacts, mitigating impacts, and pursuing "supplementary measures" (such as wetland restoration).

The EU 2020 Biodiversity Policy Strategy has set a target of "[h]alting the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, and restoring them in so far as feasible" (European Commission, 2011). To ensure no net loss of biodiversity and ecosystem services, the Strategy contemplates compensation and offset schemes.

Russia: The Water Code (2006) authorizes the federal government to "implement measures and arrangements to prevent adverse impact on water and mitigate its consequences with respect to federally-owned water bodies and water bodies located in more than two constituent territories of the Russian Federation."

Serbia: The Law on Environmental Impact Assessment (2004) defines an EIA as a "preventive measure" that aims to determine and propose the implementation of measures to "to prevent, reduce or eliminate" the adverse impacts of certain projects.

Avoid-mitigate-compensate approaches in the Neotropics

Colombia: A technical guide for the elaboration of wetland management plans in Colombia (2006) applies the Ramsar Convention's wise use concept and calls for wetland impacts to be prevented, controlled, absorbed, repaired, or compensated in the context of wetland zonation. With respect to mangroves, Colombia has adopted measures requiring forest management plans to include measures to "prevent, mitigate, control, compensate, repair, and correct" potential negative environmental impacts resulting from forest usage activities (Ministerio de Ambiente, Vivienda y Desarrollo Territorial, 1995).

An example of a local law employing a variant of the avoid-mitigate-compensate approach is Decree 062 de 2006–Alcaldía Mayor de Bogotá, which establishes mechanisms and guidelines to create and implement environmental management plans for wetlands located inside the urban perimeter of Bogotá. The decree uses the terms "prevent, mitigate, compensate" in the context of administering and implementing wetland management plans.

Costa Rica: The 1998 Biodiversity Law states that "the Ministry of Environment and Energy, in collaboration with other public and private organizations, will prepare a system of parameters" to take appropriate conservation measures, "including mitigation, control, restoration, recuperation and rehabilitation" of ecosystems. Similarly, Costa Rica's EIA rules (2004) follow a sequence requiring "prevention, mitigation, and compensation" measures depending upon the project's impact.

El Salvador: El Salvador's Law of the Environment (1998) requires an EIA, following a similar sequence or hierarchy of "prevent, attenuate, compensate" for proposed projects on fragile or protected areas and in wetlands.

Peru: Peru's National Environmental Impact Assessment System Law (2001) provides for a similar approach of "prevent, mitigate, or correct."

Trinidad and Tobago: The 2001 Certificate of Environmental Clearance Rules require that applicants conduct an EIA, which may include "an account of the measures proposed to avoid, reduce, mitigate, or remedy" any identified significant, adverse environmental impacts.

Uruguay: The 2000 General Environmental Protection Law embraces, as part of its policy and goals, the "prevention, elimination, mitigation, and compensation of negative environmental impacts."

Venezuela: The 2008 Biodiversity Management Law states that "preventive, mitigating, corrective, and compensatory" measures are to be considered to manage

the impacts on ecosystems and components of biological diversity. Venezuela also has specific norms applicable to mangroves, which call for "prevention, minimization, mitigation, and correction" measures to address potential environmental damages resulting from a proposed project or activity (Decreto No. 1843, 1991).

Avoid-mitigate-compensate approaches in North America

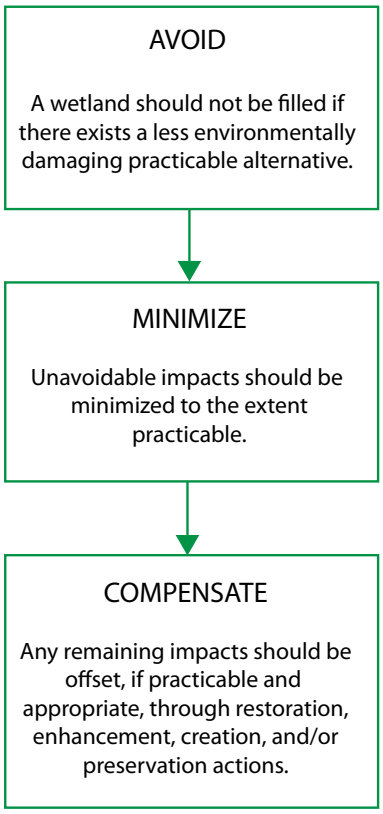
Canada: The Federal Policy on Wetland Conservation (1991) espouses a commitment to no net loss of wetland functions on federal lands and waters. The Implementation Guide for Federal Land Managers (1996) states that to achieve the goal of "no net loss," project proponents must adhere to a "strict sequence of mitigation alternatives—avoidance, minimization, and compensation."

Several Canadian provinces also follow the hierarchical progression of avoid-minimize-compensate, including Alberta, New Brunswick, Prince Edward Island and Nova Scotia (Rubec and Hanson, 2009). Interestingly, the New Brunswick Wetlands Conservation Policy (2002) contains a particularly strong endorsement of avoidance of wetland impacts. It commits to "no loss of Provincially Significant Wetland habitat and [to] no net loss of wetland functions for all other wetlands" in the province.

México: The General Law for Ecological Equilibrium and Environmental Protection (2011) requires the "prevention, minimization, or reparation" of adverse environmental impacts from projects/activities. The law also requires an EIA for projects on wetlands, mangroves, lakes, rivers, lagoons, and estuaries to "preserve and restore" the impacted ecosystems in order to "avoid or reduce to a minimum" adverse environmental impacts.

Corkscrew Swamp Sanctuary, US Ramsar Site that includes wetland compensation. Copyright: © Allyson Webb.

USA: The federal Clean Water Act (CWA)(1972, as amended) requires permits for impacts to aquatic resources, including most wetlands. Environmental Protection Agency regulations (2008) require an "avoid-minimize-compensate" sequence. Thus, for CWA permits, a permittee should avoid wetland impacts to the extent practicable. If impacts cannot be entirely avoided, they should be minimized. Any remaining wetland impacts must be compensated for through restoration, enhancement, creation and/or preservation. Many states and local governments have similar requirements. At the federal level, compensation provided through wetland banks is the preferred mechanism (EPA, 2008).



U.S. National Research Council, 2001. Compensating for Wetland Losses Under the Clean Water Act. Available at: http://www.nap.edu/openbook.php?record_id=10134&page=66.

Avoid-mitigate-compensate approaches in Oceania

Australia: Australia has numerous forms of biodiversity offset programs, and a common feature is an avoid-mitigate-compensate framework. For example, Queensland's Environmental Offsets Framework Policy of 2008 provides that "[e]nvironmental impacts from development must first be avoided and if not avoidable then minimised" and "[e]nvironmental offsets are only applicable when the impacts cannot be avoided or minimised." Thus, Queenland's Policy for Vegetation Management Offsets (2011) emphasizes that a

> land-based offset may be proposed by an applicant for particular development activities . . . only . . . where the applicant has demonstrated to the chief executive that the development has first avoided and minimised the impacts of the development on vegetation prior to proposing an offset.

Western Australia offers similar guidance for its environmental offset program. Biodiversity Guidance Statement No. 19 (2008) notes that "[m]itigation, in an environmental context, refers to a sequence of considerations designed to help manage adverse environmental impacts, which includes (in order of preference): avoidance, minimisation, rectification, reduction and offsets." A position statement (2006) underscores the hierarchical nature of the approach: "[E]nvironmental offsets represent a 'last line of defense' for the environment, only being used when all other options to avoid and mitigate environmental impacts have been considered and exhausted."

The Kingborough Biodiversity Offset Policy in Tasmania (2010) echoes the theme: "Offsets will only be considered where . . . [t]he proponent has adequately demonstrated the need for an offset, including that all effort has been made to avoid and minimise impacts on natural values, including alternative locations or designs for the development."

Fiji: The Environment Management Act 2005 governs environmental impact assessments and states that "the approving authority must take into account whether there exist any technically or economically feasible measures that would prevent or mitigate any adverse environmental or resource management impact." Additionally, approval of the EIA "may be subject to the requirement of an environmental cash bond to be deposited into the [Environmental Trust] Fund as a security to cover the probable cost of preventing or mitigating any environmental damage to the area and its surroundings."

New Zealand: The Resource Management Act of 1991, which can apply to activities affecting wetlands, imposes "a duty to avoid, remedy, or mitigate any adverse effect on the environment," which can be seen to be the equivalent of an avoid-mitigate-compensate approach. In the context of a Biodiversity Offsets Programme, the Department of Conservation (2010) has affirmed that

> The priority is to avoid impacts, first by transparent exploration of all alternatives, then by avoidance through careful footprint design. The second priority is to minimise the impacts of a project on biodiversity; the third is restoration. A biodiversity offset is the final option in this 'mitigation hierarchy'.

The Department of Conservation (2011) emphasizes that "[i]t is essential to note that offsets do not replace the mitigation hierarchy, but are a means to address the residual adverse biodiversity impacts arising from project development after appropriate avoidance and mitigation measures have been taken."

Conclusion

This review of environmental laws and policies demonstrates that an avoid-mitigate-compensate approach is common throughout all Ramsar regions. It is neither new nor radical, and it appears in many forms all over the globe. The approach is often applied to all ecosystems, not just wetlands.

It is important to note, however, that the examples presented in this review are not intended to suggest the level of implementation on the ground but have been chosen to illustrate the widespread adoption of the approach in a variety of laws and policies. The extent to which these laws and policies are applied in a manner that results in effective avoidance, mitigation, and compensation requires further study.

References and sources

General references and sources

European Commission, 2001. Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites: Methodological Guidance on the Provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC. Available at: http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/natura_2000_assess_en.pdf.

Forest Trends, 2012. Business and Biodiversity Offsets Program. Available at http://www.forest-trends.org/program.php?id=117.

Madsen, B., Carroll, N. & Moore Brands, K. 2010. State of Biodiversity Markets Report: Offset and Compensation Programs Worldwide. Not cited in the text. Available at: http://www.forest-trends.org/documents/files/doc_2388.pdf.

Madsen, B., Carroll, N., Kandy, D. & Bennett, G. 2011. 2011 Update: State of Biodiversity Markets Offset and Compensation Programs Worldwide. Not cited in the text. Available at: http://www.forest-trends.org/documents/files/doc_2848.pdf.

Rio Tinto, 2008. Rio Tinto and biodiversity: Achieving results on the ground. Rio Tinto's Biodiversity Strategy. Available at: http://www.riotinto.com/documents/ReportsPublications/RTBidoversitystrategyfinal.pdf.

U.S. National Research Council, 2001. Compensating for Wetland Losses Under the Clean Water Act. Available at: http://www.nap.edu/openbook.php?record_id=10134&page=66.

Country-specific references and sources

Australia

Environmental Protection Authority, 2006. Environmental Offsets: Position Statement No. 9. Available at: http://edit.epa.wa.gov.au/EPADocLib/1863_PS9.pdf.

Environmental Protection Authority, 2008. Guidance for the Assessment of Environmental Factors (in Accordance with the Environmental Protection Act 1986): Environmental Offsets—Biodiversity, No. 19. Available at: http://www.epa.wa.gov.au/docs/2783_GS19OffsetsBiodiv18808.pdf.

Kingborough Biodiversity Offset Policy, Policy Number 6.10, 2010. Available at: http://www.kingborough.tas.gov.au/webdata/resources/files/Biodiversity_Offset_Policy.pdf.

Queensland Government Department of Environment & Resource Management, 2011. Policy for Vegetation Management Offsets, Version 3. Available at: http://www.derm.qld.gov.au/environmental_management/environmental-offsets/pdf/policy-for-vegetation-management-offsets.pdf.

Queensland Government Environmental Protection Agency, 2008. Queensland Government Environmental Offsets Policy. Available at: http://www.derm.qld.gov.au/register/p02501aa.pdf.

Burkina Faso

Desire, Y.N. 2007. Étude d'impacts environnemental et social du projet aurifère de Inata, Burkina Faso. Fiche Technique MOGED. Institut de L'Énergie et de L'Environnement de la Francophonie. Available at: http://www.polymtl.ca/pub/sites/eie/docs/documents/304_Fi_Inata_Burkina_Faso.pdf.

Le President du Faso, 2001. Décret nº 2001-342/PRES/PM/MEE portant champ d'application, contenu et procédure de l'étude et de la notice d'impact sur l'environnement. Available at: http://www.ecolex.org/ecolex/ledge/view/RecordDetails;DIDPFDSIjsessionid=4925026C2A933BDEDB43ADE957B6AB18?id=LEXFAOC030790&index=documents.

Canada

Government of Canada, 1991. The Federal Policy on Wetland Conservation. Available at: http://publications.gc.ca/collections/Collection/CW66-116-1991E.pdf.

