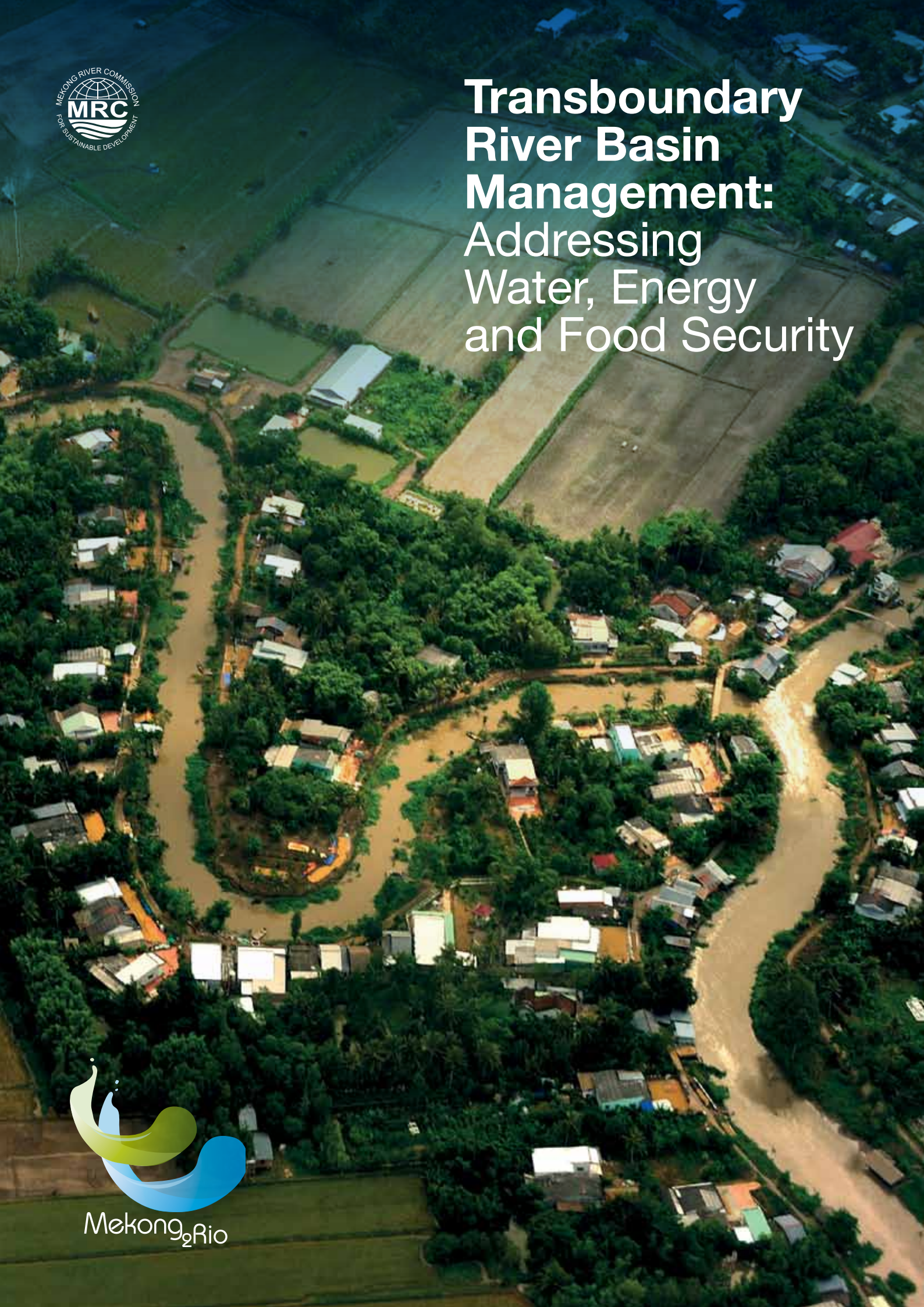

Transboundary River Basin Management: Addressing Water, Energy and Food Security

Transboundary River Basin Management: Addressing Water, Energy and Food Security

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Mekong River Commission
Vientiane, Lao PDR 2012

Cite this document as: Bach H, Bird J, Clausen TJ, Jensen KM, Lange RB, Taylor R, Viriyasakultorn V and Wolf A (2012). Transboundary River Basin Management: Addressing Water, Energy and Food Security. Mekong River Commission, Lao PDR.

ISBN: 978-99-32-412-05-1
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Contents

List of case study boxes

Preface

About 40 per cent of the world's population lives in river basins that are shared by countries. These transboundary basins cover almost half of the Earth's land surface and provide over 60 per cent of global freshwater flow. Transboundary river basin management is something that concerns many of us.

Water, energy and food security are central elements for society. Having access to sufficient food is set out in the UN declaration of human rights. Without water we quickly perish. Modern society is highly dependent on energy for our daily life; for transport, industry and in our homes. Securing food, sufficient water and enough energy are all necessary elements in supporting social and economic development for societies around the world.

Bringing people out of poverty, securing livelihoods and supporting development are key elements of our work in managing transboundary river basins, but these efforts have to be sustainable, otherwise they may be wasted or even degrade the lives of others. Following the current 'business as usual' trajectories are increasingly unsustainable and finding solutions that are viable and sustainable is a challenge.

The Bonn2011 Conference: "The Water, Energy and Food Security Nexus – Solutions for the Green Economy" preparing for the Rio+20 conference suggested that part of the solution is to realise that water, energy and food security are connected in critical ways and to address the issues in an integrated way through close collaboration of all actors from the three sectors. Acknowledging the significant contribution of the Bonn Conference, the Mekong2Rio Conference took a step forward in exploring the water, energy and food security nexus in a transboundary context, moving from rhetoric to practice.

The Mekong River Commission aims at holding an international event every two years to share experiences in transboundary water resources management, and building on the Bonn conference, the logical theme this time was to address the nexus in transboundary river basins.

With the gathering of river managers and water experts from 14 international river basins, 16 international organisations and two regional intergovernmental bodies, the conference lent weight to a wide range of water management issues and perspectives. We are living in an information age and although different forms of communication can be used as we are living in different corners of the world, events like the Mekong2Rio Conference are essential starting points to identify individuals and organisations with whom we can continue interaction and information sharing. The more than 350 participants fully explored the opportunity of the Mekong2Rio Conference sharing experiences and lessons learned as well as networking and forging new relationships, and I regard the interaction between the participants and the establishment of new relationships as a key result of the Mekong2Rio Conference.

In order to try to build on this event in the most useful way it was decided to produce a document which captured the subject matter discussed and it is my privilege to introduce this book presenting a synthesis of the discussions at the conference and conveying its messages to a wider audience. We hope that this publication will provide reference to current and inspire new thinking around the water, energy and food security nexus in a transboundary context, leading to innovative solutions around the world.

The Mekong River Commission would like to express sincere thanks to all the partners who have provided assistance over the years to improve transboundary river basin management, thank the authors of this publication for their efforts to disseminate the results and the conference participants for their valuable contribution to a successful event. I'm convinced that this publication will inspire managers across the water, energy and food security nexus to approach the future challenges based on the lessons learned and ideas presented.

Hans Guttman
Chief Executive Officer
Mekong River Commission Secretariat

Executive Summary

A major theme of the international Mekong2Rio conference held in May 2012 in Thailand was how transboundary rivers can best meet the water, energy and food needs of riparian populations while minimising negative impacts. More than 350 participants from 14 river basin organisations, together with water and environment ministers, government officials, policy makers, development agencies, international organisations, non-government organisations, the private sector and other stakeholders shared experiences and discussed the particular challenges of the transboundary context for governance and use of shared water resources.

The Mekong2Rio conference sent a message to the Rio+20 conference, the United Nations Conference on Sustainable Development, to raise awareness of the particular issues of transboundary river basin management.

This report is a synthesis of information presented at the conference to discuss new solutions from a transboundary river basin management perspective in the framework of the water, energy and food security nexus.

The nexus approach acknowledges the links between water, energy and food in management, analysis, planning and implementation. In doing so, water related strategies and plans are designed in collaboration between relevant authorities and stakeholders, with the aim of avoiding cross-sector impacts and, perhaps more importantly, looking for combined solutions and synergies for more efficient resource use. The conference considered the transboundary aspects of this approach. Planners and decision makers must take account of connections between the sectors to reduce the likelihood that decisions in one area will have negative impacts in another. On the positive side, synergies and common solutions can result when water, energy and food security problems are tackled together.

Agriculture is the world's major water user and one of the biggest challenges for water managers is to increase the efficiency of irrigated agriculture and reduce waste so that water can be made available to other sectors without adversely affecting the environment or food security. These pressures coincides with requirements to produce more food to for growing populations with increasing ability and wish to get more food and a diet with an increasing share of meat. The resultant need for increased productivity and reduction of waste poses major challenges, not least in river basins and aquifers shared between states.

The demand for energy is increasing and the era of climate change calls for a diversification of energy supply. Investments in energy efficiency are an important driver of sustainable development as they reduce the need for additional investments in supply capacity. Countries face different challenges transitioning to a low carbon economy, depending on factors such as their level of natural resources and capacity to diversify their energy mix and the choice of energy mix can have transboundary and long-term implications for water and food security. Large-scale investments in renewable energy technologies, such as biofuels and hydropower, may have impacts on water and food security at local and transboundary scales. Transboundary cooperation can in this context

All four Lower Mekong Basin countries were represented at the Mekong2Rio International Conference.


Dr. Dechen Tsering addresses the plenary session at the Mekong2Rio International Conference.


Dr. Fritz Holzwarth talks about challenges and solutions at the Mekong2Rio International Conference.

Hans Guttman addresses the media at the Mekong2Rio International Conference.

enhance a broader set of benefits and opportunities than individual unilateral country approaches. While regional energy supplies can provide mutual benefits, countries may be reluctant to integrate their energy systems because it makes them more dependent on other countries.

Some of the key drivers of food security are population growth and economic growth. In addressing food security issues, governments often respond with initiatives that increase water consumption and energy intensive irrigation. A particular challenge in transboundary basins is the potential impact on downstream users. In some areas an opportunity for sustainable increase in agricultural productivity could lie in the use of supplementary irrigation for rain-fed agriculture in addition to a variety of other aspects of agricultural practices affecting agricultural productivity. Like energy, increasing water use efficiency is an area with high potential for productivity gains.

New solutions for water, energy and food security can be found by the three sectors working together and a regional perspective can provide mutual benefits. Upstream plentiful resources can supply downstream areas with high demands and/or resource scarcity while delivering economic benefits to the upstream providers. A multi-purpose approach for dams may increasingly be used to provide solutions to food security issues by increased irrigation, and at the same time provide water supply, energy, flood protection, jobs and economic development. However, sustainability challenges still remain, as do the challenge to actually agree upon and implement benefit sharing.

Smoothing out of seasonal variations in water supply through construction of water storages has improved access to water and food in many regions, provided flood control and, where the storage is also used to generate hydropower, access to energy. But, the reductions in seasonal variations of river flow through construction of water storages affect river flow regime, natural sediment transport and environmental flows. This in turn affects seasonally inundated wetlands, species whose life cycles rely on variations in flow and on coastal fisheries through the loss of sediment trapped behind dam walls.

Water for ecosystems is often given a lower priority when ecosystem services are regarded as less important than other uses. Restoring and maintaining environmental flows needed to secure water for ecosystems and good water quality are issues high on the agenda in many of the world's transboundary river basins. Many river basins face water quality problems caused by discharge of wastewater and runoff from agriculture. Wastewater treatment and other measures to abate pollution should be implemented before the damage is done, by which time work will be needed to not only reduce pollution but also to restore degraded ecosystems. Ecosystem services underpin water, food and energy security and in a green economy this natural infrastructure is recognised. The key to working with ecosystem services in the water, energy and food security nexus is to be able to

quantify them and estimate their economic value. The cost of ignoring ecosystem services can be very high, as illustrated by several case studies in the report.

Poor people who depend on wetland related food production such as rice and fish are very vulnerable to any reduction in access to water. While the economic growth created by hydropower and other developments has the potential to reduce poverty as the economy grows, the extent to which benefits initially reach the poor is not entirely clear and the trade-offs of dam developments include their impacts on natural resources, which are the basis for the livelihoods of the rural poor. Considering dams as multiple-use systems that can contribute to local livelihoods is one way of ensuring that local people benefit from these developments. Finding ways to do this can be difficult but some options that are being tested include exploiting seized land areas around the dam that are only inundated seasonally and creating other suitable livelihood opportunities, such as rice-fish systems where floodwaters fill rice paddies during the wet season.

The nexus approach differs from IWRM in that whereas IWRM tries to engage all sectors from a water management perspective, the nexus approach treats the three issues – water, energy and food security as equally important. Engaging these development areas and potential trade-off issues requires a significant shift away from direct sharing of water towards sharing of benefits at a regional scale. In transboundary basins competing national interests, security concerns and upstream-downstream trade-offs may create barriers to realising the advantages of regional management of natural resources. Nonetheless, an increasingly limited supply of natural resources, a greater emphasis on green development and concerns about climate change could drive greater integration across the water, energy and food security nexus.

Transboundary River Basin Organisations need scientific evidence on which to base the development of strategies and plans. They also need to monitor the river system to measure the impacts of management actions. Decision support systems that incorporate socio-economic and environmental data with simulation models can provide basin development scenarios that include nexus issues. But building a transboundary decisions support system that integrates water, energy and food poses huge challenges for international river basins. This includes sharing of data and information between countries not only on water, but also on energy and food production and policies and dissemination of results through a stronger transboundary science-policy dialogue. And, a good decision support system does not guarantee sustainable outcomes, it only provides the data, models and scenarios that feed into political negotiations on the development of transboundary waters. There is a need for improved information and knowledge about trade-offs at the basin scale. River Basin Organisations have a role to play in linking the scientific community, basin water-user community and political decision makers, identifying incentives for collaboration and influencing national decisions for transboundary benefits.

All stakeholders need to be involved from an early stage to identify the knowledge required for natural resources management, e.g. by establishing partnerships between the government, science and stakeholders. But most international River Basin Organisations struggle to achieve the balance between maintaining a regional perspective and engaging local populations who will experience the impacts of regional development. As a result, alternative organisations have been established to provide information and a voice for people at the grassroots level.

The private sector has an important role to play as investors, developers, producers and consumers of natural resources. Governments need to establish long-term policies and plans for sustainable use of resources and implement legislative frameworks that introduce social and environmental safeguards to secure long-term sustainability of private investments. In a transboundary context, this means developing regional development frameworks that take account of the opportunities as well as potential impacts of private sector investments.

Results of transboundary water management such as infrastructure developed at a transboundary scale, improvements in the state of the environment, water resource benefits that create wealth for the basin population, improved access to water services and protection of international public good are the ultimate goals of transboundary river basin management but are – as demonstrated throughout this publication and elsewhere – not easy to realise. In this context, the nexus approach provides opportunities for new insight and options for solutions to water, energy and food security issues.

1. Background

Mekong2Rio was an international gathering of key players aiming to share their expertise in transboundary water resources management. It was the first in a series of biennial conferences of its kind convened by the MRC. It was aimed at adding a water dimension to Rio+20, whose themes were centered on a green economy in the context of sustainable development and poverty eradication and the institutional framework needed.

1.1 Introduction

How can transboundary rivers best meet the water, energy and food needs of riparian populations, exploring synergies between the three sectors and minimising negative impacts? This was a major theme of the Mekong2Rio conference convened by the Mekong River Commission (MRC), co-sponsored by 16 partners and hosted by the Royal Thai Government in Phuket, Thailand from 1–3 May 2012. The conference objective was to address the transboundary dimension of the water, energy and food security nexus with particular emphasis on the challenges that rapid human-made developments and environmental change pose to the sustainable management of transboundary river basins.

More than 350 participants from 14 river basin organisations, together with water and environment ministers, government officials, policy makers, development agencies, international organisations, non-government organisations, the private sector and other stakeholders shared experiences and discussed the particular challenges of the transboundary context for governance and use of shared water resources. The Mekong2Rio conference provided river basin organisations and related stakeholders a chance to strengthen networks, learn from each other, widening their perspectives and expertise in order to more efficiently manage their resources.

Rapid development in many parts of the world, including the Mekong region, is putting increasing pressure on water resources, especially demands for energy and food production. This requires new approaches to tackle the water, energy and food security problems in an integrated way. Exploring the opportunities of the nexus between water, energy and food security was discussed at the Bonn2011 Nexus Conference: "The Water Energy and Food Security Nexus – Solutions for the Green Economy" in preparation for the Rio+20 conference, the United NationsConference on Sustainable Development, which was held in June 2012 in Rio de Janeiro, Brazil.

The Mekong2Rio conference sent a message (see Annex II) to Rio+20 to raise awareness of the particular issues of transboundary river basin management.

This report draws on information presented at the conference to discuss new solutions from a transboundary river basin management perspective in the framework of a nexus approach. The report presents ideas from managers of river basins throughout the world, including Asia's Ganges, Indus, Yellow, Mekong and Aral Sea river basins, Australia's Murray-Darling, Europe's Danube, Africa's Niger, Nile and Congo and America's Amazon, Columbia, Mississippi and Parana-La Plata river basins. (See Annex I for a list and description of the participating river basin organisations). Two regional intergovernmental bodies were also represented at the conference: the Southern African Development Community that is applying a 'Protocol on Shared Watercourses' to guide cooperation in 13 transboundary river basins; and the United Nations Economic Commission for Europe that is using the 'Convention on the Protection and Use of Transboundary Watercourses and International Lakes' for similar purposes. The United Nations Environment Programme also

participated, sharing their views and vision on a necessary transition towards a greening of the world's economies.

The aim of this report is to make the conference findings available to all stakeholders. It begins by presenting as background the main aspects of the nexus approach, briefly explains the green economy concept and outlines some of the major challenges of transboundary river basin management. It provides a synthesis of information presented at the conference and explores the major themes and issues discussed and debated.

The authors, MRC and the sponsoring partners hope that it will provide a resource and material for further discussion for decision makers and water resource managers as well as managers and practitioners in the fields of energy and agriculture. Annex 3 provides a list of presenters, panellists, chairpersons and facilitators. Other conference material is available on the MRC website: www.mrcmekong.org.

1.2
The water, energy and food security nexus

The rate of progress towards achieving the Millennium Development Goals and predicted future challenges in providing basic commodities such as water, energy and food calls for a rethink of the approaches to overcome development challenges. On a global scale, about 0.9 billion people lack adequate access to safe drinking water, 2.6 billion people lack access to safe sanitation, close to 1 billion people are undernourished and at least 1.3 billion are without access to electricity (UN 2011, IEA 2011). Demands are expected to grow exponentially due to demographic and lifestyle changes and economic growth and, at the same time, climate change is likely to increase pressure on resources, adding to the vulnerability of people and ecosystems (Hoff, 2011).

Water, energy and food security issues are interconnected in many ways. Energy production can influence water demand, e.g. through demand for cooling water, storage in hydropower dams and irrigation for biofuel production. Production of biofuel may also compete with food production for land and water, while water use efficiency can affect food security as well as energy requirements. The choices people make about what food they eat, which are closely linked to demographic and lifestyle changes and economic growth, influence both water and energy demands.

Box 1. Saving electricity and water used for food production in India – the water, energy and food security nexus

About 20% of India's electricity is used for irrigation. Power subsidies have allowed farmers to pump water excessively, including groundwater. In the face of an unstable power supply, farmers responded by leaving their pumps turned on around the clock to ensure irrigation, resulting in further power shortages and over-use of water. This badly affected the rural communities, which also suffered from intermittent power.

In Gujarat, the state government introduced a scheme that 're-wired' the state with thousands of kilometres of new power lines, and separated electricity supplies for villages from those for irrigation tubewells. Villages can now rely on 24 hours of constant electricity and farmers have a reliable supply of eight hours of uninterrupted full voltage power. A strictly scheduled roster helps to separate peak energy demand for irrigation from that for villages. This change from the previous situation of frequently interrupted, variable voltage power at unpredictable times has had a number of positive effects. Consumption of electricity for pumping groundwater and electricity subsidies have declined; receding groundwater levels have stabilised; the gap in livelihoods between rural villages and cities has narrowed; and enterprises such as mills, tailoring, welding and many others have a reliable power supply – vital for creating new jobs. Farmers have embarked on ambitious new cropping schemes made possible by a reliable supply of water during critical periods. Gujarat has recorded 9.6% annual growth in agricultural GDP (compared to 2.9% for the country) as a result of the new rural power system combined with other development initiatives.

Source: Shah 2009.

Planning and decision making must take account of these linkages so that impacts from one area do not have damaging consequences in another. Even more importantly, synergies and common solutions result when water, energy and food security problems are tackled together rather than through a 'silo' or sector approach, as illustrated in the example in Box 1. When nexus thinking (Box 2) is considered, new opportunities and options appear in response to the development challenges. The nexus perspective furthermore increases our understanding of the interdependencies between water, energy and food and raises awareness and

Box 2. What is the water, energy and food security nexus?

The nexus approach acknowledges the links between water, energy and food in management, analysis, planning and implementation. In doing so, water related strategies and plans are designed in collaboration between relevant authorities and stakeholders, with the aim of avoiding cross-sector impacts and, perhaps more importantly, looking for combined solutions and synergies for more efficient resource use. The trade-offs that may arise are analysed and discussed considering the relevant water, energy and food security issues as well as potential impacts on or relations to environment, climate, people's livelihoods and other economic sectors.

In a transboundary context, additional aspects arise to do with identifying solutions and synergies across state boundaries and analysing and agreeing on trade-offs for decision making.

engagement of policy makers across the three sectors. This way of thinking provides an informed and transparent framework for determining and resolving trade-offs across sectors and with other policy areas such asclimate and biodiversity.

Discussions of the nexus approach during 2010–2011 in preparation for the 2012 Rio+20 Conference arrived at the following key recommendations at the Bonn2011 Conference (German Government, 2011):

Increase policy coherence by ensuring that synergies and trade-offs among water, energy and food are identified both in design and implementation of policies, plans and investments. And by incentivizing co-operation and coordination for mutually beneficial approaches, multiple benefits and fewer unintended or adverse consequences.

Accelerate access by progressively realizing – in a more coordinated way – the human rights obligations related to water, sanitation, energy and food to reap the resulting health, productivity and development benefits. And by prioritizing access for the poor and the marginalized in sector strategies, planning and investments.

Create more with less by increasing resource productivity, establishing mechanisms to identify the optimal allocation of scarce resources for productive purposes, and sustainably intensifying the use of land and water to achieve equitable social, economic and environmentally sound development.

End waste and minimize losses by reducing waste and losses along supply chains to capture significant economic and environmental gains within and across sectors and reduce demands on water, land and energy. And by changing mindsets and incentivizing technological development to turn waste into a resource and manage it for multiple uses.

Value natural infrastructure by investing to secure, improve and restore the considerable multi-functional value of biodiversity and ecosystems to provide food and energy, conserve water, sustain livelihoods and contribute to a green economy while strengthening the basic role that nature plays in supporting life, well-being and cultures.

Mobilize consumer influence by acknowledging and actively utilizing the catalyzing role that individuals have in choosing consumption patterns on water, energy and other resource footprints and improving efficiency of resource use both through their direct actions and in influencing the way business is done.

The nexus approach and its insistence on the necessity for integration between three of the basic elements of people's well-being, i.e. ensuring access to water, energy and food, while considering ecosystem functions and livelihoods contributes solutions towards a green economy, which is one of the key approaches for moving global development forward in a sustainable way.

1.3
Greening the economy

The current patterns of growth and development that consume rather than renew natural capital undermine the source of livelihoods and the poor and most vulnerable will be the worst affected. Decades of creating new wealth through a "brown economy" model based on fossil fuels have not substantially addressed social marginalization, environmental degradation and resource depletion. In addition, the world is still far from delivering on the Millennium Development Goals by 2015 even though the target on access to safe drinking water is met, 0.9 billion people are still without access to improved water resources (UN 2011). An alternative path is needed and on this basis the UN has introduced the concept of the green economy. It does not replace the ideas of sustainable development but recognises that alternative approaches are needed to achieve sustainable development goals.