New Brunswick Natural Resources and Energy & New Brunswick Environmental and Local Government, 2002. New Brunswick Wetlands Conservation Policy. Available at: http://www2.gnb.ca/content/dam/gnb/Departments/nr-rn/pdf/Wetlands-TerresHumides.pdf.

Rubec, C.D.A. & Hanson, A.R. 2009. Wetland mitigation and compensation: Canadian experience. Wetlands Ecology & Management 17: 3–9. Available at: http://www.springerlink.com/content/l0r839236g2lw114/fulltext.pdf.

Wildlife Conservation Branch, Canadian Wildlife Service, Environment Canada, 1996. The Federal Policy on Wetland Conservation: Implementation Guide for Federal Land Managers. Available at: http://www.ec.gc.ca/Publications/6AD07CA9-1DDD-4201-ACCF-B18E-41FCB350/FederalPolicyonWetlandConservationImplementationGuide1996.pdf.

China

Advisory Council on the Environment (ACE), 2008. Nature Conservation in the Deep Bay Area. Report of the Nature Conservation Subcommittee. ACE Paper 22/2008, Hong Kong (on file with Ramsar Secretariat).

Bennett, T. M. 2009. Markets for Ecosystem Services in China: an Exploration of China's "Eco-Compensation" and Other Market-based Environmental Policies. Forest Trends. Available at: http://www.forest-trends.org/documents/files/doc_2317.pdf.

Colombia

Alcalde Mayor de Bogota, 2006. Decreto 062 del 14 de marzo del 2006, Por medio del cual se establecen mecanismos, lineamientos y directrices para la elaboración y ejecución de los respectivos Planes de Manejo Ambiental para los humedales ubicados dentro del perímetro urbano del Distrito Capital. Available at: http://www.alcaldiabogota.gov.co/sisjur/normas/Norma1.jsp?i=19659.

Ministerio de Ambiente, Vivienda y Desarrollo Territorial, 2006. Resolución No. 196 del 01 de febrero del 2006, Por la cual se adopta la guía técnica para la formulación de planes de manejo para humedales en Colombia. Available at: http://www.minambiente.gov.

co/Puerta/destacado/vivienda/gestion_ds_municipal/RESOLUCIONES/RL019606.pdf.

Ministerio del Medio Ambiente,1995. Resolución No. 1602, Por medio de la cual se dictan medidas para garantizar la sostenibilidad de los manglares en Colombia (on file with Ramsar Secretariat).

Costa Rica

Asamblea Legislativa de la República de Costa Rica, 1998. Ley de Biodiversidad N° 7788 del 23 abril de 1998. Available at: http://www.wipo.int/wipolex/en/details.jsp?id=896.

Presidente de la República, 2004. Reglamento General sobre los Procedimientos de Evaluación de Impacto Ambiental (EIA). Decreto Nº 31849-MINAE-S-MOPT-MAG-MEIC del 24 de mayo del 2004. Available at: http://www.ecolex.org/ecolex/ledge/view/RecordDetails;DIDPFDSIjsessionid=E52679ED87FF97CD4DEF50F508FD3422?id=LEX-FAOC077492&index=documents.

Egypt

Egyptian Environmental Affairs Agency, 2009. Guidelines of Principles and Procedures for Environmental Impact Assessment. Ministry of State for the Environment. Available at: http://www.eeaa.gov.eg/arabic/main/guides/English_EIA_guidelines.pdf.

El Salvador

Asamblea Legislativa de la República de El Salvador, 1998. Ley de Medio Ambiente del 04 de Mayo de 1998. Available at: http://www.oas.org/dsd/fida/laws/legislation/el_salvador/el_salvador_233.pdf.

European Union

Directive 2000/60/EC, of the European Parliament and of the Council of 23 October 2000 Establishing a Framework for Community Action in the Field of Water Policy, 2000. O.J. (L 327) (Water Framework Directive). Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:327:0001:0072:EN:PDF.

European Commission, 2000. Managing Natura 2000 Sites: The Provisions of Article 6 of the 'Habitats' Directive 92/43/EEC. Available at: http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/provision_of_art6_en.pdf.

European Commission, 2001. Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites: Methodological Guidance on the Provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC. Available at: http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/natura_2000_assess_en.pdf.

European Commission, 2011. Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Subcommittee of the Regions. COM (2011) 244 final. Available at: http://ec.europa.eu/environment/nature/biodiversity/comm2006/pdf/2020/1_EN_ACT_part1_v7%5b1%5d.pdf.

Fiji

Environment Management Act, 2005. Available at: http://www.paclii.org/fj/legis/num_act/ema2005242/.

Ghana

Ghana Environmental Protection Agency, 1999. Environmental Assessment Regulations. Available at: http://www.epa.gov.gh/ghanalex/acts/Acts/ENVIRONMENTAL%20ASSESSMENT%20REGULATION,1999.pdf.

Ghana Environmental Protection Agency,2004. Strategic Environmental Assessment (SEA) Manual. Available at: http://www.epa.gov.gh/index.php?option=com_docman&task=cat_view&gid=109&Itemid=116.

India

Ministry of Environment and Forests, 1992. Notification I, S.O. 85(E) of 29 January, 1992. Environmental Impact Assessment Notifications. Available at: http://www.ceeraindia.org/documents/lib_c3s2_EIAnoti_160300.htm#Notification%20I.

Japan

Ministry of the Environment, 1997. Environmental Impact Assessment. Law No. 81 of 1997. Government of Japan. Available at: http://www.env.go.jp/en/laws/policy/assess/index.html.

Tanaka, A. 2008. How to assess "no net loss" of habitats–A case study of Habitat Evaluation Procedure in Japan's Environmental Impact Assessment. Available at: http://www.yc.tcu.ac.jp/~tanaka-semi2/pdf/tanaka/tanaka2008_152.pdf.

The Third National Biodiversity Strategy of Japan, 2007. Available at: http://www.env.go.jp/en/focus/attach/071210-e.pdf.

Malaysia

State of Sabah, 2002. Environment Protection Enactment No. 12 of 2002. Available at: http://www.sabah.gov.my/jpas/laws/EPE/EPE02.pdf.

México

Cámara de Diputados del H. Congreso de los Estados Unidos Méxicanos, 2011. Ley General del Equilibrio Ecológico y la Protección al Ambiente del 28 de enero de 1988. Available at: http://www.diputados.gob.mx/LeyesBiblio/pdf/148.pdf.

Mongolia

Environmental Protection Law of Mongolia, 1995. Available at: http://www.investmongolia.com/law12.pdf.

Law of Mongolia on Environmental Impact Assessment, 2001. Available at: http://www.unece.org/env/eia/documents/WG13_may2010/Mongolia_Law_on_EIA.pdf.

Namibia

Ministry of Mines and Energy (MME), 2010. Strategic Environmental Assessment for the Central Namib Uranium Rush. Main Report. MME, Windhoek. Available at: http://www.saiea.com/uranium/index.html.

Parliament of the Republic of Namibia, 2007. Environmental Management Act No. 7 of 2007. Available at: http://www.met.gov.na/Documents/Enivronmental%20Management%20Act.pdf.

New Zealand

Department of Conservation, 2010. Biodiversity Offsets Programme. Available at: http://www.doc.govt.nz/upload/documents/conservation/biodiversity-offsets-programme.pdf.

Department of Conservation, 2011. Biodiversity Offsets Programme Update. Available at: http://www.doc.govt.nz/upload/documents/conservation/biodiversity-offsets-factsheet.pdf.

Resource Management Act, 1991. Available at: http://www.legislation.govt.nz/act/public/1991/0069/latest/DLM230265.html.

Peru

Ministerio del Medio Ambiente, 2001. Ley del Sistema Nacional de Evaluación del Impacto Ambiental Nº 27446. Available at: http://www.oefa.gob.pe/documentos/marcojuridico/MJ004_L27446.pdf.

Russia

Russian Federation Council, 2006. Water Code of the Russian Federation of 26 May, 2006. No. 74-FZ . Available at: http://www.cabri-volga.org/DOC/PolicyRoundtable/WaterCodeOfRF-UnofficialEnglishTranslation.pdf.

Serbia

Law on Environmental Impact Assessment, 2004 Law No. 135/2004. Available at: http://nfp-cs.eionet.eu.int/fol785273/fol965125/fol318371/EIA_LAW.pdf.

South Africa

Department of Environmental Affairs and Tourism, 2009. National Biodiversity Framework. Available at: http://www.greengazette.co.za/pages/national-gazette-32474-of-03-aug-2009-vol-530_20090803-GGN-32474-002.

KwaZulu-Natal Province, 2010. Concise Guideline for Biodiversity Offsets. Final Draft (on file with Ramsar Secretariat).

National Environmental Management Act, 1998. Act No. 107 of 1998. Available at: http://www.environment.gov.za/polleg/legislation/natenvmgmtact/natenvmgmtact.htm.

Trinidad and Tobago

Minister of the Environment of the Republic of Trinidad and Tobago, 2001. The Certificate of Environmental Clearance Rules. Legal Notice No. 104 of 2001. Available at: http://www.ema.co.tt/cms/images/stories/pdf/104-certiticate%20of%20environmental%20clearance%20rules.pdf.

Uganda

Ministry of Natural Resources, 1995. National Policy for the Conservation and Management of Wetland Resources. Available at: http://www.ramsar.org/cda/en/ramsar-documents-wurl-policies-national-wetland-21174/main/ramsar/1-31-116-162^21174_4000_0__.

National Environment Management Authority, 2000. The National Environmental (Wetlands, River Banks and Lake Shores Management) Regulations. No. 3/2000. Available at: http://www.nemaug.org/regulations/wetlands_riverbanks.pdf.

Uruguay

El Senado y la Cámara de Representantes de la República Orinetal del Uruguay, 2000. Ley General de Protec-

ción del Medio Ambiente. Ley Nº 17.283. Available at: http://www0.parlamento.gub.uy/leyes/AccesoTextoLey.asp?Ley=17283&Anchor=.

USA

Federal Water Pollution Control Act (Clean Water Act) of 1972 (as amended). 33 U.S.C. § 1344. Available at: http://www.epa.gov/lawsregs/laws/cwa.html.

U.S. Environmental Protection Agency, 2008. Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material. 40 C.F.R. § 230. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2011-title40-vol25/pdf/CFR-2011-title40-vol25-part230.pdf.

Venezuela

Asamblea Nacional de la República Bolivariana de Venezuela, 2008. Ley de Gestión de la Diversidad Biológica. Available at: http://www.ecolex.org/ecolex/ledge/view/RecordDetails;DIDPFDSIjsessionid=9911A95564026D385DFD%20A8993171CDE8?id=LEXFAOC089953&index=documents.

Normas Para la Protección de los Manglares y sus Espacios Asociados, 1991. Decreto Nº 1843. Available at: http://www.pnuma.org/deramb/actividades/gobernanza/cd/Biblioteca/Gobernanza%20Ambiental/normativa%20venezolana/D.P.manglares.pdf.

Vietnam

Minister of Natural Resources and Environment, 2011. Decree No. 29/2011/ND-CP of April 18 2011, providing strategic environmental assessment, environmental impact assessment and environmental protection commitment. Available at: http://faolex.fao.org/docs/pdf/vie107003.pdf.

Briefing Notes series

This series is prepared by the Ramsar Convention's Scientific and Technical Review Panel (STRP) in order to share relevant, credible and interesting scientific and technical information on wetlands with a broad audience. Briefing Notes are reviewed internally by STRP members and a small internal editorial panel, comprised of the STRP Chair and the responsible Thematic Work Area lead or task lead, assisted by the Convention's Deputy Secretary General.

Briefing Notes are published by the Ramsar Convention Secretariat in English in electronic (PDF) format. When resources permit, they will be published in French and Spanish as well (the other official languages of the Ramsar Convention) and in printed form.

A full list of current Briefing Notes can be found at www.ramsar.org/BN. Information about the STRP can be found at: www.ramsar.org/STRP-main/. For more information about Briefing Notes or to request information on how to correspond with their authors, please contact the Ramsar Secretariat at strp@ramsar.org.

Authors: Prof. Royal C. Gardner, STRP Invited Expert 2009-2012 and Director, Institute for Biodiversity Law and Policy, Stetson University College of Law, USA (GARDNER@law.stetson.edu); Marcela Bonells, J.D. Candidate, Stetson University College of Law; Erin Okuno, J.D. Candidate, Stetson University College of Law; Juan Manuel Zarama, LL.M. Candidate, Stetson University College of Law.

Citation: Gardner, R. C., Bonells, M., Okuno, E., Zarama, J. M. 2012. *Avoiding, mitigating, and compensating for loss and degradation of wetlands in national laws and policies.* Ramsar Scientific and Technical Briefing Note no. 3. Gland, Switzerland: Ramsar Convention Secretariat.