UNEP defines a green economy as one that results in "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (UNEP 2010). In its simplest form, a green economy is low carbon, resource efficient and socially inclusive. In a green economy, growth in income and employment should be driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency and prevent the loss of biodiversity and ecosystem services. The development path should maintain, enhance and, where necessary, rebuild natural capital as a critical economic asset and as a source of public benefits. This is especially important for poor people whose livelihoods and security depend on nature. The key aim for a transition to a green economy is to eliminate the trade-offs between economic growth and investment on the one hand and gains in environmental quality and social inclusiveness on the other. The main hypothesis is that the environmental and social goals of a green economy can also generate increases in income, growth and enhanced well-being. Critical to attaining such an objective is to create the enabling conditions for public and private investments to incorporate broader environmental and social criteria (UNEP 2011).

In green economies, the role of water in both maintaining biodiversity and ecosystem services and in providing water for human use is recognised, valued and paid for. The use of technologies that encourage efficient forms of recycling and reuse is encouraged. Given that the vast majority of usable fresh water is channelled towards agriculture, any global consideration of water allocation must consider the factors that determine the efficiency of water use in this sector. One of the biggest challenges facing water managers is to find a way to significantly increase the productivity of irrigated agriculture so that water can be made available to other sectors without adversely affecting the environment or food security (UNEP 2011).

The greening of agriculture refers to the increasing use of farming practices and technologies that simultaneously: (i) maintain and increase farm productivity and profitability while ensuring the provision of food on a sustainable basis, (ii) reduce negative externalities and gradually lead to positive ones, and (iii) rebuild ecological resources (i.e. soil, water, air and biodiversity "natural capital" assets) by reducing pollution and using resources more efficiently. A diverse, locally adaptable set of agricultural techniques, practices and market branding certifications such as Good Agricultural Practices (GAP), Organic/Biodynamic Agriculture, Fair Trade, Ecological Agriculture, Conservation Agriculture and related techniques and food-supply protocols exemplify the varying shades of "green" agriculture (UNEP 2011).

Greening of the energy sector aims to achieve a renewable and sustainable energy system. This involves improvements in energy efficiency, a much greater supply of energy from renewable sources and reducing greenhouse gas emissions and pollution. The most direct approach is to reduce the use of fossil fuels. Improvement in energy efficiency reduces dependence on fossil fuels, in many cases with net economic benefits (UNEP 2011).

"In green economies, the role of water in both maintaining biodiversity and ecosystem services and in providing water for human use is recognised, valued and paid for."

1.4
Transboundary river basin management challenges

Managing large, complex, transboundary water systems requires a different approach to overseeing smaller water systems where local issues are the key concerns. To adequately address the additional challenges that exist at the larger basin scale, managers need to do more than simply expand local governance mechanisms. Management authorities at the basin level need to balance local community needs with those of the wider society and environment. Cross-sector and cross-scale information are essential for improving coordination and ensuring appropriate dialogue amongst concerned stakeholders (Bach et al. 2011).

The issues on the transboundary river basin scale typically include soil erosion and sediment generation, pollution, other forms of watershed degradation caused by inappropriate land use and activities associated with extractive industries, such as mining and forestry, along with the development of water resources through the construction of storage structures and increasing extraction of groundwater. All these issues have a profound impact on the functionality of ecosystems and their provision of critical services (Bach et al. 2011). Watershed degradation, urbanisation and population increase are factors that decrease natural resilience to extreme weather events such as storms and torrential rains, leading to flash floods in upland areas and extreme inundation of floodplains and coastal areas. The human-induced changes to river basins are compounded by increased water scarcity. With its inextricable links to food security and economic development, water scarcity, which is driven by population growth, dietary change, urbanisation, globalisation, biofuel production and climate change, is becoming one of the defining issues of the 21st century.

Managers of transboundary river basins face particular challenges related to different national (sometimes conflicting) interests, power disparities between riparian states, differences in national institutional capacity, limited information exchange and lack of sufficient basin scale knowledge and institutional capacity to make decisions. The complexity of the functional issues of a basin mentioned above is thus combined with an often equally complex institutional and political situation. Despite these difficulties, conflicts over water are often more rhetoric than actual and international river basins have provided avenues for cooperation more often than led to disputes (Wolf et al. 2003). This indicates the value of cooperation and, considering the increasing pressure on and competition for limited resources, underpins the future perspectives of transboundary river basin management and the need for transboundary river basin organisations to apply new approaches, such as the nexus approach.

2. Transboundary nexus perspectives – moving towards a greener economy

The nexus approach adds a new dimension and, at first sight, complexity to transboundary river basin management. It also provides opportunities for new insight and options for solutions to water, energy and food security issues. Considering the nexus between water, energy and food security in management of transboundary waters is not entirely new – the various examples below demonstrate that very clearly, but the systematic focus on the three security issues helps us understand their interdependencies as well as the linkages with ecosystem services. The nexus approach helps to identify key development drivers and to unpack and clarify the development challenges and necessary trade-offs in transboundary river basins.

2.1 Increased water demand and climate variability

Agriculture is the world's major water user, withdrawing about 70% of the water people use at global scale, while water for domestic consumption is about 10% and the rest is used by industry (Comprehensive Assessment of Water Management in Agriculture 2007). The consumptive water use by agriculture may be an even higher percentage since part of the industrial withdrawal, e.g. the energy sector withdrawal of water for cooling, is recharged into the river. While these are global averages, the industry withdrawal percentage can be higher, in the order of 40–50% in some regions, e.g. in Europe and North America, where drought periods resulting in lack of water for cooling can lead to energy deficiency.

Water demand increases are driven by economic growth and population growth as well as changes in practices and technologies in the major water use sectors, such as the increased use of irrigation and the increasing demand for bioenergy. Water withdrawal has increased faster than population growth over the past 50 years leading to declining water availability per person, although the growth has not been as fast as economic growth (Comprehensive Assessment of Water Management in Agriculture 2007).

Projections indicate that future water demand may outstrip supply. The scenarios indicating increasing water withdrawal predict that the increase is mainly from industry, of which energy production is an important part

(Figure 1). It is therefore likely that use of water for agriculture will need to become more efficient due to the growing demand from the energy sector. With an increasing population, this requires the agricultural sector to produce more food with less water.

Part of the solution to this challenge could be simply reducing waste. The loss of water through waste of agricultural products and food is massive, leading to the conclusion at a global scale that food security can be maintained if this wastage, which is estimated at about 50%, is curbed (Lundqvist et al. 2008).

The large variation in water availability caused by seasonal differences in precipitation has been one of the main drivers for modification of river water regimes, such as increasing water storage to support irrigation and food security. For example, in the Indus Basin, construction of dams has shifted the water availability between seasons from an 80/20 ratio in the wet/dry season to a current 60/40 distribution, which has enabled expansion of irrigation as well as electricity production. Provision of energy for economic growth and revenue generation is another key driver for building storage in parts of the basins where the natural conditions offer an energy potential for electricity production. The hydropower potential of many of the world's large rivers such as the Mekong,

> "Water security is about water quantity, water and people's vulnerability to risk"

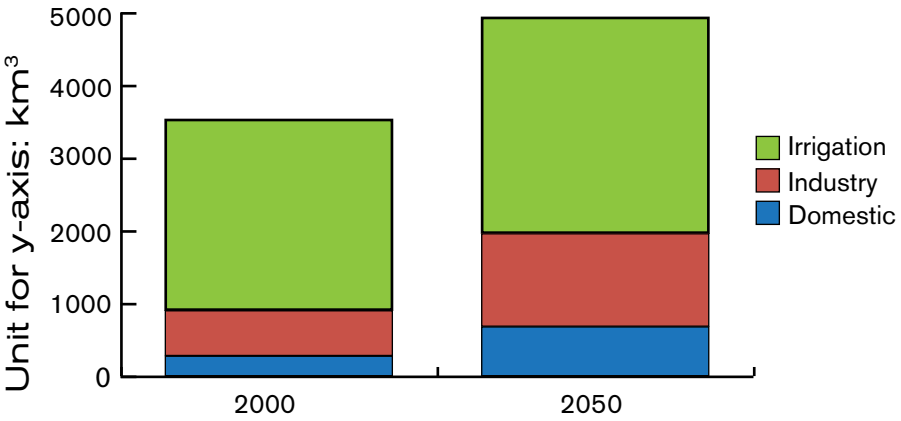


Figure 1. Water withdrawal by sector in 2000 and 2050 in an economic optimistic scenario (Comprehensive Assessment of Water Management in Agriculture 2007).

Congo and Nile rivers is huge but largely untapped, whereas the large rivers in USA, China, South Asia and Europe are regulated by series of dams. In these latter cases the key issues for transboundary river basin management have changed from development to protection and restoration of the river ecosystems and biodiversity, for example in the Columbia, Yellow and Danube Rivers. Water security is not only about water quantity, it is also related to water quality and people's vulnerability to risk, which reflects society's resilience to impacts from water related hazards. Poor people are the most vulnerable to water related security issues such as water scarcity, climate variability resulting in floods and droughts, and impacts of climate change on water availability and variability. In some river basins, such as the Mississippi, Columbia and Yellow rivers, water storages have been constructed with flood control as at least one of the main purposes, whereas in other basins, such as the Mekong, the approach to flood management has been 'living with floods'. In the context of climate change however, this approach may have to be adjusted.

When the focus is on economics, the water for ecosystems can easily be overlooked in favour of other competing demands for water. The degradation of water quality reduces the availability of clean water for healthy ecosystems, water supply and agriculture. This is another factor under pressure from growing populations and urbanisation. The environmental flows needed to secure water for ecosystems and good water quality are issues high on the agenda in many transboundary river basins around the world, e.g. the Yellow, Ganges, Danube and Columbia rivers, thus bringing ecosystem functions and services (Box 3) into the nexus of water, energy and food security.

> "When the focus is on economics, the water for ecosystems can easily be overlooked in favour of other competing demands for water."

Box 3. Ecosystem functions and services in transboundary rivers

Natural wetlands provide goods and services, which are critical to the people dependent on these ecosystems. Wetlands are sources of food and resources for sale, they can provide flood protection for cities and clean wastewater flowing out of urban areas. They store water for irrigation, given the right natural conditions provide opportunities for hydroelectric generation and protect coastlines from erosion and natural disasters. Their functions, and thereby the goods and services of the ecosystems, require that they are maintained, which is one of the challenges of river basin management and an even greater challenge in a transboundary context where degradation in one country may affect other nations.

Wetland goods are often also presented as direct uses. One of the most important direct uses of wetlands is rice cultivation in irrigated and seasonally flooded areas. Freshwater capture fisheries and aquaculture are also important, providing animal protein at a much lower cost than from farmed animals. Among other direct uses, wetlands provide grazing lands for water buffalo, a source of wood and fibrous plants used as building materials, medicinal plants and foods gathered to supplement rural people's diets and water for household use.

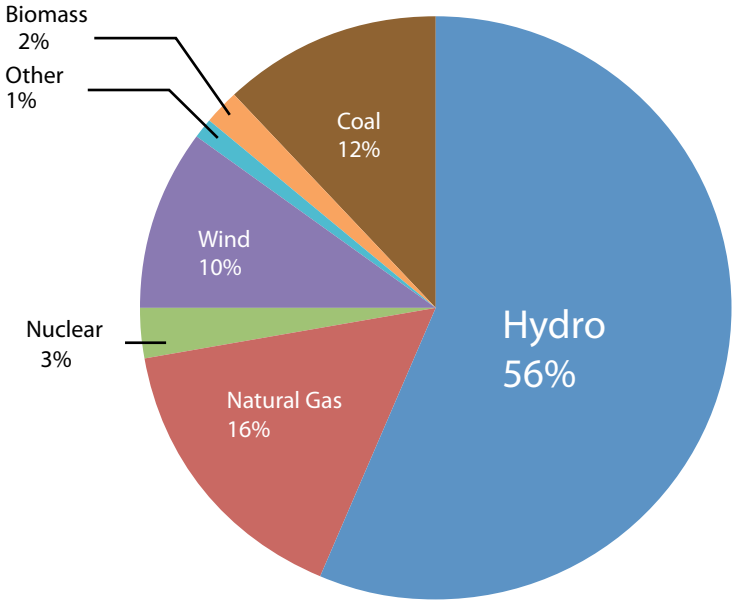
Wetland services or indirect uses of wetlands are sometimes less obvious but no less important. Natural wetlands absorb floodwaters that could otherwise be disastrous during the wet season. The floods bring benefits by replenishing the nutrient-rich sediment needed for the agriculture of the river floodplains and river banks and help to sustain fish-spawning habitats. Many types of wetlands provide a natural purification function by removing excess nutrients and toxins that enter the water from agricultural, industrial and municipal sources. They help to recharge groundwater aquifers and, especially in the case of coastal mangroves, protect against erosion.

Wetlands also serve important cultural functions, with the rivers and their seasonal cycles providing a focus for water festivals and funeral traditions. Tourism and water transportation supported by rivers are examples where the water ecosystems contribute to the economy indirectly. In some large river basins river transport was the first and most important driver of transboundary cooperation (e.g. the Congo river) and it is often included as an aspect of cooperation (e.g. the Mekong, Danube and Amazon rivers).

2.2
Increasing energy demand and the renewable energy push

The global demand for energy is growing. As economies and populations increase, booming mega-cities, industrial expansion and agricultural intensification place huge demands on countries to secure a stable energy supply for their citizens and industries. This is just as true for developing countries, where universal access to reliable and affordable sources of energy has yet to be achieved.

Oil prices continue to increase despite the economic crisis in Europe and the USA, as rapid economic growth in developing economies increases global demand, e.g. about 90% of the energy demand growth over the period 2010–2035 is in non-OECD countries (IEA 2011). The global call for transition to a 'low carbon' economy to mitigate the impacts of climate change creates further incentives to look for alternative energy sources and more efficient use of energy. The renewable energy sources are being promoted mainly for power generation, transportation (biofuel) and combustion (biomass). The non-hydro renewables are expected to increase their share in power generation from 3% in 2009 to 15% in 2035. The contribution of hydropower to global power generation is expected to remain at about 15% (IEA, 2011). Securing a sustainable, affordable and accessible 'low carbon' supply of energy is a key challenge for both developed and developing countries. Most renewable-energy sources need continued support through subsidies to compete in energy markets (IEA 2011) and renewable energy sources may affect water and food security, e.g. biofuel production competing with agricultural production for land and water, and hydropower infrastructure modifying flow regimes with potential effects on downstream ecosystems and water availability. Energy security in the era of climate change involves a diversification of energy supply and more focus on demand management. Water availability, whether due to natural conditions or to use in competing sectors or countries in transboundary basins, affects the opportunities for diversification and thereby energy policies.



> “Countries' choice of energy mix can have transboundary and long-term implications on water and food security.”

Figure 2. Northwest energy capacity profile, Columbia River Basin.

On the demand side, energy efficiency may often be the most cost-effective solution, reducing the need for additional investments in supply capacity. At the global scale, the most important contribution to reaching energy security and climate goals comes from energy efficiency (IEA 2011). In the Columbia River Basin, energy efficiency was estimated as the region's third largest 'resource' after hydropower and coal as it reduced the need for investment in energy production (Figure 2). Energy efficiency may also create nexus benefits, as the energy saved in one sector is available for other uses, e.g. irrigation for food production. Consequently, investments in energy efficiency are an important driver of sustainable development in the green economy, mitigating nexus trade-offs.

Different countries face different challenges in the transition towards a low carbon economy depending on factors such as their level of natural resources, consumption and production of energy, degree of infrastructure development and the technological capacity to diversify their energy mix. This is important in a transboundary context as illustrated for the Nile basin where the upstream countries such as Congo and Ethiopia possess huge hydropower potential whereas the downstream country of Egypt has an electricity consumption per capita more than 10 times higher than any of the other 10 riparian countries. Cooperation between riparian countries provides important tools to mitigate current and future energy security challenges in international river basins. Construction of regional electricity grids and establishment of regional energy markets may create flexibility in energy systems and a diversification of supply (Box 4).

However, decision-makers may have quite different perceptions of what energy security means and countries may be reluctant to integrate their energy systems as it involves making their economies more dependent on other countries. Realising the benefits of cooperation on energy systems in transboundary river basins is a key challenge for decision-makers. The goal should be cost-effective and sustainable solutions for a green economy, including maintaining or even improving other benefits the river provides to riparian populations.

The transition to a low carbon energy system also poses challenges to the private sector, which includes developers of the renewable technologies. In promoting development of renewable technologies, governments have to create energy policies that are 'long, legal, and loud'. Energy policies need to be 'long' in the sense that they are built on careful spatial analysis and modelling of future supply and demand, natural resource availability and their impacts on water and food security, as well as the environment. At the same time these policies must take a long-term perspective to introduce a degree of certainty for potential investors. This is important because the energy infrastructure that countries decide to implement now will be the building blocks of the energy system for the next decade. 'Legal' means translating policies into legal frameworks and securing coherent implementation. 'Loud' energy policies convey a strong message to the private sector about the desired development strategies and create powerful incentives for private investments in renewable energies and energy efficiency.

Box 4. Energy security in the Greater Mekong Sub-region (GMS)

	Hydro	Gas	Oil	Coal
	MW	Bill cm.	Mill tons	Mill tons
Cambodia	9,703	-	10	-
Lao PDR	17,979	-	-	20
Myanmar	100,600	590	7	2
Thailand	4,568	340	50	1,239
Viet Nam	35,103	217	626	150
Guangxi	17,640	-	173	2,167
Yunnan	104,370	-	-	23,994

Table 1. Energy resources in GMS countries and regions of China. Source: ADB.

The GMS depends on Middle East oil for 78% of its energy and is therefore vulnerable to price shocks. Establishing a strategic petroleum reserve like OPEC and China have is not an option but regional cooperation does include a petroleum security agreement at the ASEAN level. The GMS countries have diverse energy resources (Table 1) but there is an imbalance between countries in terms of reserves, production and consumption. Sharing of supply through regional cooperation and diversification of energy sources is key to achieving energy security. The regional approach within the GMS includes exchange of knowledge and experiences of management, best practice energy efficiency improvement and establishing regional power grids and power markets. This can solve some energy security problems and balance resource differences while providing revenues for economic development for resource rich countries. In this way regional power grids can become a driver for other infrastructure development, including hydropower dams. Diversification of energy sources would involve an increasing share of renewable energy, including sustainable hydropower development and biofuels, which potentially have impacts on water and food security. Assessments of hydropower development, including installations on the mainstream of rivers, show that it would decrease the availability of living aquatic resources, with a negative effect on food security. Bio-energy expansion implies increased production of e.g. sugarcane, palm oil and cassava, which may increase regional sufficiency and long-term sustainability of fuel supply, but may also create food security problems by replacing traditional crops with plantations and also land access problems, which mostly affect the poor.

2.3 Population, economic growth and changing consumer habits

The key food security drivers are population growth (more people to feed) and economic growth. As people's incomes increase they consume more food and tend to eat more meat, which costs more to produce in terms of land, water and energy per calorie than other sources of food. Furthermore, practices such as biofuel production put pressure on land resources, while climate change is a challenge for agricultural practices and food security. The global discussion on food security is focussed almost entirely on agriculture but freshwater and coastal fisheries and aquaculture are also important for riparian populations, especially for the poor and for supplying proteins and micro-nutrients (Box 5).

Water withdrawal for irrigation has revolutionised agricultural productivity in many parts of the world. In the Indus Basin for example, irrigation has doubled productivity for a range of crops. Similarly, projections from the Niger Basin Authority indicate that a six-fold increase in irrigated area would enable an increase in rice production to satisfy 69% of demand in the basin (up from 17%). In both cases water withdrawal is enabled through construction of increased water storage. The importance of irrigation for food security is also demonstrated in water sector strategies, for instance in the Southern African Development Community region, the water sector priority for food security is formulated as a goal to double the land under irrigation by 2015. All three examples demonstrate the importance and linkages between water and food security in a transboundary context. In addressing food security problems, governments often respond with initiatives that increase water consumption in competition with other sectors and increase the use of energy intensive irrigation practices, i.e. water pumping to compensate for water scarcity in the dry season. A particular challenge in transboundary river basins is that downstream users may suffer. Many examples exist of river basins where the water is fully allocated, leaving no room for further expansion in irrigated land area. These include the Yellow, Indus and Niger rivers and the Murray Darling Basin. An additional tendency in agricultural development, e.g. in Africa and South East Asia, is the industrialisation of agriculture through land leasing by foreign investments (see also Box 11, section 7.3). This has a range of implications for the riparian populations as land ownership is not always clear and capacity to understand, engage and benefit from such investments is limited, at both local and sometimes government

level. The land investments also affect water use and therefore water as well as food security (Jägerskog et al. 2012) and transboundary implications may be foreseen when such developments occur in upstream countries.

The documented yield differences between countries and regions with similar climatic and soil conditions suggest that opportunities exist to increase productivity. Various opportunities to potentially improve yields include selecting optimal plant varieties, increased use of inputs, more effective irrigation and more adaptive and informed responses throughout the cropping season(s). An opportunity for sustainable increases in agricultural productivity could lie in the use of supplementary irrigation for rainfed agriculture rather than full-scale irrigation. The value of this approach has been demonstrated in pilot studies in the Nam Ngum basin in Lao PDR, and is particularly relevant in the Mekong region where about 75% of the agricultural food production is rainfed. Groundwater is used for supplementary irrigation in many basins (e.g. the Indus and Ganges) and represents an opportunity in other basins, reducing the need for creation of storage infrastructure, which may help address transboundary concerns. Groundwater is, however, a limited resource and in some basins is already overexploited, which suggests that regulation of groundwater use for irrigation is needed. As mentioned, improved irrigation is only one of many factors affecting agricultural productivity and, depending on the prevailing conditions, only a partial answer to providing the necessary yield improvements to achieve food security. Increasing water use efficiency is generally acknowledged as an area with high potential for productivity improvement. In the Indus basin for example, it is estimated that only half as much water is required to produce current agricultural production as what is actually used.

> “Improved irrigation is only one of many factors affecting agricultural productivity and only a partial answer to providing the necessary yield improvements to achieve food security.”

Inland fisheries and aquaculture are often regarded as an addendum to agricultural production when discussing food security in river basins. The coastal and marine fisheries and delta aquaculture fed by river nutrients in transported sediments are similarly disregarded. Many river basins treat fish as a biodiversity and ecosystem conservation issue rather than a food security one (e.g. Columbia, Danube and Yellow rivers). For other rivers, like the Mekong, fish and other aquatic animals are of key importance to food security (Figure 3), particularly for poor and vulnerable people and therefore a key aspect in addressing nexus trade-offs such as the potential impacts from hydroelectricity dam development on wild fish catch (Box 5).