The Convention on Wetlands (Ramsar, Iran, 1971) – called the Ramsar Convention – is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance and to plan for the "wise use", or sustainable use, of all of the wetlands in their territories.

Ramsar Convention Secretariat
Rue Mauverney 28
CH-1196 Gland, Switzerland
Tel.: +41 22 999 0170
Fax: +41 22 999 0169
E-Mail: ramsar@ramsar.org
Website: www.ramsar.org

STRP
Scientific and Technical Review Panel

Briefing Note

Number 4, May 2012

Ramsar Convention on Wetlands

The benefits of wetland restoration

The primary objective of this Briefing Note is to raise awareness, across all sectors, of the potential benefits of wetland restoration. Its intention is to catalyse efforts that stem the loss and degradation of wetlands, enhance ecosystem functioning, and thus increase wetland benefits. By highlighting the linkages with existing Ramsar documentation, this Briefing Note expands upon the existing guidance on wetland restoration while referencing other examples of publicly available documents in the last section.

Key Messages

Stop the global loss of wetlands

The world's wetlands continue to be lost and degraded at an alarming rate as a result of human activities. Consequently, the essential benefits provided by wetlands to people continue to be seriously eroded. These benefits, derived from wetland ecosystem services, are unique, varied and extend across many sectors, but their contribution and value is not always fully captured in wetland management decision-making. A better understanding of wetland benefits is required in order to make the case for halting further loss and degradation, and to support activities that assist in the recovery of their biodiversity and ecosystem functioning.

Prioritize the protection and restoration of wetlands

Removing the stressors or pressures on the ecological character of wetlands is the best practice for preventing further loss and degradation; when this is not feasible, however, or when degradation has already occurred, wetland restoration must be considered as a potential response option. The commitments and obligations under the Ramsar Convention clearly mandate wise use and the avoidance of wetland loss and degradation in the first instance. The Convention has also provided national governments and others with a framework on how to avoid, mitigate and compensate for wetland loss and degradation which includes opportunities for wetland restoration.

Understand the appropriate role for wetland restoration

Restoration is not a substitute for protecting and ensuring the wise use of wetlands, i.e., the potential to restore a wetland is not a justification or suitable trade-off for the continued degradation of wetlands. Furthermore, while restoration can play an important role in enhancing wetland benefits, experience shows that a "restored" wetland rarely provides the full range and magnitude of services delivered by a wetland that has not been degraded.

Encourage holistic wetland restoration objectives

In the past, some wetland restoration efforts have failed due to, among other things, narrow objectives which focus on one benefit or a partial suite of ben-

Download PDF at www.ramsar.org/bn/bn4.pdf

Purpose of this BN

This Briefing Note provides advice on how to prioritize and implement the adopted Ramsar principles and guidelines on wetland restoration (Annex 1). It also advises on the relevance of other guidance to assist the following audiences in restoring wetlands:

- Ramsar National Focal Points; national, subnational and local policy-makers; legislators and regulators; administrators; planning and implementing bodies involved in restoration of degraded wetlands; and
- Practitioners implementing wetland restoration activities on the ground, including inter alia wetland managers, NGOs, communities, corporations, and local/state/provincial councils and administrative units.

Authors

Sasha Alexander, STRP Representative of the Society for Ecological Restoration

Robert McInnes, STRP Representative of the Society of Wetland Scientists

efits. The inability to recognize or appreciate the potential for achieving multiple benefits across sectors has, in some cases, precluded cost-effective, participatory approaches to wetland restoration that may be more successful in recovering benefits and delivering more sustainable outcomes for people and the environment.

Recognize the full suite of wetland restoration benefits **Decision-makers are urged to take immediate and appropriate measures to recognize the full suite of environmental, cultural and socio-economic benefits from wetland restoration.** For example, in the tropics, mangroves and peat swamp forests play a critical role in carbon storage and climate regulation. The failure to recognize these multiple benefits often greatly undermines the rationale for wetland restoration and compromises future well-being.

The importance of wetland ecosystem services

Introduction

The Ramsar Convention defines wetlands as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres" (Article 1.1). The Convention also recognizes the interdependence of humans and wetlands and the irreplaceable resources they provide to society.

In all of their myriad forms, wetlands are collections of plants, animals and micro-organisms (biotic components) that interact with the non-living environment (abiotic components) and exist within and form an integral part of the larger landscape, i.e., watersheds, catchments and river basins. It is the unique range of hydrological conditions of wetlands which determines its biodiversity and ecosystem functioning. Due to their inherent diversity, wetlands are highly productive systems that play a fundamental and disproportionate role in providing a multitude of ecosystem services that sustain all life on the planet, regardless of the particular landscape in which they are found.

Wetlands perform many functions on local, regional and global scales – from providing wildlife habitat and basic necessities for humans to regulating atmospheric processes and geochemical cycles. While these benefits are not always obvious or measurable, they are nevertheless critical. Different wetlands provide a range of valuable services according to their type, size and location. The influential Millennium Ecosystem Assessment recognizes the enormous global economic importance of wetlands, valued at up to US$15 trillion dollars in 1997 (MA, 2005). Our increased understanding of the importance of wetland services has led to a greater appreciation of their value. The legal and/or cultural protection of wetlands by many societies and governments is an explicit recognition of the benefits they provide, although these measures have not, in many places, proven sufficient to stem the extent and rate of wetland loss and degradation.

Some wetland ecosystem services have direct market values or quantifiable benefits to specific sectors or stakeholders, such as the cost of water for agricultural production, or the value of fish to fisherfolk. Most wetland ecosystem services, however, such as water filtration and wildlife habitat, indirectly benefit society at large and are therefore classified as public or non-market benefits. The difficulty of assessing and quantifying these indirect benefits means that they are often given low priority within the competing demands for wetland services. In planning for the wise use of wetlands, governments and wetland managers must protect and restore these public benefits and work to ensure their equitable distribution. The non-competitive nature of these indirect or public benefits also provides a large

Background

Resolution X.10 *Future implementation of scientific and technical aspects of the Convention*, Annex II, requested the Scientific and Technical Review Panel (STRP) to undertake two tasks under Thematic Work Area (TWA): Wetland Management – Restoration, Mitigation and Compensation. Task 9.2 specifically requested the STRP to:

> Prepare proposals for updating and expanding existing Ramsar guidance on restoration and rehabilitation of lost or degraded wetlands, in the context of Resolution X.16 on *A Framework for processes of detecting, reporting and responding to change in ecological character*, including approaches to prioritization and links with other Ramsar tools and guidance, *inter alia,* those on climate change and on economic values of ecosystem services.

The initial phases of this review work were undertaken during 2009-2011 by the STRP, and its findings and recommendations are provided in a "Summary Report on Activities 2009-2012". Amongst the recommendations presented in that report was a proposal to prepare an STRP Briefing Note on wetland restoration prior to Ramsar COP11 in July 2012.

number of stakeholders with a powerful rationale to protect and restore wetlands.

Wetland loss and degradation

When wetlands are degraded, the broad range of benefits they produce begins to deteriorate and eventually vanish. In some cases, degradation occurs because one particular benefit is valued above all others, such as water supply for irrigation in agricultural production systems. Wetland degradation is defined as the alteration of an existing or intact wetland resulting in a simplification or disruption in its structure, function and composition and, in turn, a loss of biodiversity and ecosystem services. This is most often caused by human activities or disturbances that are too frequent or severe to allow for natural recovery. Not only have population pressures and other human-induced stressors resulted in the degradation of wetlands across the globe, but the effects of climate change (e.g., sea level rise, temperature increases, changes in flood and drought patterns) are also increasingly impacting the quality and flow of wetland services. The continued loss and degradation of wetlands will result in a further reduction in benefits and thus negatively impact human health and well-being into the future, particularly for the poor and disenfranchised who often depend disproportionately on these public goods and services.

The benefits of restoring degraded wetlands

The Ramsar Convention defines restoration in its broadest sense, including activities that promote a return to previous conditions as well as those that improve the functioning of a wetland without necessarily seeking to return it to its pre-disturbance condition (Ramsar HB19[1]). This notion of restoration proceeds from the widely-cited definition of ecological restoration as "the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed" (SER, 2004). The attributes of successful wetland restoration activities include: 1) the utilization of native wetland species in characteristic assemblages and functional groups, 2) self-sustaining and resilient wetland ecosystems integrated within the larger landscape, and 3) the reduction or elimination of the drivers of wetland degradation (SER, 2004). In 2002, the Ramsar Convention adopted principles and guidelines for wetland restora-

1 Reference to the Ramsar Wise Use Handbooks in this Briefing Note adopts the shorthand of "Ramsar HB[Number of the Handbook]". All references are to the 4th edition of the Handbooks. The Handbooks are available for download in PDF format at www.ramsar.org/handbooks4.

Wetland biodiversity and ecosystem functioning

Biodiversity underpins ecosystem functioning which, in turn, produces "services". These ecosystem services are defined as the benefits that people obtain from ecosystems (MA, 2005) and they include **provisioning services** (e.g., food, fibre, fuel, water); r**egulating services** (e.g., climate, floods, disease, waste and water quality); **cultural services** (e.g., recreation, aesthetic enjoyment, tourism, spiritual and ethical values); and **supporting services** necessary for the production of all other ecosystem services (e.g., soil formation, photosynthesis, nutrient cycling).

A recent meta-analysis indicates that restoration activities that enhance biodiversity are positively correlated with the increased provisioning of ecosystem services (Rey Benayas *et al*. 2009). Figure 1 on page 7 portrays the causal relationship between different socio-economic sectors, wetland restoration activities, biodiversity and ecosystem functioning, and the delivery of benefits. Because the objectives of restoration activities have become increasingly focused on ecosystem services (Bullock *et al*. 2011), it is important to account for the impacts of wetland use on biodiversity and ecosystem functioning. When the drivers of wetland degradation cannot be reduced or eliminated, restoration activities can still play a role in reducing negative impacts and enhancing benefits.

Human health and sustainable livelihoods

The ability of wetlands to filter and supply fresh water is perhaps the single most important service impacting the health of urban, rural and coastal communities around the world. In addition to supplies of fresh water, many communities are dependent in one way or another on the services provided by wetlands for their subsistence and economic livelihoods, further increasing the urgency and importance of restoring degraded wetlands.

Water, food and energy security

Water, food and energy security in many countries are, in large part, dependent on wetland functioning and are necessary conditions for economic development and poverty alleviation. Wetland restoration is one tool to redress the over-exploitation of groundwater and the draining or diversion of surface water, particularly in low-income countries with significant population pressures and susceptibility to desertification, land degradation, and drought (DLDD). Food and energy security are also threatened by the same unsustainable uses and pressures that negatively impact the fisheries, agriculture, water supply and treatment, hydro-electric and transport sectors.

Resilience of socio-ecological systems

Protecting and restoring wetlands should be a critical element in national and global strategies to mitigate and adapt to climate change. Restoring degraded wetlands increases the adaptive capacity of these ecosystems and their dependent communities to absorb and adjust to extreme events and other disturbances, such as floods, droughts, and sea level rise. Wetland restoration activities that enhance resilience are therefore critical to the health and sustainability of socio-ecological systems. However, we must understand the nature of climatic and ecological changes that are likely to occur regionally in order to properly design wetland management and restoration plans at the mega-watershed level (Erwin, 2009).

Eco-cultural restoration of the Mesopotamian Marshes, Iraq

In the 1990s, in the aftermath of the first Gulf War, the government led by Saddam Hussein drained the Mesopotamian Marshes to punish the indigenous tribes, collectively referred to as the Marsh Arabs, for their support of the uprising in the aftermath of the conflict. The Marsh Arabs had been living in and traditionally managing the marsh ecosystem for over 5,000 years, and in this largely arid climate, the marshes were the only source of fresh water for wildlife and human livelihoods. A network of canals was built to divert water from the Euphrates and Tigris Rivers, reducing the marshes to less than 10% of their original size. As a result, the marshes dried or became saline, wildlife populations collapsed, and the Marsh Arabs were forced to leave. Since 2003, a number of NGOs have been working to remove large drainage canals and re-establish water flows to the marshes, and by 2007 approximately 50% of the marshes had been restored. Rare and endangered wildlife gradually returned, as did components of the livelihoods of the Marsh Arabs embodied in their traditional fisheries, gardens and water buffalo, an ecologically and culturally important species. The eco-cultural restoration of the Marsh Arabs in Iraq stills faces significant challenges, including dam construction, recent droughts, and reduced flows that are causing the marshes to dry again. As a result, the wildlife resurgence is under threat and the Marsh Arabs who did return face the prospect of having to leave again. An international framework for basin planning and the equitable allocation of water rights is urgently needed to protect the people and nature of the Mesopotamian Marshes.