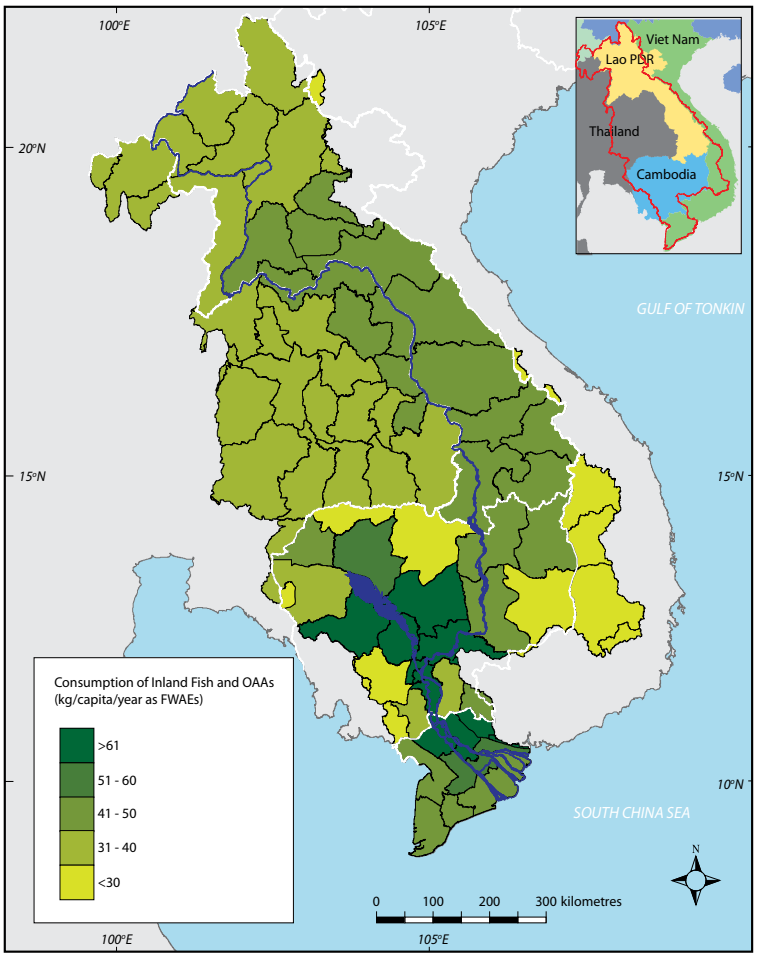


Figure 3. Consumption of Inland Fish & OAA in the Lower Mekong Basin In kg/capita/year as FWAEs (Fresh Whole Animal Equivalent weights) (Hortle, 2007)

Box 5. The Mekong fishery – contribution to food security

Capture fisheries contribute most to total catches in the Lower Mekong Basin (LMB) but their importance is under-recognised due to a lack of statistics on most elements of the fishery. In particular, no statistics are regularly collected to quantify catches from small-scale family fishing (part-time or seasonal), which produces most of the total catch. LMB governments generally promote aquaculture to compensate for a perceived decline in capture fisheries, as well as to stabilise production and income and to increase export revenue. Aquaculture is well developed in Thailand and Viet Nam, where it may be contributing about half of the total yield from the fishery, whereas the capture fishery is much more important in Cambodia and Lao PDR. A regular and accessible supply of good quality water and the availability of flat land are features that favour aquaculture, so many areas of the LMB appear to offer opportunities. However, development is constrained by a number of factors, including the availability of breeding stock and feed, security of tenure of land and water, capital and technical know-how. Capture fisheries can generally offer a much higher return than aquaculture for the millions of individuals who make relatively small investments in equipment to fish for subsistence or supplementary income. It is estimated that about 40 million or 66% of the LMB population is involved in fisheries activities at least seasonally or part time. The yield of wild fish and other aquatic animals in the inland LMB is estimated at about 2.3 million tonnes (Mt) per year. Aquaculture production is estimated at about 1.9 Mt and about one million tonnes of aquaculture products are exported from the basin. This estimate is conservative as it does not take into account wastage and use in fish and animal feed. At current first-sale prices, the total value of the fishery (capture and culture) is about US$3.9–7 billion per year (range due to variation in wholesale prices), but its value could also be judged by its replacement cost, profitability, contribution to food security and nutrition. It is estimated that fish supplies up to 60% of high quality protein for the LMB populations. The nutrients and organic material in the Mekong's plume support a significant coastal fishery. Assessments of the plans for hydropower development suggest that fisheries will be substantially affected, mainly due to obstruction to fish migration. Aquaculture and reservoir fisheries can't compensate for the loss of wild fish production, which means that the planned hydropower development thus threatens food security.

Source: MRC, 2010.

2.4
Nexus solutions and challenges

Smoothing out of seasonal differences in rainfall, and thus water availability, has greatly assisted basin populations gain access to water and food and, in cases where water storage is also used for hydroelectric power generation, also to energy, e.g. the Indus, Niger and Yellow river basins. Solutions to food, water and energy security are, in this way, found or planned by the three areas working together. Greater cooperation and joint investment make for better solutions and, conversely, a lack of transboundary cooperation and investment in river basins holds back development.

A regional perspective on nexus resources management can provide mutual benefits for riparian countries and national natural resource constraints can be alleviated through transboundary cooperation, infrastructure development and trade among countries in the region. For example, in Southern Africa the basins in the south face increasing water scarcity and have the highest food, water and energy demands. The northern basins have plenty of water but it is not providing significant benefits for their economies and their energy demands are low. From a regional perspective the solution could be investments in hydropower and food production in the north for exports to the southern countries. This would make it possible for southern basins to free water from irrigation to industrial and commercial expansion, creating a larger labour market and reducing the dependency on coal-fired thermal power stations. Addressing water, energy and food security at the transboundary level has a potential to generate closer strategic links between countries around regional solutions, eventually improving sustainability and regional political and economic security.

The situation in the Nile Basin also demonstrates the opportunities of the nexus approach in a transboundary context. The major differences in water availability across the basin, the upstream potential for hydropower development and downstream demands, as well as major differences in economic development, suggest that cooperation to optimise water resources development considering water, energy and food security would have huge potential benefits. The past lack of cumulative impact monitoring and management and a complex governance situation in the Nile Basin has resulted in serious environmental degradation and the expected nexus deliverables are not yet realised. A comprehensive basin-wide study was undertaken to analyse the electricity demand and supply balance at a

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Addressing water, energy and food security at the transboundary level has a potential to generate closer strategic links between countries around regional solutions eventually improving sustainability and regional political and economic security.
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regional level. The study recognised the need to plan hydropower development in the context of multipurpose use of water resources to maximise benefits and minimise negative cumulative impacts. It also proposed a robust transmission back-bone to ensure adequacy and reliability of power supply as well as maximising the inherent opportunities presented by the vast energy resource mix in the region.

Some governments see development of dams in many of the shared river basins as a tool for transboundary approaches to water supply, job creation and economic growth, illustrating the water, food and energy linkages. Yet challenges remain, especially for local communities, ecosystem health and fisheries. Increased dam development for energy production, irrigation or flood control threatens the inland, delta and marine fisheries through impacts on fish migration and loss of habitats and livelihoods. Capture fisheries are in many cases an irreplaceable source of food that can't be replaced by increased aquaculture and reservoir fisheries. Local communities also face challenges through loss of land, which may be only partly addressed by relocation and compensation. New approaches are needed to optimise benefits for all water users, including the local population (see section 4.3).

Climate change is expected to cause sea level rise and increase seasonal climate variability, resulting in increased floods and droughts, which may affect water and food security. The adaptation responses (Figure 4) made for each part of the nexus can affect the others negatively or positively, e.g. the agricultural sector may wish to increase irrigation to combat drought impacts, which results in increasing water and energy consumption; and flood mitigation may warrant construction of extra storage, providing opportunities for power generation and increase in water level and river flow during the dry season.

Assessing, mitigating and distributing trade-offs such as the loss of fisheries and benefits, such as flood control and energy production across borders is a complicated endeavour, which calls for intense dialogue between stakeholders across multiple levels

"Assessing, mitigating and distributing trade-offs such as the loss of fisheries and benefits, such as flood control and energy production across borders is a complicated endeavour, which calls for intense dialogue between stakeholders across multiple levels."

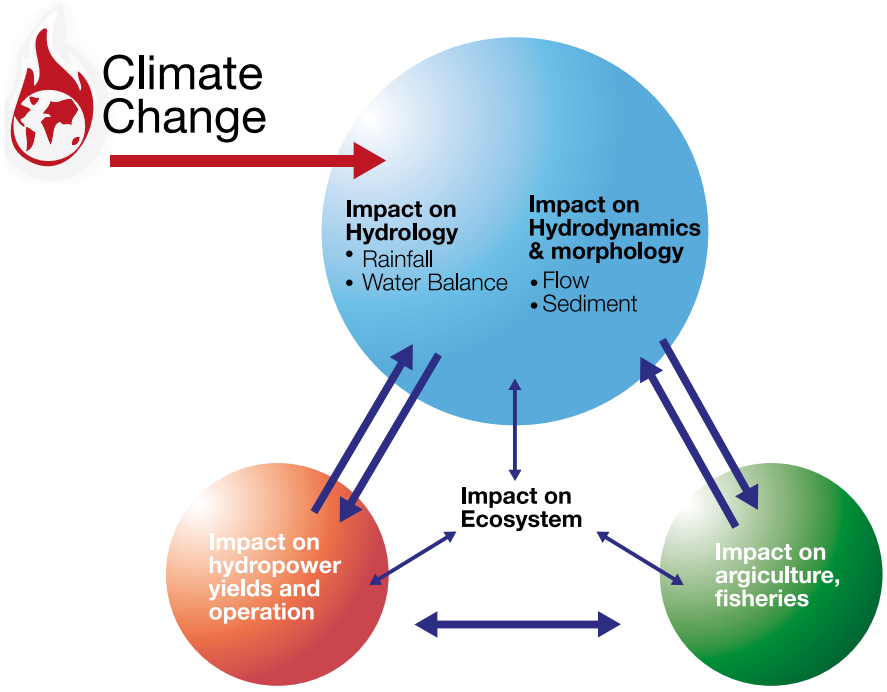

Figure 4. Implications of climate change adaptation on water, energy and food security.

3. Investing in natural capital and benefiting from productive ecosystems

The predominant economic development paradigm in many countries needs to change towards a more balanced approach which recognises the importance of investment in and protection of natural capital and the need to maintain livelihoods and ecosystem functions by moving towards greener economies.

3.1 Ecosystems and biodiversity – lessons from the world's rivers

Many of the world's large rivers have been developed to harvest nexus benefits such as energy production and water for irrigation. As populations and agriculture develop along the river banks, flood protection is implemented and the rivers become receptacles for human and industrial waste. These interventions have had a major impact on the environmental quality of many rivers, including their water quality, sediment transport, ecosystem health, biodiversity and ecosystem goods and services.

Many river basins face water quality problems caused by discharge of wastewater from growing populations and industrial development as well as runoff from agriculture containing excess fertilisers and pesticides. In transboundary rivers, an additional complexity arises as pollution may affect other countries. This is initially dealt with by establishing transboundary environmental monitoring systems to assist basin management. Water quality problems are, for example, experienced in the heavily populated Ganges River Basin, where a Ganga Action Plan was initiated in 1985 to try to improve the river's environmental quality. It was only partly successful and was replaced in 2009 by the establishment of the National Ganga River Basin Authority, which is chaired by the Prime Minister and is attempting to foster a whole-of-basin approach to ensure effective abatement of pollution and conservation of the river. The International Commission for the Protection of the Danube River also has pollution reduction as one of its management programmes, targeting water quality improvements through improved wastewater treatment. While this has improved the water quality, problems related to excess nutrient runoff from agriculture and hazardous substance pollution are still considered important management issues for the Danube. The lessons learned from these experiences suggest that wastewater treatment and other

measures to abate pollution should be implemented in the first place rather than after the damage is documented, by which time work will be needed to not only reduce pollution but also to restore damaged ecosystems.

Construction of dams or other regulators changes the river flow regime and natural sediment transport and affects environmental flows, i.e. the flow of water within rivers and groundwater systems to maintain downstream ecosystems and their benefits. It is not only a matter of reduced flows but also shifting in seasonal variations and reducing seasonal variability (e.g. increasing low-flow and reducing high-flow levels). This will affect seasonally inundated wetlands and species whose life cycles respond to the seasonal variation, e.g. fish spawning. Trapping of sediments behind dams and the effects this has on sediment and nutrient transport downstream – and eventually the impacts on river deltas and coastal waters – have been documented for many large rivers including the Nile, the Indus and the Mississippi. Sediments are deposited in the deltas and their loss means that the coastline will recede, such as in the case of the Mississippi delta. The nutrients attached to the sediment feed the flood recession agriculture along the rivers as well as the coastal fisheries at the delta. Trapping of these nutrients means the collapse of coastal fisheries, as was experienced in the Mediterranean Sea outside the Nile delta, the Mexican Gulf outside the Mississippi delta and the Arabian Sea at the Indus delta.

Reduction in environmental flows is frequently experienced in river basins where water extraction for agriculture, industry, energy and household consumption, as well as constructed storages, reduces the flow, particularly in the low-flow part of the season. An example is the Yellow River, where the environmental flow was used as one of the key parameters considered in restoration and protection efforts.

Another parameter used to assess and monitor environmental impacts on species and ecosystems is connectivity or habitat fragmentation. This is used in the Danube and has been used to try to predict the possible impacts of dam development in the Mekong River, where planned dams would drastically reduce ecosystem connectivity in the Lower Mekong Basin. A key issue in relation to ecosystem connectivity is the barrier effect to up- and downstream fish migration. The impacts of dam developments in the Columbia and Mississippi rivers on the fish stocks clearly document the damage of habitat fragmentation on migratory fish.

3.2
Cultural value of rivers

Planning for development is about finding optimal solutions, not only in terms of energy and food security but often also meeting other needs, such as the need to consider a river's cultural or spiritual values.

In the Ganges River Basin for example, one of the most heavily populated river basins in the world, the river is not only a lifeline to millions of people who depend on it for their daily needs, but also regarded by Hindus as the most sacred river. People bring their dead to the river, whether bodies or ashes, to send them to the next world. Sometimes, if a family cannot afford firewood for cremation, a partly burned corpse is thrown into the water. For the living, bathing in the Ganges is just as important, to wash away their sins in these holy waters.

In the Mekong River, Buddhist traditions include several religious ceremonies and traditions, including the water festival held at New Year in April and the boat racing festival in October. Festivals are annually held along the length of the Mekong river, mostly linked to agricultural seasons or Buddhist holidays. Local communities give thanks to the spirits of the land, trees and water, for allowing crops to flourish, fisheries to provide food, and protection for the lives of both the living and the dead. Each town and village has their own activities taking place at specific spots along the river with a long history going back generations. The banks of the Mekong and its tributaries have lent themselves for centuries to spiritual contemplation, resulting in many temples and sacred trees being sited on points which afford unparalleled views across the river. Most large trees in Thailand, Lao PDR and Cambodia are believed to have a soul or resident spirit. Stands of spirit forests are closely associated with the spiritual welfare of individual villages and different ethnic groups, and their decrease through commercial development is one of the great cultural losses of LMB countries (SEA 2010).

A river's religious and traditional cultural significance has a bearing on the development of infrastructure projects. In India it concerns the importance of the uninterrupted flow of the Ganges, diversion of the river from its course and leaving large stretches dry or with little water; and the effect of hydropower projects on water purity. In the past, Indian courts have directed the government to release excess water into the Ganges (which would otherwise be diverted for agricultural use) during the holy 'Magh' month (January-February) so people can perform religious ceremonies at the holy city of Allahabad. One reason for the establishment of the National Ganges River Basin Authority was the demands of civil society, including religious leaders.

In the Mekong context, the cultural issue concerns the permanent inundation of the river bank stretches where ceremonies used to take place. The loss of spiritually and culturally significant locations (spirit forests, cultural sites) is something considered in an EIA of infrastructure projects, but the extent to which this has affected decision making is not known. In the Lancang River (the Upper Mekong Basin), one of the mitigation actions in relation to hydropower developments was the relocation of ancient trees, an indication of the value attached to them.

The Godavari river in India is used for bathing, religious immersion, drinking, sewage disposal and ridding of dead bodies. Photo by Rod Howes.

3.3
Nature becomes part of the solution

Services from ecosystems underpin water, food and energy security – whether abundance of fish, flows to turn turbines or water stored to mitigate scarcity and supply irrigation. Services provided by nature perform many of the functions of infrastructure, e.g. upland watersheds store water, wetlands store and clean water, floodplains buffer floods, rivers provide water transport and mangroves and coral reefs reduce disaster risk for coastal communities. These services are known as natural infrastructure. In fact, ecosystem services are at the centre of the water, energy and food security nexus (Figure 5).

However, the value and productivity of ecosystems are often overlooked. The costs and benefits of the infrastructure functions of nature, including for lowering risk, have typically been excluded in policy frameworks for economic development and poverty reduction. But there is a case for investing in 'natural' or 'green' infrastructure. It supports multiple objectives, such as drinking water, livelihoods and biodiversity conservation (e.g. environmental flows).

Ecosystems are an integral part of the water infrastructure necessary for urban and peri-urban development. Including natural infrastructure as a way of meeting the water needs of cities and urban areas will have benefits in terms of conservation, development and cost-effectiveness. The benefits of adopting this approach often exceed the costs, for example, Beijing, a city of almost 20 million people, saves US$1.9 billion per year in water supply and water filtration functions by protecting the forests of the city's upstream Miyun watershed. Similarly, in New York City, the costs of conserving the forests and wetlands of the Catskill, Delaware and Croton watersheds to maintain water quality were less than a third of the projected cost to the city for building a new water filtration plant. In Uganda, the Kampala wetlands provide waste water management benefits worth US$1.9 million a year (Krehnak et al. 2011).The costs of ignoring ecosystem services can be very high, especially for the poor and vulnerable. In the Senegal delta for example, the Diama dam was constructed in 1985 to stop dry season influx of saline water into the lower delta and to store water for irrigation. But without the annual floods, the delta became more saline, choked with invasive weeds and carried more water-borne diseases. Only 44,000 ha of the planned 375,000 ha of irrigation were farmed. Daily income per fisher was reduced substantially, grasses, which women used for weaving, died and livestock grazing virtually ceased. In 1994, managed flood releases were instigated to restore seasonal flooding to the delta, resulting in a return of ecosystem services. By 1998, daily income per fisher was restored, more than 600 women were collecting weaving materials from the delta and cattle were again grazing there (at the rate of more than 150,000 cattle days per year) (Krehnak et al. 2011). The lesson from this and many other examples is that ecosystems are needed for the functioning of society and the economy and hence need to be considered in efforts to achieve energy and food security.

Fixing past failures to incorporate nature into infrastructure investments is costly. In another example, from the Komadugu Yobe basin upstream from Lake Chad in Nigeria, engineers built dams in the 1960s and '70s to supply fresh water to the expanding urban population of Nigeria's second largest city, Kano. Altered streamflow patterns downstream devastated ecosystems and a reduction in annual flooding meant a lack of water for crops. Fisheries, agricultural and pastoral livelihoods were destroyed. To overcome this ecological imbalance and restore the basin and food and water security for the 23 million people living there, in 2006 the Government of Nigeria and the governments of the six riparian states set up a US$125 million trust fund for the Komadugu

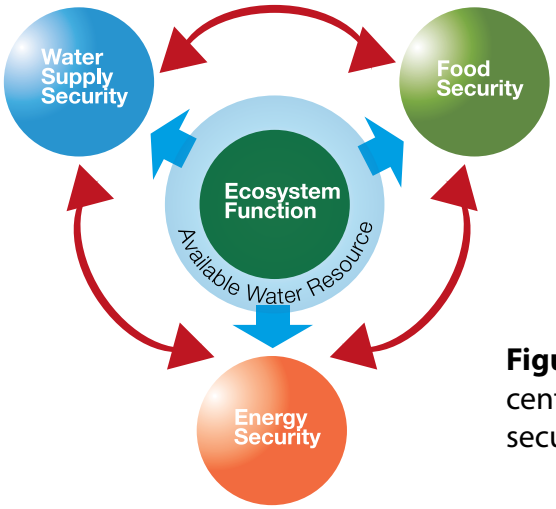

Figure 5. Ecosystem functions are central to water, energy and food security. Modified from Hoff 2011.

Yobe Basin. Investment in the natural infrastructure of the basin means that river channels are being cleared, wetlands and fisheries restored and navigation is once again possible (Krehnak et al. 2011).

The key to working with ecosystems in the nexus is to be able to quantify the services they provide and estimate their economic value. Economic valuations from the infrastructure benefits of ecosystem services are based on market prices for products (e.g. wetland fisheries), the cost of replacing ecosystems through engineering (e.g. water filtration) or the costs of damage avoided (e.g. flood attenuation).

Strategies for investing in natural infrastructure can readily be incorporated into broader infrastructure packages but appropriate mechanisms for investment are needed. The major forms of investment in natural infrastructure include:

- Public-private partnerships for payment for ecosystem services– to promote the conservation of upstream areas through compensationforecosystem-friendly land-use practices
- Strategic river basin investment – can be the basis for strategic nvestments in multiple sectors, e.g. Columbia's Magdalena Basin, where faced with historic, year-long flooding, the government has realised that ecosystem-based approaches to planning and development are needed
- Sustainable dam management to help meet water, energy and food demand
- Certifiable standards for watershed stewardship.

Integration of natural infrastructure in investments is fundamental to greening of the economy. There are limits to what ecosystem services will achieve but the limits are not clear. Planners need to combine built and natural infrastructure and start projects by looking at what ecosystem services already exist and what functions they can perform.

4. Poverty reduction through development and access to resources

The rural poor in many countries depend on wetland related food production such as rice and fish, making them very vulnerable to any reduction in access to water for their basic livelihoods. Infrastructure development for large-scale energy and food production in transboundary basins needs to address this nexus issue through thorough analysis and stakeholder dialogue, including mitigation considerations.

4.1 Access to basic needs – water, energy and food security

Documenting the success of transboundary cooperation on nexus solutions, such as improving food security and providing access to safe and reliable water and energy services, is a complex task. While substantial progress has been demonstrated for the MDG target on access to safe drinking water, access to basic sanitation lags behind. Water also plays a major role in other MDGs and their targets related to poverty, health, food security and the environment. For most of these goals progress remains slow. Similarly, other indicators show little improvement: the number of people living with water scarcity is expected to rise until 2025, water withdrawals keep rising, access to water services is still a major problem in many basins and the fight against malaria has started to show results, cholera – another water related disease – is becoming more prolific.

Multipurpose dams have been able to provide outputs related to all three nexus security issues. In Yunnan Province, China, the cascade of dams on the Lancang River (Upper Mekong Basin) provides electricity as the key driver and, in addition, economic growth, with the aim of improving the province's status as second to last in terms of GDP per capita. The associated benefits include flood control, irrigation and water supply. In the Indus basin, better regulatory control of river flow and the use of groundwater supplements to irrigation water have resulted in substantial increases in agricultural productivity and an end to the famines of previous times. Hydropower outputs from the basin have increased electrification of industries, irrigation systems and villages, increasing the number of electricity consumers six-fold. In the Niger Basin, three dams have been planned

and commissioned for construction to provide hydroelectricity. The increased water flow, particularly in the dry season, will enable two farming seasons and improved navigation. The expected results up to 2027 include a fivefold increase in the area of irrigated land and number of jobs created and substantial improvement in self-sufficiency for rice.

The economic growth created by developments in the water, energy and food sectors have and will continue to reduce poverty as society develops, but the extent to which the benefits initially reach poor people is not clear and in some cases the poor are the first to pay the price for such developments. The trade-offs of developments such as dams, including impacts on ecosystems and the services they provide, such as wild fish catch, collection of other aquatic animals and various materials used for clothing and shelter, affect people depending on these services. These natural resources are the basis for the livelihood of the rural poor.

4.2
Livelihood dependence on natural resources

The most vulnerable to any reduction in access to basic needs are the rural poor. It is characteristic of many of the large river basins in developing countries that the rural people account for about 70% of the population. This is the case for the Niger, Congo and Mekong basins. There are many definitions of poverty, related to monetary measures, nutrition (calorific values) and access or rights based approaches to water, food, energy, education, health services etc. Different pictures and policies emerge depending on which aspects of poverty/wealth are focused on. For example, the definition of poverty as $1 per day can lead to a (worthy) focus on increasing cash income, but other dimensions may be overlooked. Lifestyle opportunities, health and education are also important. There is no perfect method to address all concerns and expectations across cultures and countries. Monetary and calorific values are however obvious choices considering the linkages between poverty and water-related resources (agricultural products such as rice, fish and other aquatic animals).

In the Mekong river basin for example, studies indicate a high reliance on wetland dependent local foods, especially rice and fish. These water-dependent resources contribute about one-third of the income for the populations living within a 15 km corridor along the Mekong. More than 80% of the calories come from rice, while aquatic based food (fish and other aquatic animals) contribute up to 15% (Hall and Bouapao 2011). If this source of food was removed, the daily intake would drop below the recommended food poverty level defined by minimum daily calorie intake, indicating the value of fish and other aquatic animals for food security for people depending on subsistence food sources (Table 2).

Vulnerability is expressed through people's ability or inability to shift to other sources of income, such as livestock rearing or employment, and their opportunity to buy food if the subsistence fishery declines. Poor people are the most vulnerable as they lack the necessary resources and capacity to change occupations and would have difficulty earning the extra income to purchase more of the food they need. Even though fish and other aquatic animals may not form a large proportion of the daily calorie intake or income source, a small shift such as eliminating the contribution from fish and other aquatic animals, can push people below the poverty line. Poor people are therefore very vulnerable to changes in access to these resources.