Services enhanced: *water supply/recharge, agricultural productivity, livestock management, native biodiversity, cultural identity, carbon sequestration, etc.*
Sectors benefited: a*griculture, water, transport, climate change, livelihoods*, *etc.*

Stevens, M. 2011. Eco-cultural restoration of the Mesopotamian marshes, southern Iraq in *Human Dimensions of Ecological Restoration*. Springer, New York.

tion to assist decision-makers and wetland managers (Ramsar HB19).

Restoring lost or degraded wetlands represents a valuable and cost-effective opportunity for society to recover and enhance benefits for human health and well-being, including reduced risk from storms and other extreme events, improved food and water security, and the capacity to mitigate and adapt to climate change. The restoration of mangroves and near-shore habitats, for example, provides food (fish and invertebrates) and other basic necessities, habitat for birds, reptiles and mammals, carbon sequestration, and climate protection, and it contributes to enhanced socio-economic resilience among coastal communities. The total value of benefits that flow from a restored wetland can often be several times higher than the cost of restoration when added to the value of the benefits lost due to degradation. As nature characteristically provides ecosystem services at a lower cost than human-made systems, wetland restoration can be a cost-effective, long-term strategy for achieving conservation and development objectives simultaneously.

Although restoration can clearly play an important role in enhancing existing and recovering lost benefits, experience shows that a "restored" wetland rarely provides the full range and magnitude of services delivered by a wetland that has not been degraded (Moreno-Mateos *et al*. 2012). Thus, the first priority should be to conserve and sustainably use wetlands rather than allow for their continued degradation. Regrettably, given the current state of loss and degradation, conservation alone is not sufficient to protect and enhance these wetland benefits. Restoration has now become a necessary wetland management tool in many countries to ensure a desirable and sustainable future.

Wetland restoration benefits multiple sectors

Wetlands have the potential to provide long-term benefits to multiple sectors concurrently, such as agriculture, fisheries, water, forestry, health, energy, extractive industries, recreation, transport, education, development, and indigenous and local communities. The relative importance given to various wetland benefits derived from restoration activities will depend to some extent on the degree of information available to decision-makers and wetland managers. When considering wetland restoration opportunities, an adequate evidence base is needed to demonstrate and communicate the full suite of benefits and their relevance across sectors.

Here, sectors are defined as discrete subdivisions within a socio-economic system such as private landowners and corporations, local, regional or national authorities, and components of civil society, including NGOs and indigenous and local communities. In the past, many wetland restoration projects and programmes have been driven by the nature conservation sector or the environment departments in governments, which often had

Mangrove restoration: Vietnam and the Philippines

Mangrove restoration in Vietnam and the Philippines has been ongoing for over 20 years. These efforts are described as "ecosystem-based" and "community-based" approaches to deal with the uncertainty surrounding anticipated climate change, associated sea level rise, and coastal erosion. Mangrove ecosystems protect communities and coastal habitats from storms and typhoons, efficiently store carbon, and play a critical role in maintaining fisheries which provide for economic livelihoods.

In Vietnam, an estimated 50,000 hectares of monoculture plantations of primarily *Rhizophora stylosa, Kandelia candel*, and *Sonneratia caseolaris* were planted from 1994 to 2006. Where successful, primarily in the north, benefits for coastal protection and fisheries have been significant. Although the overall project costs were estimated at US$1.1 million, the investment has saved US$7.3 million per year in dyke maintenance. It is estimated that some 7,750 families have benefited from mangrove restoration, including income generation, reduced vulnerabilities and improved nutrition from restored fish populations. However, the net increase in the total area of mangroves over this same time period was only 15,000 ha, which was probably due to encroachment into existing mangroves. In the Philippines, similar attempts at monoculture plantations of *Rhizophora spp*. on 40,000 ha of mudflats cost US$17.6 million but with only limited success. Both of these examples illustrate that successful restoration can benefit local coastal communities with payments for plantings and increased incomes from improved fisheries, but large-scale failures are common. Ecological Mangrove Restoration is one approach that recommends a careful evaluation of existing topographic and hydrologic conditions prior to site selection as well as practitioner and volunteer training before implementation.

Services enhanced: *food/nutrition, fish/invertebrate habitat, climate protection, native biodiversity, carbon sequestration, etc.*
Sectors benefited: *fisheries, water, climate change, human health, livelihoods, etc.*

Lewis, R. R. 2009. Methods and criteria for successful mangrove forest restoration. Chapter 28, pp. 787-800 in G.M.E. Perillo, E. Wolanski, D. R. Cahoon, and M.M. Brinson (eds.) *Coastal Wetlands: An Integrated Ecosystem Approach*. Elsevier Press.

Powell, N., M. Osbeck, S.B. Tan, and V.C. Toan. 2010. *Mangrove restoration and rehabilitation for climate change adaption in Vietnam*. World Resources Report Case Study.

Samson, M.S. and R.N. Rollon. 2008. Growth performance of planted mangroves in the Philippines: revisiting forest management strategies. *Ambio* 37:234-240.

Two year old mangrove restoration site through low-cost manual removal of dikes by the local fisherman and their families on the island of Tanakeke, Sulawesi, Indonesia (© R. Lewis)

the singular objective of recovering wildlife habitat. In order to gain support from multiple sectors with diverse interests in wetland restoration, stakeholders must be made aware of all the possible environmental, cultural and socio-economic benefits and given the opportunity to participate in planning and implementation.

Community and grass-roots participation in wetland restoration activities often contribute to their long-term success by educating local communities and focusing attention on the causes of degradation, as well as by creating employment and a more equitable distribution of benefits. However, care must be taken to properly train community volunteers and provide appropriate guidance from experienced managers and restoration professionals. Similarly, the use of indigenous or traditional knowledge can contribute to the long-term success of restoration activities by providing critical insights into historical conditions that may improve the design and implementation of wetland restoration projects and programmes. These are essential components of the participatory approach advocated by the Ramsar Convention (Ramsar HB7).

Wetland restoration activities that optimize for a narrow range of ecosystem services and result in trade-offs in the delivery of competing services often preclude the provision of an equitable suite of benefits. For example, wetland restoration projects or programmes that exclusively target improvements in water quality and flow for the urban or agricultural sectors may neglect wildlife habitat, sedimentation, and nutrient cycling that support a wide variety of other services. In order to ensure greater equity and the long-term sustainability of wet-

The Working for Water Programme, South Africa

In the mid-1990s, South Africa initiated a national ecosystem restoration programme, modelled on Payments for Ecosystem Services. It is a replicable prototype for many developing countries and perhaps industrialised countries as well. Using restoration to address development issues as well as conservation objectives, the government-funded Working for Water (WfW) programme employs tens of thousands of people to clear mountain catchments and riparian zones of harmful alien invasive plants in order to restore natural fire regimes, hydrological functioning, native biodiversity, and the productive potential of the land. As the benefits of restoring hydrological processes have become more and more apparent, water utilities and municipalities are now contracting WfW to restore entire catchments in order to improve their water supplies. Despite some shortcomings, the WfW programme provides many valuable lessons for overcoming the conflicts that can arise when addressing complex economic, ecological and social issues.

Services enhanced: *water supply/recharge, agricultural productivity, livestock management, native biodiversity, carbon sequestration, etc.*

Se**ctors benefited:** a*griculture, water, climate change, livelihoods*, *etc.*

Turpie, J.K. *et al*. 2008. The working for water programme, South Africa. *Ecological Economics* 65: 788 –798

Participatory approaches and stakeholders

Involvement of local and indigenous people in wetland restoration falls within the general resource management approach known as *participatory management.* Terms such as collaborative, joint, community-based or co-management are more or less synonymous in this context. *Stakeholders* are taken to be bearers of separate interests and/or contributions for the management of a wetland, with a particular focus on *interest groups* within local and indigenous communities. The government agencies responsible for wetland management and local authorities may also be considered as stakeholders.

The term *community* as used in the Ramsar Handbooks can be understood at two levels. On one level it represents a more or less homogeneous group that is most often defined by geographical location (e.g., a village), but possibly by ethnicity. At this level, the community may have very distinct interests compared with other major stakeholders (e.g., government agencies, businesses and NGOs). On another level, it represents a *collection* of different interest groups such as women and men, young and old, fisherfolk and farmers, wealthy and poor people, and different ethnic groups. Even in relatively unified communities, it is likely that these subgroups have different interests and perspectives that need to be taken into account in the participatory management process and specifically in setting targets for wetland restoration.

Ramsar Convention Secretariat, 2010. *Participatory skills: Establishing and strengthening local communities' and indigenous people's participation in the management of wetlands.* Ramsar handbooks for the wise use of wetlands, 4th Edition, vol. 7. Ramsar Convention Secretariat, Gland, Switzerland.

land restoration outcomes, an Ecosystem Approach is often best suited to effectively manage the design and implementation of restoration activities as well as prioritize the inevitable trade-off in benefits.

The Ecosystem Approach is a strategy for the integrated management of land, water, and biological resources that promotes conservation and sustainable use in an equitable way (Finlayson *et al.* 2011). The Ramsar Convention's concept of wise use is perhaps the oldest example of the Ecosystem Approach among the intergovernmental processes concerned with the conservation and sustainable development of natural resources. In addition to understanding ecological processes within the context of the larger watershed or river basin, restoration projects and programmes must be designed and implemented with the aim of fostering multisectoral cooperation and stakeholder participation to allow for the pooling or leveraging of knowledge and resources, the resolution of long-term governance issues, and equitable socio-economic development. Under these circumstances, wetland restoration can be a "win-win" proposition that, with limited resources, enhances the quality of life for both people and nature (Figure 1).

The CBD's Ecosystem Approach outlines twelve principles, two of which are particularly relevant to wetland restoration considerations (CBD, 2004). Principle 1 recognizes that sectors often have different economic, cultural and societal needs which determine the benefits they seek from wetland restoration activities. It therefore encourages communication and collaboration among different sectors in order to establish common ground, determine the types of activities to be undertaken, and equitably manage the trade-offs between multiple benefits. Principle 3 encourages sectors and stakeholders to consider the impacts of wetland restoration activities on other ecosystems and in the context of the wider landscape.

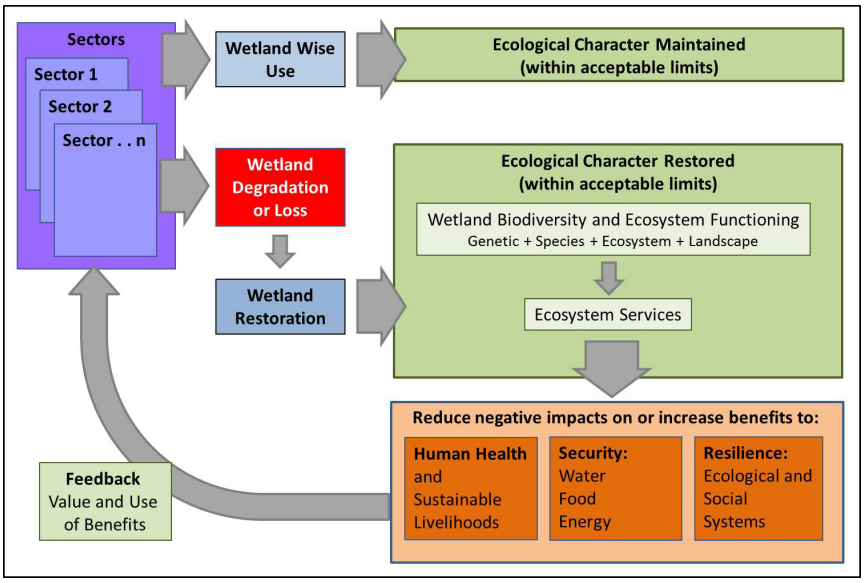


Figure 1: Relationship between sectoral use of wetlands and the delivery of benefits (modified from TEEB 2010).

Wetland functioning and benefits in the wider landscape

Whenever possible, wetland restoration planning and design should be conducted at the river basin, watershed or catchment level. A multi-scale approach, both spatial and temporal, to wetland restoration that fully accounts for connectivity within the larger landscape is best suited to enhance biodiversity and ecosystem functioning over the long term and deliver multiple benefits. Since wetlands connect terrestrial (upland), tidal and marine environments, these linkages must be strengthened so as to optimize wetland functioning while avoiding negative impacts on adjacent ecosystems, both aquatic and terrestrial.