The substantial reduction in wild fish catch caused by dam developments, which has been documented in major river basins such as the Columbia and Mississippi, means a substantial loss of animal protein, a source that needs to be replaced somehow. Such a shift would have knock-on effects on land use, the economy, the environment and society. Replacement of fish protein through livestock and protein rich crops would require a significant increase in agricultural area and water use. To grow livestock or protein sources, such as soybeans requires water for irrigation of fields and pastures as well as a substantial increase in agricultural land. With the prospect of an increased food and water demand, which is already adding to the pressure on water and land, this is probably not a sustainable scenario. Most likely, the need for imported foodstuff would increase along with increased prices for protein, affecting the poor. As an example from the Lower Mekong Basin reveals proposed dam construction in the Lower Mekong Basin predicted to considerably reduce fish catch place heightened demands on the resources necessary to replace lost protein and calories. Additional land and water required to replace lost fish protein with livestock products have been modelled using land and water footprint methods. Two main scenarios cover projections of these increased demands and enable the specific impact from the main stem dam proposals to be considered in the context of basin-wide hydropower development. Scenario 1 models 11 main stem dams and estimates a 4–7% increase overall in water use for food production, with much higher estimations for countries entirely within the Basin. Land increases run to a 13–27% increase. In scenario 2, covering another 77 dams planned in the Basin by 2030 and reservoir fisheries, projections are much higher: 6–17% for water, and 19–63% for land. These are first estimates of impacts of dam development on fisheries and will be strongly mediated by cultural and economic factors (Orr et.al.2012). Such increased water requirements would probably be possible to accommodate, but a requirement for additional pasture land at the mentioned scale is presumably unrealistic considering that the agricultural land area in the Mekong

basin is constant or slightly declining. The alternative would be importing food, which would result in land use changes and affect water, energy and food security issues in exporting countries as well as placing economic pressure on the importing countries and increasing food insecurity for poor people due to a need to buy protein sources. This would add to regional, and perhaps even global, food insecurity.

Study Site	Rice	Aquatic	Other	Total
Cambodia Study Site	1,643	335	143	2,121
	77%	16%	7%	
Lao PDR Study Site	2,377	300	494	3,171
	75%	9%	16%	
Thailand Study Site	1,854	281	336	2,471
	75%	11%	14%	
Viet Nam Study Site	1,445	301	120	1,864
	77%	16%	6%	
All Study Sites (No.)	1,850	303	274	2,407
All Study Sites (%)	76%	13%	11%	

Table 2. Pilot survey estimates of food (kcal) from wetland related resources in the Lower Mekong Basin (Hall and Bouapao 2011). The World Bank poverty line is 2100 kcal.

4.3 Mitigation of development impacts and benefit sharing at local level

> "The rural poor are the most vulnerable to any reduction in access to water resources such as fish which they depend on for nutrition and livelihood."

Considering reservoirs as multiple use systems that can contribute to local livelihoods as well as generating hydropower ensures that local people derive benefits from hydropower developments. This has its challenges, however. One of the key issues is the lack of land. Exploiting the seized land areas around the reservoir that are only inundated part of the year is one approach (Box 6), which would address some of the issues of relocation. Resettlements and moving away from the livelihood activities people were familiar with and adapting to new opportunities can often be difficult. Ensuring that new livelihood opportunities are technically viable is important. Moreover, to ensure long-term sustainability and success, it is critical that these livelihood opportunities are socially and economically suitable and take into consideration local cultural contexts and also the institutional constraints both within and between the countries. Management of these challenges requires careful analysis of the different impacts faced and/or understood by various stakeholder groups and their direct participation in planning and management processes such as designing and implementing resettlement plans. Mechanisms to enable these practices and minimise institutional constraints need to be incorporated simultaneously.

There are several examples of retrofitting infrastructure to mitigate impacts on ecosystem services, such as opening of spillways of dams to allow fish passages, which however is very costly in terms of lost power production. This is being experienced in the Columbia River. In the Senegal Delta, managed flood releases were instigated to restore seasonal variability, thus allowing local people to enjoy the benefits of the ecosystem services they had lost when the dam was built. Repair of such failures is very costly, not only in terms of cost of investment and lost production, but also in terms of the suffering experienced by local people.

Box 6. Benefit sharing at the local level – living with hydropower projects in the Mekong Basin

Living with hydropower projects is an approach to enhance the livelihoods of local people. This approach treats hydropower projects as multi-use systems that can contribute to local livelihoods as well as generating hydropower or providing water for irrigation. It has been developed by studying cases in Lao PDR, Cambodia and Vietnam under the "Challenge Program for Water and Food in the Mekong", which showed that distribution of costs and benefits of hydropower projects can vary across social groups and localities, i.e. among upstream-downstream communities, gender and ethnic groups. The sharing of benefits at local level included sharing of project services (electricity or water supply), sharing of non-monetary benefits (resource entitlements and priority in hiring) and sharing of monetary benefits (development funds, taxes, revenue sharing and sharing of ownership). The electricity supplied to national power grids was claimed to also benefit the local population. The non-monetary benefits relating to enhancement of livelihood options have not been well studied. Monetary benefits were often provided in forms of development funds and taxes to local authorities. There was no clear mechanism to ensure that the revenue was used specifically for local development and more direct sharing schemes have not been widely used.

Key issues identified with regards to people's livelihood were limited access to agricultural land and limited diversification of livelihood strategies. In response to these findings, introducing farming systems that are adapted to the variations in water levels created by the reservoir projects is now being tested. These systems include adapting to farming in draw-down areas of the dams and shifting to 'rice-fish' systems, where flood waters fill rice paddies during the wet season, turning them into fish ponds. Such innovative development of small-scale farming systems can increase land availability, improve livelihoods and provide non-monetary compensation and benefit sharing, at least for people in the reservoir area.

Source: AIT and Challenge Programme for Water and Food.

5. Creating policy coherence across the nexus

The nexus approach, its elements and thinking are not entirely new in water resources management. Integrated water resources management (IWRM) also has a strong focus on engaging all relevant sectors. The innovation in the water, energy and food security nexus approach is to engage the three important sectors on equal grounds with the aim of breaking the walls between the 'silos'.

5.1 Engaging water, energy and food security on equal grounds

The key innovation of the nexus approach is that it recognises that water resources management, at national and river basin level, is not only for water or environment ministers. Because of their particular importance compared to other sectors, the energy and food aspects need to be included on equal grounds and not as mere 'water stakeholders' to secure real engagement and create policy coherence across the nexus.

IWRM provides a framework for water policy and strategy development at national level, in most countries through the development of IWRM plans and strategies with IWRM defined as: "the process, which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of ecosystems" (GWP 2000). The essence of IWRM is that such developments happen in an 'integrated' manner, involving national economic planning authorities and the many sectors that depend and/or impact on water resources (such as, in addition to food and energy, domestic use, health, recreation/ tourism, navigation and industry), along with relevant stakeholder groups in civil society, private sector, academia etc. In some countries (such as Malawi and Zambia) the IWRM process has been driven by the national planning authorities and thus truly involved all sectors from the outset. In most countries however, the process has been driven by the 'water/ environment sector', with other sectors consulted but not substantially involved. Hence in most IWRM planning the water demands and water quality requirements of all sectors may have been addressed, as well as the impact of these sectors in the water resources system, but the policy and strategy developments within sectors themselves have not adequately considered the vital cross-cutting role of water. A well designed IWRM process should ensure this, but too often does not reach the policy level in energy and water sectors and a gap between

policy and implementation has been recognised. The nexus thinking and IWRM principles are aligned, but the practice of true involvement, and ownership, of the food and energy sectors in IWRM is often lagging behind, which is what the water, energy and food security nexus approach aims to solve.

The nexus approach makes it explicit to explore the opportunities of coordinated and integrated actions between water, energy and food and aims to break down the 'silo' thinking between the three development areas (Figure 6). More strategic and long-term discussions of national water, energy and food security policies and their inter-linkages are needed. As the energy and food sectors are brought into discussions, the opportunities for broader discussions may be increased. Instead of simply discussing water demand for the energy and food sectors, and trade-offs between competing water uses in the basin, the nexus approach would discuss food, energy and water strategies that optimise benefits from all angles. Mechanisms for addressing the trade-offs, including those affecting ecosystems, need to be jointly considered in dialogue between the sectors themselves to ensure policy coherence at national level, and proper coordination, planning and joint operations at basin level.

While IWRM at the national level focuses on policies and strategies, water management needs to respect the basin as the basic unit for implementing IWRM on the ground, and hence also for addressing the nexus. To understand the water, energy and food security nexus in a basin (river, lake or groundwater) requires an integrated basin-wide perspective of future development options, together with building knowledge and encouraging dialogue among all stakeholders about the opportunities and risks of more cooperative basin-wide management. This may happen in the context of a formal river basin organisation or through more informal processes. IWRM offers a well-known framework for these discussions in a basin context and is particularly useful because it is implemented at all scales, from watershed through to the transboundary basin. However, it is necessary to accommodate the ambitions of the nexus approach by active involvement and buy-in by the authorities and other stakeholders of all of the three sectors (Box 7).

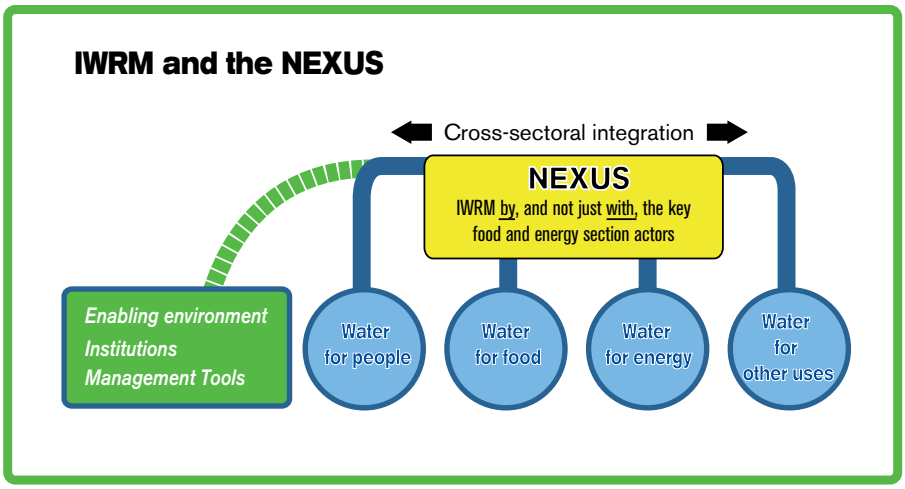

Figure 6. The difference between IWRM and nexus approaches. In blue, the traditional IWRM illustration of cross-sectoral integration at the top, 'touching' the sectors, and in yellow the 'deeper' and more inclusive integration with the food and energy sectors

> "The nexus approach makes it explicit to explore the opportunities of coordinated and integrated actions between water, energy and food and aims to break down the 'silo' thinking between the three development areas."

Box 7. IWRM and the nexus perspectives in river basin management in the Nam Ngum Basin, Lao PDR.

The 17,000 km2 Nam Ngum River Basin is situated in Lao PDR, in the upstream part of the Lower Mekong Basin. The Nam Ngum, a major tributary, joins the Mekong at Vientiane and flows through the Vientiane plain, the country's main rice production area. In the past, the basin's inhabitants thought they had plenty of water to accommodate everyone's needs forever. The historical economy focused on subsistence production of rice, collection of forest products, fishing, production of handicrafts from wood, bamboo, and rattan and slash and burn agriculture. Economic development since 1970 includes development of irrigation in the downstream Vientiane Plain to support national food security (large schemes, pump lift). The Nam Ngum 1 hydropower plant with a large storage reservoir on the Nam Ngum River commenced in 1971, and five more hydropower plants are currently under construction or planned. Large-scale gold mining, cassava processing, steel making (melting scrap metals, etc.), potash mining and fertiliser production are also carried out in the basin and water demand from residential and industrial users is increasing. Overall, the basin water resources are adequate for all future uses envisaged within the basin, but proper coordination and consultations between the various interests and stakeholders are essential. Environmental flow from the Nam Ngum into the Mekong is critical for downstream users and ecosystems, particularly in the dry season.