Wetland restoration activities that focus on re-establishing a specific hydrologic regime must consider how this might alter the hydrology and functioning of adjacent ecosystems. Restoration outcomes or benefits may not always be favourable to or desired by the surrounding communities. Thus, the enhancement of benefits from wetland restoration must be considered at the landscape or regional scale. For example, diverting water from a river to restore a wetland might reduce the flow of freshwater to an estuary and affect salt-sensitive fish species which, in turn, could negatively impact the livelihoods of fisherfolk. However, the lack of detailed scientific data at larger landscape scales should not deter the planning and implementation of smaller wetland restoration projects and programmes which still require appropriate site-specific information.

Restoration activities should also strive to maintain the diversity of wetland ecosystems within the landscape so as to protect overall species, habitat and functional diversity while recognizing that the benefits delivered by wetland restoration may accrue at some distance from site-specific activities, such as groundwater recharge or migratory bird habitat. Integrated river basin management (Ramsar HB9) and coastal zone management (Ramsar HB12) strategies recognize that wetland conditions are determined by landscape-scale ecological processes, such as water supply, sedimentation, and geomorphology. These, in turn, are often influenced by socio-economic factors that tend to drive wetland loss and degradation, such as population growth, conversion of wetlands for agriculture, and the felling of forests in upland areas. In order for wetland restoration to be effective and realize multiple benefits, a shared vision and on-the-ground planning and coordination among the relevant public and private stakeholders is critical, and so is an understanding of the ecological history of the proposed restoration site. In doing so, the education, recreation and income-generating benefits of wetland restoration have the potential to reach a broad community of stakeholders.

Prioritizing and making the case for wetland restoration

Restoration in national decision-making

Wetland restoration is needed to counteract the loss and degradation of wetland ecosystems and their benefits in many countries (Acreman *et al*. 2007). The catalysts for initiating wetland restoration activities are present at a number of levels, from obligations under international treaties to local opportunities and community-based initiatives. This Briefing Note does not present a prioritization framework. Rather it highlights the circumstances under which wetland restoration should be considered and provides recommendations on how wetland restoration can be prioritized by decision-makers. The essential element in prioritizing wetland restoration is to recognize the benefits it can deliver to people. However, the recognition that wetland restoration has relevance across multiple sectors is dependent on a broad understanding and awareness of these opportu-

nities. The need for awareness extends both across and among government departments or socio-economic sectors and vertically within the same departments and sectors. Examples of policy sectors where wetland restoration can play a role include, among others, climate change, economic investment, development planning, housing, sanitation and water resources, food production, transport and education. Governments need to encourage dialogue and leadership across these sectors to ensure that social, economic and environmental benefits are delivered.

Many countries have national policies and laws which explicitly or implicitly call for wetland restoration. Some of these encourage a strategic approach to wetland restoration, such as targeting the restoration of degraded ecosystems in order to deliver on their commitments to achieving the Aichi Biodiversity Targets for 2011-2020, and they are thus embedded in National Biodiversity Strategies and Action Plans (NBSAPs). Similarly, there are a range of international conventions with commitments which, whilst not explicitly referencing restoration, can be delivered by restoring degraded wetlands. For instance, wetland restoration has a role to play in meeting the Millennium Development Goals, especially with regard to the environmental sustainability objectives, and also for achieving the targets under the United Nations Framework Convention on Climate Change by reducing emissions and enhancing carbon stocks in forested wetland ecosystems (Alexander *et al*. 2011).

Under the commitments of the Ramsar Convention, and manifest in National Wetland Policies, a strategic approach should consider prioritizing wetland restoration in order to avoid or mitigate impacts on designated Ramsar Sites or, if degraded, to reinstate their ecological character. Wetland restoration in this context should be carried out within the framework of the overall management of protected areas, the protected area network, and the surrounding land- or seascape. A number of factors can influence decision-making, such as whether restoration is an appropriate intervention, whether it is economically and ecologically feasible, whether it is a relatively high or low priority for the specific site or system, who should be involved, and what the appropriate goals and outcomes might be. An evaluation of information, such as management objectives for the site and relevant local or national policies and legislation, is an obvious starting point. A review of regional and international conservation strategies, goals, programmes and policies could help define the design of a wetland restoration project. For example, national, regional or global action plans associated with issues such as invasive species or climate change adaptation and mitigation may influence the selection of restoration objectives. However, local opportunities and circumstances to restore wetlands will also arise, for instance the restoration of mangroves or salt marshes in order to protect communities and coastal infrastructure from storms.

Whilst precise information on the scale of global and national wetland loss is still limited, wetland inventories and an understanding of the degree of degradation and the level of importance in terms of benefits can be used to establish local or national priorities for restoration. Wetland restoration can deliver a range of benefits to social, economic and environmental sectors that extend beyond the conservation of protected or threatened species. Local or national policies which do not directly or explicitly address biodiversity conservation, such as water resource management or disaster reduction strategies, may assist in prioritizing or highlighting such wetland benefits. Prioritization is only possible if the potential benefits of wetland restoration are first acknowledged by multiple sectors and subsequently integrated across disparate policy areas in order to identify win-win outcomes.

Restored Anne Valley Stream (© Robert J. McInnes)

When both government and non-governmental organizations are considering the prioritization of wetland restoration activities they should consider not just single wetland sites, but multiple wetlands at a variety of scales within the land- or seascape. Any assessment should also consider the feasibility and ecological necessity of restoration activities and their long-term management and sustainability. Feasibility is often dictated by the availability of finite and limited resources. By addressing the priorities from multiple sectors it may

be possible to pool limited resources in order to optimise the scope of wetland restoration and the range, quality and quantity of benefits delivered.

Opportunities for proactive wetland restoration

The following examples illustrate opportunities for wetland restoration that assist in delivering on a range of objectives beyond simply the recovery of biodiversity.

Degraded wetlands

Human activities have left a legacy of contaminated and degraded landscapes across the globe. In many cases, wetlands have been polluted, transformed or infilled. The revitalization and restoration of contaminated landscapes by restoring wetlands can recover ecosystem functioning which provides sustainable habitats, economic use and social benefits, such as educational activities, improvements in water quality, provision of wildlife habitat, and recreational pursuits. In some cases, wetland degradation is so severe that restoring a historical wetland type is not possible, such as the complete loss of organic soils forcing restoration to take place on a mineral substrate. Even in these circumstances, opportunities can still exist to reanimate wetland processes and restore important ecosystem services rather than specific wetland types. Further information on the restoration of degraded land is available here: http://www.cluin.org/download/issues/ecotools/ecological_revitalization_turning_contaminated_properties_into_community_assets.pdf.

W*etlands, water and sanitation*

People's health and well-being are dependent on access to water and sanitation. Currently, a significant portion of the global population lacks basic sanitation. Interventions to improve this access have long been an important part of the development agenda and wetland restoration can play a crucial role as a targeted and sustainable intervention. Finding solutions to water supply and sanitation issues can often be a complex and demanding process, often because wetlands and water supply and sanitation are dealt with by different government departments and separately planned for. This is a missed opportunity for securing sustainable development and ecosystem improvements. Actions should be integrated beyond the normal boundaries of implementation, for instance through river basin plans which value all forms of water supply and wetlands, and seek to find solutions which enhance human well-being and biodiversity in a more holistic manner. For further reading, please see: http://wetlands.org/WatchRead/Currentpublications/tabid/56/mod/1570/articleType/ArticleView/articleId/2467/Default.aspx.

Declining fisheries

Globally, fish are the main source of protein for over a billion people. Two thirds or more of all fish consumed by humans depend upon coastal wetlands, such as mangroves and estuaries; these coastal wetlands are in turn reliant on a range of interdependent inland wetlands, including lakes which connect via rivers and streams to the coast. Whilst 80% of the global fishery production takes place in developing countries, the value of recreational fisheries also has huge economic significance in the developed world. It has been estimated that the overall economic impact of recreational angling in the USA is approximately $116 billion per annum (MA, 2005). Wetland restoration can stem the decline and loss of both commercial and recreational fisheries, thus enhancing both human health and economic well-being. For further reading on sustainable fisheries see ftp://ftp.fao.org/docrep/fao/006/y4773e/y4773e00.pdf.

Declining water resources

Wetlands play a vital role in the protection and delivery of water resources to human populations, including private concerns such as agriculture, mining and industry. The wise use and restoration of wetlands can help secure vital water resources for those uses in the long term and provide wider economic benefits for others. An example from North West England has demonstrated that the restoration of upland peatlands has improved the quantity and quality of water supply to over seven million residents. It has also secured livelihoods for tenant farmers and restored important biodiversity whilst reducing water treatment costs. For further information, see http://corporate.unitedutilities.com/scamp-index.aspx.

Tourism and poverty reduction opportunities

Tourism benefits from wetlands. Tourists like to swim and bathe, canoe, dive or snorkel, watch wildlife, learn about nature or just enjoy attractive scenery. Local and international tourism are often dependent on coastal areas, lakes, rivers, mangroves and other wetland ecosystems. Similarly, in many parts of the world, but especially in the developing world, millions of people rely to a great extent on wetlands for their livelihoods and food security. Experience has shown that where wetlands are degrading, poverty generally increases, escalating pres-

sures on the remaining wetland resources and leading to further wetland degradation and poverty (Kumar *et al*. 2011). By exploring the synergies between wetland restoration outcomes, such as generating tourist revenues and improving local livelihoods, multiple benefits can be realized. For further information on tourism, poverty reduction, and wetland restoration, please see http://www.wetlands.org/WatchRead/Currentpublications/tabid/56/mod/1570/articleType/ArticleView/articleId/1640/Default.aspx.

Achieving sustainable urban drainage

Wetlands can reduce peak urban runoff while providing other benefits such as improved water quality, enhanced biodiversity, and increased recreational opportunities. The restoration of wetlands can reduce or eliminate the need for expensive, hard-engineered systems to deal with flood waters and/or manage the release of untreated water downstream. With careful design of a wetland area, the quality of the stormwater can be improved whilst creating attractive multifunctional open urban areas. Urban dwellers can gain additional social, cultural, and psychological benefits from physical or visual access to restored 'natural' spaces. For information on how wetland restoration can be integrated into sustainable urban drainage, please see http://publications.environment-agency.gov.uk/PDF/GEHO0308BNST-E-E.pdf.

Regulating urban climate

Urbanisation has been shown to increase annual mean air temperatures by at least 1°C when compared to surrounding countryside, reduce solar radiation by 20%, and lower wind speeds by between 10 and 30%. The result is the creation of urban heat islands which can negatively impact both local human health and the global climate. In Bangalore, it has been estimated that between 1973 and 2009 the urban area increased by 632%, and over the past decade air temperatures have increased by between 2 and 2.5°C. During the same period almost 80% of the city's water bodies and wetlands have been lost or severely degraded. The restoration of these degraded ecosystems is advocated as a crucial element in moderating the changing urban climate. The restoration of wetlands within urban areas can help to cool the local climate, reduce urban heat island effects, and provide a range of ancillary benefits to city dwellers. For information on strategies for reducing urban heat islands and understanding the role that wetland restoration can play, see http://www.epa.gov/heatisld/resources/pdf/BasicsCompendium.pdf.

Wetland restoration within the avoid-mitigate-compensate framework

In addition to their commitments under the Ramsar Convention, many governments have adopted some form of an avoid-mitigate-compensate approach to wetland loss and degradation (Ramsar HB19). The default position should be to avoid negative changes in ecological character. However, where an impact is considered unavoidable, wetland restoration can be used to both mitigate and compensate for wetland loss and degradation both in terms of area and function. Figure 2 demonstrates various roles that wetland restoration can play in the avoid-mitigate-compensate framework, including avoiding (Figure 2C), mitigating (Figure 2D) and compensating (Figure 2E) impacts. In summary, the role of wetland restoration in the avoid-mitigate-compensate framework can be described as:

Avoid	Achieved through *ex situ* wetland restoration to avoid *in situ* degradation to a wetland.
Mitigate	Achieved through *ex* or *in situ* restoration to reduce impact on a wetland.
Compensate	Achieved by *ex situ* wetland restoration to compensate for *in situ* loss of a wetland.

Consideration of the benefits of wetland restoration

Wetland restoration has the potential to deliver a range of benefits to multiple stakeholders. Often the largest single barrier to achieving this is the failure at the outset to simply recognize the wide range of benefits that could potentially be delivered. There are a number of other barriers which lead to missed opportunities.

- Institutional and sectoral constructs, and especially planning systems, may generate a 'silo' mentality where decisions are made for the sole benefit of one sector. For instance, a water company may internalise the decision-making process to restore a wetland area to treat or 'polish' wastewater, resulting in a one-dimensional solution. The water treatment required could have been delivered through a similar but modified solution which engaged other stakeholders from outside of the confines of the water company's singular focus to deliver on a wider range of benefits.
- The limitations resulting from institutional constructs are often manifest in the adoption of formulaic solutions as a result of a lack of lateral thinking in the decision-making process. This is the 'busi-

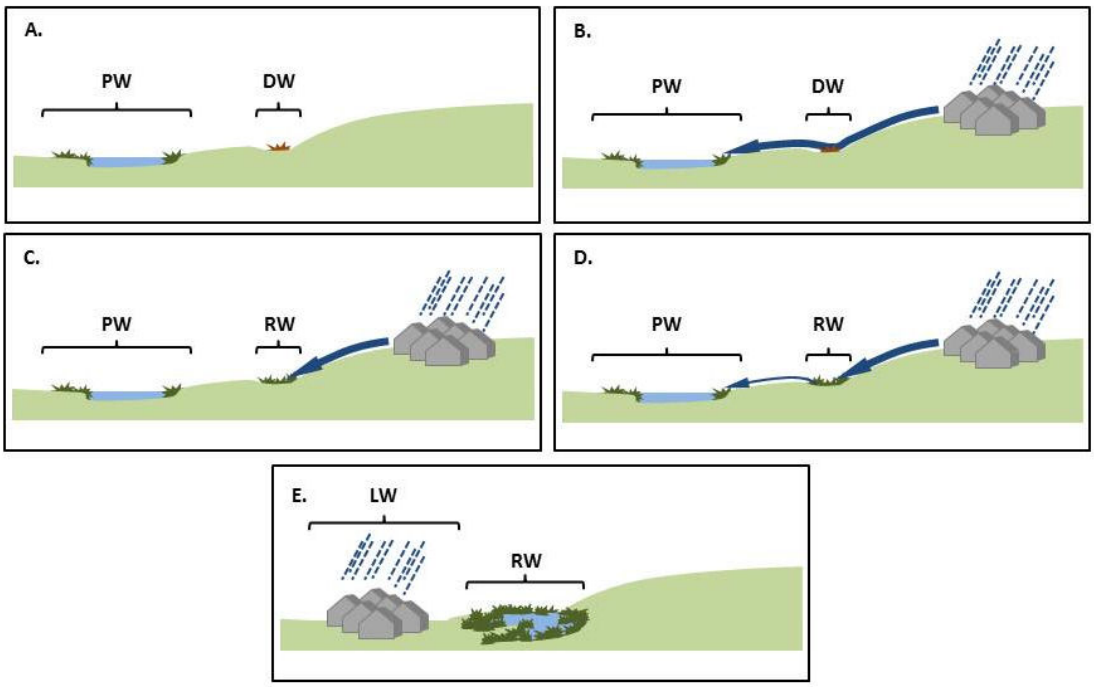


Figure 2. Schematic representation of wetland restoration options for avoiding, mitigating and compensating for wetland loss or degradation. (A) Starting conditions. (B) Development with no avoidance or mitigation of impacts to a protected wetland from polluted surface water run-off. (C) Wetland restoration (with no discharge) to avoid impacts of development on a protected wetland. (D) Wetland restoration (with controlled discharge of appropriate quality and quantity) to mitigate impact of development on a protected wetland - compensation for any residual impact may still be required. (E) Wetland restoration to compensate for the loss of a wetland through development. (Note: PW Protected wetland; DW Degraded wetland; RW Restored wetland; LW Lost wetland).

ness as usual' scenario where yesterday's solution is applied to tomorrow's problem without thinking about novel or innovative solutions. Often this simply stores up problems for the future and fails to apply the latest knowledge available.

- Limited resources, both in terms of expertise and finances, can, perversely, narrow the range of solutions considered rather than broaden the opportunities to engage more widely and consider multiple benefits and stakeholders.
- There may be a lack of understanding of the value of potential but less obvious benefits delivered by wetland restoration or the limitations in approaches to proper benefit valuation.
- There may be a potential or perceived conflict between restoring wetlands to create wildlife habitat, or as areas for protected or threatened species, and the ability of the same wetland to deliver a range of other valuable benefits to people.

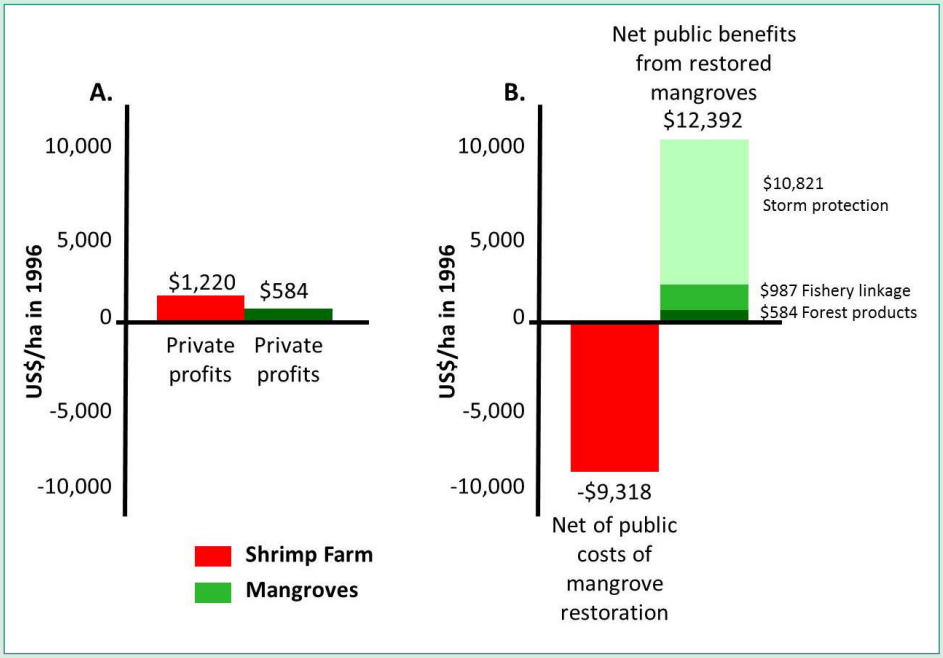
A first step in the decision-making process should be to recognize all the possible benefits that wetland restoration activities could provide. This might include using check lists of benefits (ecosystem services) and it should involve multiple stakeholders in a participatory process. The identification of multiple benefits, spreading across many sectors and stakeholders, can strengthen the economic rationale for wetland restoration projects or programmes as the benefits increase relative to the costs.

Where multiple benefits have been identified and resources are limited, trade-offs must be considered. For instance, the benefits associated with the restoration of wetlands in order to manage flood risk need to be considered against other competing benefits, such as human access and recreation. In any scenario, cross-sectoral approaches will be necessary to resolve possible trade-offs. The key issue is not the method adopted to manage trade-offs but the simple message that trade-offs often exist and will need to be considered early in the wetland restoration planning process.

The cost of restoring a wetland may differ widely according to wetland type, the degree of degradation, the restoration objectives, and the local circumstances. Trade-offs may also arise from changes in the ecosystem services provided before and after restoration. For instance, individual landowners and local communities may receive funding to protect and restore forested wetlands, in order to conserve biodiversity, reduce greenhouse gas emissions, protect soils, and mitigate natural disasters rather than to continue to intensify

Costs and benefits of mangrove restoration and shrimp farms in Thailand

A study from Thailand illustrates the importance of recognizing and capturing the potential value of wetland restoration in order to inform management decisions. Since the tsunami in 2004, there has been considerable interest in restoring mangrove forests on degraded and abandoned coastal ponds for both commercial and non-commercial purposes. Aquaculture can provide both direct and indirect income to local stakeholders. When comparing the monetary benefits associated with different uses, private shrimp farms can generate a return of US$1,220 per hectare, whereas the forest products from the restored mangroves will return only US$584 per hectare (values calculated over a nine year period with a 10% discount rate) (see figure below). This supports a commercial case for shrimp farming as opposed to the restoration of mangrove systems. However, when other ecosystem services are considered, including the important role of mitigating the impacts of storm damage as well as the value of the fishery-habitat linkage, the net benefits of mangrove restoration clearly provide a long-term value which is greater than the costs of restoration.



Services enhanced: *storm protection, food production, fisheries support, climate regulation, carbon sequestration, native biodiversity, etc.*

Sectors benefitted: *fisheries, disaster protection, rural economy, climate change, livelihoods*

Barbier, E. B. 2007. Valuing ecosystem services as productive inputs. *Economic Policy*. Vol. 49, p.178–229.

agricultural practices (often termed *payments for ecosystem services*).

Cost benefit analysis should refer to the appraisal of a project from the perspective of all of society rather than from simply the perspective of those directly involved in project decision-making. This is not always the case, however. All wetland restoration costs and benefits need to be considered in this decision-making process and the failure to capture all the ecosystem services delivered by a wetland restoration project, and the range of beneficiaries and the time-scale over which benefits will accrue, can influence the outcome of even the most rigorous cost benefit analysis. It is well understood that most economies are characterised by market failure, primarily due to the limited availability of market determined prices for many ecosystem services. Whilst there is complexity surrounding the valuation of non-market goods and services and how they are considered in cost benefit analysis, methods exist to incorporate these issues in decision-making. Irrespective of the approach, however, the assumption has been that all the benefits are defined. In the case of wetland restoration, this has often not been the case.

In addition to the failure to recognize the occurrence and value of certain ecosystem services, there are other reasons why wetland values are not taken into account properly or fully in decision-making. These include:

- *market failures* where many wetland benefits are considered *public goods* provided for free by a wetland ecosystem, or so-called *externalities,* when the market does not truly reflect the social costs or benefits of a change in the delivery of an ecosystem service;
- *perverse incentives* where policies or subsidies provide the inducement for economic activity which

Abandoned shrimp aquaculture ponds at Puntondo, Sulawesi, Indonesia (© R. Lewis)

unintentionally impedes wetland restoration or further degrades wetlands;

- *unequal distribution of costs and benefits* where the stakeholders who benefit from the ecosystem service are not the same as the stakeholders who bear the cost of maintaining the benefit; and
- *no clear ownership* or tenure, as indicated by clear boundaries, thus making the allocation of benefits difficult to define.

In the wetland restoration planning process these factors need to be considered carefully to ensure that the full social costs and benefits are accounted for, that future perverse outcomes are not delivered, and that equity of distribution of costs and benefits is understood.

Valuing wetland services

The Ramsar Convention has published technical information on the valuation of wetland ecosystem services (Ramsar Technical Report No. 3 by de Groot *et al*. 2006). A five-stage framework is proposed for conducting an integrated assessment of wetland ecosystem services (Figure 3). The main steps in the guidance are:

- Policy Analysis
- Stakeholder Analysis
- Function Analysis (inventory: identification and quantification of services)
- Valuation of services.
- Communication of the value of wetlands to all stakeholders and decision-makers.

These five steps are also linked to cost benefit analysis, multi-criteria analysis, and participatory approaches. This framework demonstrates the importance of recognizing value before moving on to quantification of the individual and multiple benefits. This construct is also reflected in the approach proposed by The Economics of Ecosystems and Biodiversity (TEEB). The TEEB approach adopts a tiered structure whereby the valuation of biodiversity and ecosystem services is accomplished in a more or less explicit manner according to the site-specific activities under consideration.

TEEB states that the first step is to *identify* and assess the full range of ecosystem services affected by a project or plan and to consider the implications for different sectors and stakeholders. The second step is to *recognize* value, which can then lead to the third which attempts to estimate and *demonstrate* the value of ecosystem services. The fourth step involves *capturing* the value of ecosystem services and, when required, seeking solutions to overcome their undervaluation. Finally, solutions should be sought based on the outcomes generated by this approach.

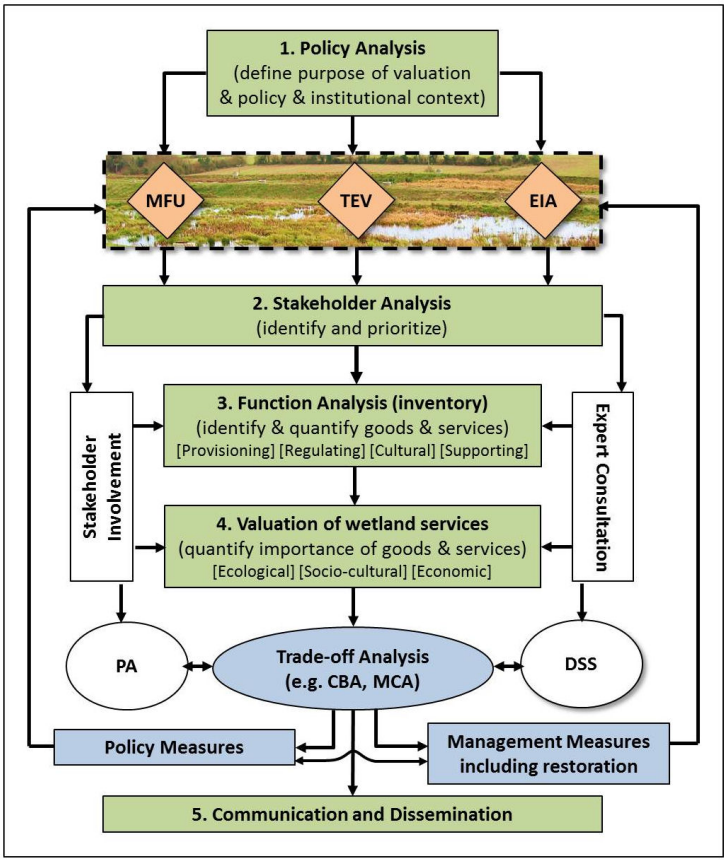


Figure 3. Framework for integrated assessment and valuation of wetland ecosystem services (from de Groot *et al*., 2006). (Abbreviations: MFU – multifunctional use of wetlands; TEV – total economic value; EIA – environmental impact assessment; PA – participatory approaches; DSS – decision support system; CBA – cost benefit analysis; MCA – multi-criteria analysis).

Raising awareness of value – The Economics of Ecosystems and Biodiversity (TEEB)

In 2007, before the magnitude of western economic downturn was truly manifest, the environment ministers from the governments of the G8+5 countries agreed to "initiate the process of analysing the global economic benefit of biological diversity, the costs of the loss of biodiversity and the failure to take protective measures versus the costs of effective conservation." This initiative was termed *The Economics of Ecosystems and Biodiversity* (TEEB).

The TEEB study drew attention to the economic benefits of biodiversity and has developed a basis for evaluating the stock of natural capital and the flow of ecosystem services through a tiered approach which seeks to recognize, demonstrate and capture value. Under some circumstances the ability to simply recognize value may be sufficient to highlight important ecosystem services so that monetary valuation may be unnecessary, or even counterproductive if it is seen as contrary to cultural norms or fails to reflect a plurality of values.

The Economics of Ecosystems and Biodiversity (TEEB). 2010. The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis. Retrieved August 15, 2011, from http://www.teebweb.org.

Linkages with existing guidance

Types of guidance

A multitude of wetland restoration guidance exists for various end-users including policymakers, implementing agencies, and practitioners on the ground. Guidance takes many forms from published literature (both grey and peer-reviewed), case studies, web-based resources, and training courses. In addition, Ramsar has produced a range of adopted guidance which should be considered when wetland restoration is being planned. Similarly, there is a considerable body of knowledge on wetland restoration contained in the Ramsar Wise Use Handbooks (see Annex 1).

Publicly available guidance, tools and technologies

Many publicly available guidance, tools and technologies for restoration exist, produced and distributed by national and local governments, NGOs, researchers, and community-based organizations around the world. They target various audiences with different levels of specificity, including policy- and decision-makers, implementing agencies, and on-the-ground practitioners. General guidance often takes the form of instruction, advice or direction that explains the fundamentals of restoring a degraded wetland, while tools and technologies describe specific methods, materials, and devices used to design, implement and monitor wetland restoration. The Convention on Biological Diversity is now compiling and consolidating publicly available guidance, tools and technologies for ecosystem restoration for distribution at CBD COP11 in October 2012.

The following are a few examples by wetland type that illustrate the wide availability of guidance. This is not meant to be a comprehensive list nor is it to be inferred that these guidance documents have universal applicability. In addition, it is important to note that these illustrative examples are not endorsed by the authors or the Ramsar Convention, but are meant to encourage wetland managers and others interested in wetland restoration to access the available guidance, tools and technologies, including cases studies and best practices, for information that is most relevant to their site-specific circumstances. An Internet search engine is a good place to start.

All Wetlands

The Wetland Restoration Specialist Group (Wetlands International), through its publications, expert database and case studies, promotes the successful restoration and conservation of wetlands worldwide by developing networks and by encouraging information exchange and cooperation. http://www.wetlands.org/Aboutus/Specialistgroups/WetlandRestorationSpecialistGroup/tabid/1120/Default.aspx

Wetland Habitats: A Practical Guide to Restoration and Management (CSIRO Publishing, Australia) is a practical and easy to use manual for wetland restoration and conservation of diverse animal species. http://www.publish.csiro.au/nid/21/pid/6349.htm

An Introduction and User's Guide to Wetland Restoration, Creation, and Enhancement (US Environmental Protection Agency) is written for the public containing 1) background on wetlands and restoration, 2) information on project planning, implementation, and monitoring, and 3) lists of resources, contacts, and funding

sources. http://www.epa.gov/owow/wetlands/pdf/restdocfinal.pdf

Restoring a Wetland (Waikato Regional Council, New Zealand) presents a simple flowchart to find out more about each step in the restoration process and allows the users to create their own Wetland Plan. http://www.waikatoregion.govt.nz/Environment/Natural-resources/Water/Freshwater-wetlands/Restoring-a-wetland/

Peatlands

The Global Peatland Restoration Manual (Greifswald University, Germany) presents a science-based and practical guide to peatland restoration for policy-makers and site managers. The work has relevance to all peatlands of the world but focuses on the four core regions of the UNEP-GEF project "Integrated Management of Peatlands for Biodiversity and Climate Change": Indonesia, China, Western Siberia, and Europe. http://www.imcg.net/media/download_gallery/books/gprm_01.pdf

The Peatland Restoration Guide (Canadian Sphagnum Peat Moss Association and New Brunswick Department of Natural Resources and Energy) was developed as a practical tool for restoring milled peatlands. http://www.peatmoss.com/pm-restguide.php

Rivers and Lakes

Manual of River Restoration Techniques (River Restoration Centre, UK) is presented in 11 separate parts, each part encompassing a significant activity, or objective, that may typically be included in a restoration project brief, with examples of techniques that may be useful in achieving the specific objectives. http://www.therrc.co.uk/rrc_manual.php

River Restoration Manual (Government of Western Australia) is a series of guidelines that provide a guide to the nature, rehabilitation and long-term management of waterways in Western Australia and are intended to be used by river restoration group coordinators and other people who are actively involved with river restoration. http://www.water.wa.gov.au/Managing+water/Rivers+and+estuaries/Restoring/River+restoration+manual/default.aspx

The Lakes Handbook, Volume 2: Lake Restoration and Rehabilitation (Wiley Publisher, UK) provides an up-to-date overview of the application of ecologically sound approaches, methods and tools with particular emphasis on sustainability, restoration and rehabilitation. http://onlinelibrary.wiley.com/book/10.1002/9780470750506

Estuaries and Tidal Wetlands

EC Guidance on the Implementation of the EU Nature Legislation in Estuaries and Coastal Zones (European Commission) provides sector-specific guidance on the implementation of the Birds and Habitats Directives in estuaries and coastal zones, and also helps citizens and stakeholders to better understand key provisions of the Directives. http://ec.europa.eu/transport/maritime/doc/guidance_doc.pdf

Restoration Science Strategy: A Framework (US National Estuarine Research Reserve System) describes the current and potential role of the NERRS in restoration science and provides a framework for how the reserve system can contribute more fully to the successful restoration of estuaries through science and education. http://nerrs.noaa.gov/Doc/PDF/Stewardship/NERRSRSSFramewk.pdf

Saltmarsh Management Manual (UK Department of the Environment, Food and Rural Affairs) describes what it is that needs to be managed and aims to help develop an understanding of how to evaluate the need for management intervention and the form that intervention might take. http://publications.environment-agency.gov.uk/PDF/SCHO0307BMKH-E-E.pdf

Community Estuarine Monitoring Manual (South Australia Environment Protection Agency) presents an estuarine monitoring framework that is suitable for use by a wide range of community groups, including a range of activities that these groups may wish to explore. http://www.epa.sa.gov.au/xstd_files/Water/Report/cemm_a.pdf

Design Guidelines for Tidal Wetland Restoration in the San Francisco Bay (Philip Williams & Assoc., Ltd., The Bay Institute, and the California State Coastal Conservancy) was produced for all individuals who have some degree of responsibility for decisions made on tidal wetland restoration design, including regulatory agency staff, land managers, resource managers and restoration practitioners. http://www.wrmp.org/design/Guidelines_Report-Final.pdf

Mangroves

Five Steps to the Successful Ecological Restoration of Mangroves (Mangrove Action Project) illustrates five important steps that should be tailored to each unique situation and coastal region where mangrove restoration is being attempted. http://www.mangroverestoration.com/pdfs/mangrove_restoration.pdf.

Best Practice Guidelines on Restoration of Mangroves in Tsunami Affected Areas (Wetlands International) provides the reader with appropriate knowledge and understanding of mangrove silviculture (planting) for coastal protection. http://www.wetlands.org/LinkClick.aspx?fileticket=EaD3s%2Bil5Mw%3D&tabid=56

Mangrove Forest Restoration in Andhra Pradesh, India (MS Swaminathan Research Foundation, India) reflects the process and results of restoration activities carried out over seven years by the project Coastal Wetlands: Mangrove Conservation and Management and is meant for foresters, field technicians, researchers and others interested in restoration of degraded mangroves. http://www.globalrestorationnetwork.org/uploads/files/CaseStudyAttachments/60_andhra-pradesh.pdf

Coral Reefs

Reef Restoration Concepts and Guidelines (The Coral Reef Targeted Research & Capacity Building for Management Programme) contains simple advice on coral reef restoration for coastal managers, decision makers, technical advisers and others who may be involved in community-based reef restoration efforts. http://www.gefcoral.org/Portals/53/downloads/Summary_brochure%20and%20restoration%20gdlines/Reef%20Restoration%20Concepts%20%26%20Guidelines.pdf

Manual for Restoration and Remediation of Coral Reefs (Japan Ministry of Environment) collects the methods, achievements, and problems of measures including 1) seeding production and settlement induction by utilizing coral sexual reproduction, 2) transplantation of coral fragments by utilizing asexual reproduction, 3) transplantation of colonies or entire reef, and 4) management of settled seeding, transplanted colonies and coral communities. http://www.coremoc.go.jp/report/RSTR/RSTR2004a.pdf

Seagrass Meadows and Shellfish Beds

Restoration of Seagrass Meadows (Oceania) describes recent techniques for seagrass restoration that may be divided into two basic groups: 1) activities focused on collecting and transplanting plants, and 2) activities focused on obtaining and planting seeds. http://www.pradariasmarinhas.com/restoration_manual.pdf

Guidelines for the Conservation and Restoration of Seagrasses in the United States and Adjacent Waters (US National Oceanic and Atmospheric Administration) discusses important issues that should be addressed in planning seagrass restoration projects, describes different planting methodologies, and proposes monitoring criteria and means for evaluating success.http://www.seagrassrestorationnow.com/docs/Fonseca%20et%20al%201998.pdf

A Practitioner's Guide to the Design & Monitoring of Shellfish Restoration Projects (The Nature Conservancy) was written to help restoration practitioners design and monitor shellfish restoration projects that restore not only the populations of target shellfish species – primarily clams, oysters, scallops – but also the 'ecosystem services' associated with healthy populations of these organisms. http://www.habitat.noaa.gov/pdf/tncnoaa_shellfish_hotlinks_final.pdf

Wetland restoration training

Whilst there is considerable literature available, the skills and experience required to implement wetland restoration on the ground should not be underestimated. Formal training in both the science and practice of wetland restoration and "lessons learned" from past failures is essential to overcome the endless cycle of repeated failures and wasted funds common for some wetland restoration project types. Given the rate of wetland loss and degradation, there is an urgency to ensuring that there are adequately trained personnel who both understand the principles underpinning wetland restoration and recognize the benefits that wetland restoration can deliver.

References

Acreman, M.C., Fisher, J., Stratford, C.J., Mould, D.J. & Mountford, J.O. 2007. Hydrological science and wetland restoration: some case studies from Europe. *Hydrology and Earth Sciences.* Vol. 11(1), p.158-169.

Alexander, S., *et al*. 2011. Opportunities and challenges for ecological restoration within REDD+. *Restoration Ecology.* Vol. 19(6), p.683-689

Bullock, J.M. *et al*. 2011. Restoration of ecosystem services and biodiversity: conflicts and opportunities. *Trends in Ecology and Evolution*. Vol. 26, No. 10, p.541-549.

Erwin, K.L. (2009). Wetlands and Global Climate Change: The Role of Wetland Restoration in a Changing World. Wetlands Ecology and Management 17: 71-84.

Finlayson, C. M., Davidson, N., Pritchard, D.E., Milton, G.R. & Mackay, H. 2011. The Ramsar Convention and ecosystem-based approaches to the wise use and sus-

tainable development of wetlands. *Journal of Wildlife Law and Policy*. Vol. 14, p.176-198.

de Groot, R.S., Stuip, M.A.M., Finlayson, C.M. & Davidson, N. 2006. *Valuing wetlands: guidance for valuing the benefits derived from wetland ecosystem services*, Ramsar Technical Report No. 3/CBD Technical Series No. 27. Ramsar Convention Secretariat, Gland, Switzerland & Secretariat of the Convention on Biological Diversity, Montreal, Canada. 46pp.

Kumar, R., Horwitz, P., Milton, G.R., Sellamuttu, S.S., Buckton, S.T., Davidson, N.C., Pattnaik, A.K., Zavagli, M. 2011. Assessing wetland ecosystem services and poverty interlinkages: a general framework and case study. *Hydrological Sciences Journal*. Vol. 56(8), p.1602-1621.

Millennium Ecosystem Assessment (MA). 2005. *Ecosystems and Human Well-being: Wetlands and Water Synthesis*. World Resources Institute, Washington, DC.

Moreno-Mateos D. *et al*. 2012. Structural and Functional Loss in Restored Wetland Ecosystems. *PLoS Biol* 10(1): e1001247.doi:10.1371/journal.pbio.1001247

Rey Benayas, J.M. *et al*. 2009. Enhancement of biodiversity and ecosystem services by ecological restoration: a meta-analysis. *Science* 325, 1121–1124

Secretariat of the Convention on Biological Diversity, 2004. *The Ecosystem Approach* (CBD Guidelines). Montreal: Secretariat of the Convention on Biological Diversity. 50 p.

Society for Ecological Restoration (SER) Science and Policy Working Group. 2004. The SER International Primer on Ecological Restoration. www.ser.org & Tucson: Society for Ecological Restoration

The Economics of Ecosystems and Biodiversity (TEEB). 2010. The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis. Retrieved August 15, 2011, from http://www.teebweb.org.

Acknowledgements

Thanks are due to the government of Finland for providing funding for development and production of this Briefing Note; to Robert Oates, Executive Director of the Thames Rivers Restoration Trust, for his contribution to the writing workshop and helpful comments on draft text; to STRP member Kevin Erwin for his overall coordination of the Thematic Work Area 8 and inputs to early drafts of the Briefing Note; and to Nick Davidson of the Ramsar Secretariat for his support and advice.

The final production of the Briefing Note has been aided greatly by the comments and suggestions made by members the reference review group, and thanks are also due to Hiromi Yamashita (Japan), Mark Bachmann (Australia), James Aronson (France), Robin Lewis (USA), An Cliquet (Belgium), Anne Tolvanen (Finland), Cui Lijuan (China), Rory Harrington (Ireland), Tuomas Haapalehto (Finland), Max Finlayson (Australia), Elif Okomus (Turkey), Lars Dinesen (Denmark) and Francisco Comin (Spain).

Dwight Peck and Monica Zavagli of the Ramsar Secretariat are thanked for their assistance with formatting and publication of this Briefing Note.

Reflooded farmland in Germany (© Robert J. McInnes)

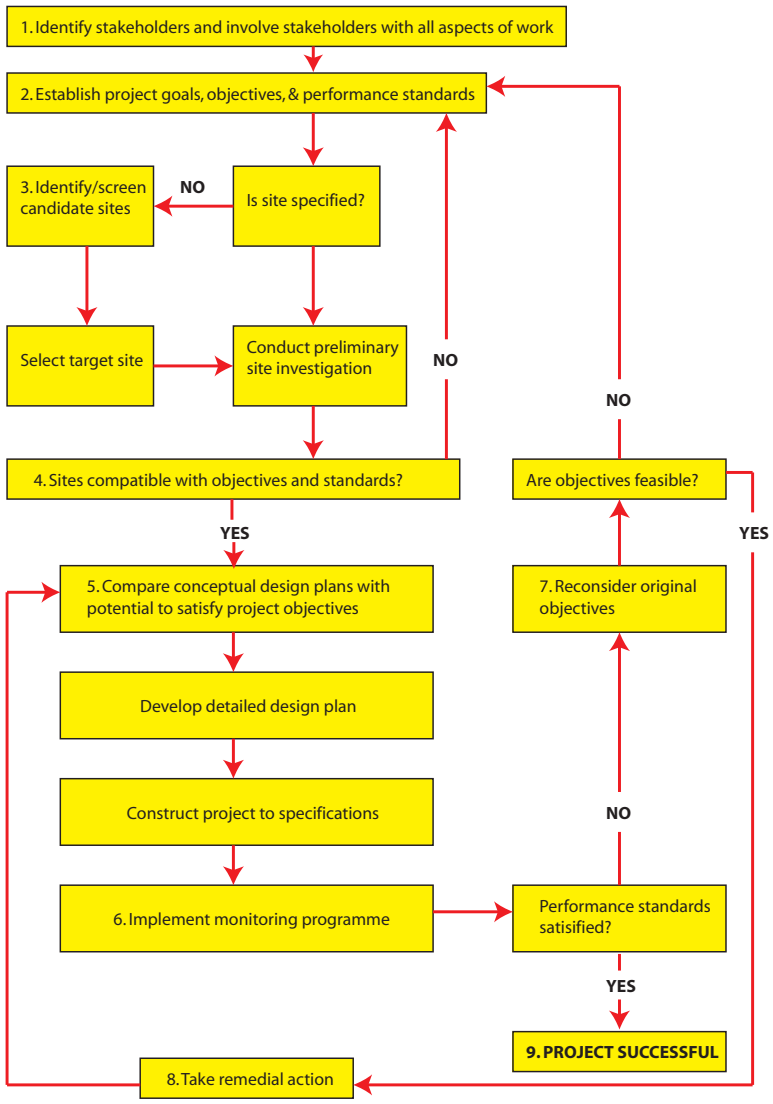
Annex 1: Linkages with existing Ramsar guidance

The Conference of the Parties to the Ramsar Convention have agreed principles and guidelines for wetland restoration (adopted as the annex to Resolution VIII.16 (2002), available as Section F of Ramsar Wise Use Handbook 19 (*Addressing change in wetland ecological character*), 4th edition, 2010). Throughout the step-wise application of these principles (see Flowchart 1), there are both explicit and implicit linkages to a range of other Ramsar-related guidance in the form of Wise Use Handbooks (HB) and Ramsar Technical Reports (RTRs).

In addition to the restoration-related guidance, the Ramsar Convention has also adopted Resolutions on the subject, often with supporting documentation which are sector-specific. Information contained within the sector-specific Resolutions also relates to wetland restoration. The following identify some of the adopted sector specific guidance:

- Environmental Impact Assessment (Ramsar HB13)
- Strategic Environmental Assessment (Ramsar HB13)
- Extractive industries (Resolution X.26)
- Urban and peri-urban planning (Resolution X.27)
- Health (Resolution X.23; RTR6)
- Agriculture (Resolution VIII.34)
- Climate change (RTR5)

Cross references to the existing Ramsar Wise Use Handbooks are provided throughout this Briefing Note. In order to expand and clarify theses linkages with the various issues and concepts identified in the Briefing Note, explicit references are provided in the following table.



Flowchart 1. Guidelines for wetland restoration. Numbers correspond to numbers in column one of the table below.

Section of Ramsar Convention's guidelines for wetland restoration	Ramsar Wise Use Handbook	Section of Handbook	Issues addressed
1. Identify/involve stakeholders	HB7 Participatory Skills	Section I: Guidelines for establishing and strengthening local communities' and indigenous people's participation in the management of wetlands	How to engage with local communities • Building trust with stakeholders • Knowledge exchange • Understanding wetland values and benefits to local communities
		Appendix 1: Case study summaries	• Case studies • Author contact details
2. Establish project goals	HB1 Wise Use of Wetlands	Section I: A Conceptual Framework for the wise use of wetlands and the maintenance of their ecological character	• Definition of wise use • Definition of ecological character • Millennium Ecosystem Assessment response options
	HB2 National Wetland Policies	Section 3.4: Policy implementation strategies	• Measures of implementation
		Appendix 1: Priorities for establishment of wetland policies	• Actions to be undertaken
		Case Study 6: Compliance strategies	• Case study including wetland restoration
3. Identify / screen candidate sites	HB9 River Basin Management	2.3 Understanding integration in the context of Ramsar, wetlands, and river basin management	• Context of restoration within river basin management
		Guidelines Box J: Guidelines for Contracting Parties relating to inventory, assessment and enhancement of the role of wetlands in river basin management	• Consideration of wetland restoration within river basin plans
		Additional Information: Economic instruments, including Payment for Ecosystem Services in Watersheds	• Economic benefits of wetland restoration within a river basin context
		6.3 Planning phase at river basin level	• Consideration of wetland restoration in river basin planning
		Guidelines Box L: Guidelines for Contracting Parties for prioritizing the protection and restoration of wetlands and their biodiversity	• Prioritization of wetland restoration within river basin plans
	HB12 Coastal Management	Guideline No. 4: Ensuring the recognition by Contracting Parties of the key role of wetlands in coastal processes	• Considering the restoration of coastal processes
		Guideline No. 5: Ensuring the recognition by Contracting Parties of the role of coastal wetlands in regulating water flows and water quality	• The role of wetland restoration to improve water quality
		Guideline No. 6: Ensuring the recognition by Contracting Parties of the role of coastal wetlands in mitigating impacts of climate change and sea-level rise	• Wetland restoration to mitigate climate change and sea level rise
		Principle 7: Coastal wetlands are highly vulnerable to degradation and loss, but although easily degraded their restoration is costly and sometimes impossible	• Issues relating to problems of restoring lost and degraded coastal wetlands
		Guideline No. 11: Ensuring that Contracting Parties consider issues related to the degradation, loss and restoration of coastal wetlands	• Consideration of wetland restoration in coastal management
	HB13 Inventory, Assessment and Monitoring	Appendix: Assessment tools contained within the Integrated Framework for Wetland Inventory, Assessment and Monitoring	• The role of wetland restoration in mitigating impacts

	HB15 Wetland Inventory	Background and context	Using inventories to set priorities for wetland restoration
5. Develop detailed design plan	HB9 River Basin Management	2.3 Understanding integration in the context of Ramsar, wetlands, and river basin management	• Context of restoration within river basin management
	HB10 Water Allocation and Management	Section 5: Tools for determining water allocations for wetland ecosystems	• Requirements for water quantity and quality • Methods for determining water allocation for wetlands
		Section 7: Management tools for the implementation of water allocations to wetland ecosystems	• Understanding water supply and demand issues • Implications of catchment management
	HB11 Managing Groundwater	Section 3: An Overview of groundwater-related wetlands	• Understanding groundwater-surface water interactions
		Section 4: Understanding groundwater-related wetlands	• Understanding water balance components of wetlands
		Annex 1: Water transfer mechanisms in groundwater-related wetlands	• Hydrological relationships for different wetland types
6. Implement monitoring programme	HB18 Managing Wetlands	Section C: Developing a management planning process	• Guidance on managing and monitoring wetlands after restoration
	HB13 Inventory, Assessment and Monitoring	Appendix: Assessment tools contained within the Integrated Framework for Wetland Inventory, Assessment and Monitoring	• Methods for the long-term monitoring of restored wetlands

Briefing Notes series

This series is prepared by the Ramsar Convention's Scientific and Technical Review Panel (STRP) in order to share relevant, credible and interesting scientific and technical information on wetlands with a broad audience. Briefing Notes are reviewed internally by STRP members and a small internal editorial panel, comprised of the STRP Chair and the responsible Thematic Work Area lead or task lead, assisted by the Convention's Deputy Secretary General.

Briefing Notes are published by the Ramsar Convention Secretariat in English in electronic (PDF) format. When resources permit, they will be published in French and Spanish as well (the other official languages of the Ramsar Convention) and in printed form.

A full list of current Briefing Notes can be found at www.ramsar.org/BN. Information about the STRP can be found at: www.ramsar.org/STRP-main/. For more information about Briefing Notes or to request information on how to correspond with their authors, please contact the Ramsar Secretariat at strp@ramsar.org.

Authors: Sasha Alexander, STRP Representative of the Society for Ecological Restoration. Contact: sasha@ser.org; Robert J. McInnes, STRP Representative of the Society of Wetland Scientists. Contact: rob@rmwe.co.uk.

Citation: Alexander, S., and McInnes, R. 2012. *The benefits of wetland restoration.* Ramsar Scientific and Technical Briefing Note no. 4. Gland, Switzerland: Ramsar Convention Secretariat.

The Convention on Wetlands (Ramsar, Iran, 1971) – called the Ramsar Convention – is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance and to plan for the "wise use", or sustainable use, of all of the wetlands in their territories.

Ramsar Convention Secretariat
Rue Mauverney 28
CH-1196 Gland, Switzerland
Tel.: +41 22 999 0170
Fax: +41 22 999 0169
E-Mail: ramsar@ramsar.org
Website: www.ramsar.org