Pollution and flooding are major challenges in the basin. Pollution incidents from some activities have harmed other enterprises and also affected rural communities. In 2011, a large flood seriously damaged rural settlements and destroyed crops and cattle, raising questions about the operation of the reservoirs. The effect of climate change on water and food security is an added concern.

The Lao Government has decided to manage the Nam Ngum basin using IWRM methods, and adopted an IWRM plan for the basin in 2009. By bringing together the representatives of different, and often conflicting, interests and making information available to all, future risks will be recognised earlier and better anticipated, applying the twin principles of user pays and polluter pays. A permanent Secretariat to serve the planned Nam Ngum River Basin Committee is led by the Ministry of Natural Resources and Environment, and sub-basin committees have been formed to engage basin stakeholders. The link to the national government offers possibilities for stronger overall monitoring and management, a pre-condition for effective management of the Lower Mekong Basin nexus, characterised by high capacity for energy production upstream and high capacity for food production downstream.

A special "Hydropower and Mining Forum" is being developed to facilitate cooperation between the government and the hydropower and mining companies, bringing the Ministry of Natural Resources and Environment (water), the Ministry of Agriculture and Forestry, (food) and the Ministry of Energy and Mining (energy) to the table together with the private developers. In a sense, in this way Lao PDR is already practising nexus thinking at the basin level and 'enhancing' the IWRM process through this special forum, bringing together the three key players. The intention is to pilot the forum at basin level – between the specific actors in that basin – and subsequently upscale to national level.

5.2
Particular governance challenges and opportunities in transboundary basins

Engaging the three nexus perspectives and the potential trade-off issues entails a significant shift away from direct sharing of water, which is often at the centre of transboundary river basin management, towards sharing of benefits at a regional scale. This perspective does not necessarily correspond to prevailing national priorities and security concerns. The other side of the transboundary nexus coin is that diverging national interests and issues outside the water, energy and food sectors can make countries hesitant to link their national security to their neighbours. Security concerns, upstream-downstream trade-offs and riparian bilateral relationships may create barriers for realising the advantages of regional management of water, energy and food resources. Overcoming these political barriers is not easy. However, increasingly limited natural resources, a greater emphasis on greener development and constraints on the ability of the natural capital of basins to absorb infrastructure could drive greater integration across the water, energy and food security nexus. This would in turn contribute to greater geo-political stability, while longer histories of regional stability will assist with a growing political willingness to share strategic resources. The potential security considerations involved in transboundary water, energy and food security management calls for an expansion of river basin management to include a broader array of politicians, government agencies and other stakeholders. The collaborative framework of transboundary river basin organisations provides a platform for such dialogues. Some modification or flexibility in interpretation of the current frameworks may be needed to ensure relevant stakeholders are fully engaged and to break down the 'silos'.

One of the great concerns for river basin managers is climate change. It will directly affect the water, energy and food security nexus by changing the availability and sustainability of these resources, particularly the water regime, drinking water, agriculture and ecosystems. The regional scale of impacts as well as the potential solutions and the urgent need for action calls for regional cooperation. Climate change impacts need to be considered within the water, energy and food security nexus perspective. Adaptation measures in one sector of the nexus may have effects on the other issues (e.g. increasing energy intensive irrigation as a response to drier conditions; establishing increased water storage as flood control measures affecting downstream water users). Thus, broad assessments of the impacts of adaptation measures are needed to improve policy coherence. Allocating scarce resources and proposing adaptation measures to meet increasing demand needs to be done without compromising sustainability and by promoting prosperity and human well-being.

Moving towards a transboundary perspective on water, energy and food security issues involves engaging multi-sector and multi-stakeholder platforms for dialogue, planning and decision-making on regional development. Transboundary river basin organisations would be instrumental in facilitating this process, which adds more complexity and more stakeholders to transboundary river basin management – but also increases the chance of realising regional economic, social and environmental benefits of cooperation on water, energy and food resources.

While the regional enabling policy framework for the nexus approach may be available, the implementation is still a challenge.

6. The science-policy dialogue and sharing of data and information

Nexus thinking needs to be based on scientific evidence of the gains to be made. So, an added focus is needed on research and development, including decision support systems and sharing of data and information, along with dissemination of results through a stronger science-policy dialogue.

6.1 Data collection and sharing for transboundary nexus perspectives

Transboundary collaboration calls for scientific evidence on which to base the development of strategies and plans. Similarly, implementation of plans and their impacts, positive or negative, need to be monitored, which requires data and information about the shared river or aquifer system. A common component of most information systems supporting transboundary river basin management is data gathered from monitoring systems designed to collect information regularly about specific parameters, at certain locations and frequencies. The monitoring understandably focuses on water resources related issues such as water quantity and quality and derived environmental aspects (as described in Box 8 for the Lower Mekong Basin), while connections to energy and food are less common, probably because the links between water, energy and food are not made explicit and people do not realise the value of recording this information.

The data compiled at transboundary level may come from either national monitoring systems, where information is exchanged with other countries or from monitoring systems designed and implemented regionally. Information systems range from those where the riparian countries undertake regular monitoring and compile the results in a common database at the regional level, which is the method used in the Danube river basin, to systems where the regional organisation controls the monitoring stations, sampling, analysis and compilation, such as the case of the Niger Basin Authority, which is fully responsible for river monitoring. In the Lower Mekong Basin the approach is somewhere in between as the riparian countries perform sampling and analysis with support from

the MRC Secretariat, which compiles the information and maintains the regional database (Box 8). Although continuous monitoring systems appear indispensable for transboundary river basin management, not all large transboundary river basins have them, e.g. the Nile basin, where basin knowledge so far has been established through inventories and specific studies.

Continuous monitoring systems offer information about a limited set of parameters, usually confined to hydrology, sediment and water quality aspects. Diagnostic studies, specific inventories and studies, and large-scale river basin surveys, on the other hand, can provide a broader general knowledge about a range of physical, environmental, social and economic aspects, which would not be cost-efficient to include in regular monitoring programmes. One such large-scale study is the Joint Danube Survey 2, regarded as the world's biggest river research expedition. It was conducted in 2007 with the main goal to produce comparable and reliable information on water quality and pollution for the entire Danube River and many of its tributaries to raise awareness about the state of the river among riparian populations.

Integrated studies or assessments take the data and information one step further by providing comprehensive analyses to support management at a strategic level through overall assessment of performance of strategy and action plan implementation. These overall assessments aim to provide policy-relevant scientific information and a description of the state of affairs. In a transboundary river basin this information may be compiled in "State of the Basin" reports covering the geographical unit of the basin and responding to relevant basin issues and development strategies. The MRC publishes regular State of the Basin reports, the latest in 2010, and the Nile Basin initiative is planning to publish a State of the Basin report in 2012. These integrated assessments very often consider energy and food aspects more specifically and provide insight into the linkages between water, energy and food security issues, yet very clearly seen from the water perspective.

Access to and sharing of information is a challenge with added complexities in a transboundary context. One issue is the power associated with knowledge and another, the perceived risk of interference by other parties (states). Data gathering and information sharing has been identified as a key factor for successful transboundary river basin management (Falkenmark et al. 2009) and is consistently highlighted in discussions on the perspectives of the water, energy and food security nexus approach. The challenges include the need for gathering and sharing data on energy and food in addition to the current focus on sharing of water resources related data.

Box 8. Lower Mekong Basin monitoring and information system

The Lower Mekong Basin information system has provided a continuous time series on hydrology and water quality for more than 25 years, offering opportunities to analyse system dynamics as well as trends. Data on sediments have recently been added to the routine monitoring and the feasibility of monitoring of anthropogenic substances such as heavy metals and pesticides is under consideration. A system for monitoring of biological parameters, such as zooplankton and benthic organisms, has been developed but cannot yet be considered a routine monitoring activity.

Social impact monitoring and vulnerability assessment is the latest development in the Mekong river monitoring system, aimed at assessing how many people rely on the river's natural resources for their livelihoods, where these populations are located and how vulnerable they might be if the river's resources were reduced. A pilot study was conducted in 2009 (Hall and Bouapao 2010) and a baseline for the Mekong corridor covering 15 km on each side of the Mekong mainstream was undertaken in 2011 (expected to be published in 2012). Future regular monitoring activities will provide updated data, allowing communities and governments to monitor developments and assess trends in people's livelihoods.

The principles of implementation of the Mekong monitoring system include establishing an agreed river monitoring network, using harmonised monitoring methods and full engagement by the riparian countries, which conduct the sampling and analysis in their respective parts of the river basin. The MRC Secretariat (MRCS) receives the monitoring data, conducts quality control, maintains databases and compiles and publishes a regional synthesis. The MRCS also supports the riparian countries in their monitoring tasks and provides capacity building.

Data sharing is regulated by the Procedure on Data and Information Exchange and Sharing, one of the five MRC procedures (see Box 11). The key concept of this procedure is to focus on data and information necessary for implementation of MRC programmes, distinguishing between 'nice' to share and 'need' to share with emphasis on the latter. What is needed can however be interpreted in many ways, which translates into gaps in time series and geographic coverage of databases, including even basic hydro-meteorological data. The factors that in practice tend to impede data and information exchange are numerous while clarity and trust are key factors facilitating data and information exchange.

6.2
Decision support systems to support the nexus approach

Regional decision support systems (DSSs) are being developed in many transboundary river basins around the world such as the Nile, Mekong and Ganges Rivers (Box 9). By integrating data (e.g. climatological, hydrological and environmental data) with simulation models (e.g. water, environment and economic sector output) and applying multiple criteria for analysis, a DSS can produce scientifically validated basin development scenarios presenting costs and benefits to decision-makers. When these models and assessments include the nexus perspectives, as they often do, the trade-offs of the nexus approach are made visible and can be used in dialogues between basin stakeholders.

Building a transboundary DSS that integrates water, energy and food sector developments poses major challenges in international river basins. The scientific basis of a DSS, i.e. data and models, involve the technical challenges of monitoring and modelling complex ecosystems and the multitude of human-environment and economic interactions. DSSs in international river basins also involve a considerable degree of social elements in terms of cooperation, institutional adaption and capacity building. This can be illustrated by the case of the Lower Mekong Basin, where countries wish to retain a capability to verify the results using their own independent capacity. Legal frameworks and regulatory practices and procedures need to be adapted to facilitate data sharing and common monitoring methodologies. Institutions need to develop the knowledge management systems, databases and analytical processes and tools to create interdisciplinary approaches and enable competencies to be effectively deployed.

In reality, transboundary DSSs can suffer from a lack of or poor quality data and be only partly suitable in a nexus context, because they so far have failed to incorporate energy and food security aspects to an extent that make them relevant for these sectors. Insufficient data may be due to low capacities in riparian countries or scepticism among decision-makers about sharing data. Limited coordination between sectors may relate to poor administrative capacities or 'turf wars' between line agencies.

DSSs generated by transboundary river basin organisations can benefit from employing expert teams, where all riparian countries are represented, building their trust in the DSS tools. This is the key approach for the International Commission for Protection of the Danube River (ICPDR), where technical expert groups are populated and led by country experts. Staff of river basin organisations can, through close cooperation with national research institutions, line agencies and other stakeholders, increase ownership of DSSs and help to break deadlocks over information sharing and coordination between line agencies. A DSS that supports transboundary trade-off dialogues on water, energy and food security issues will involve a multitude of actors who each contribute a part of the solution.

Building international institutions that can generate a shared knowledge base, such as a DSS, contributes to informed decision-making and may facilitate conflict resolution. However, scientifically based, technically sound and cooperative DSSs do not in themselves guarantee sustainable outcomes. Decision-makers and other stakeholders may misinterpret or misuse DSS results. The DSS only provides the data, models and scenarios that feed into political negotiations on development of transboundary waters. Scientific and technical knowledge do not necessarily provide win-win solutions where consensus can readily be achieved. Trade-offs between sectors, stakeholders and countries may be inevitable, increasing the risk of conflict. However, a publicly accessible and shared DSS increases the transparency of decision-making and focuses attention on conflicts of interest, distributional impacts and venues for compromise when riparian countries negotiate on the development of nexus resources.

Box 9. Ganges River strategic basin assessment

The South Asia Water Initiative (SAWI), a partnership between the United Kingdom, Australia, Norway and the World Bank is providing support to the countries that share the rivers that rise in the Greater Himalayas. SAWI has recently completed a techno-economic analysis of transboundary opportunities and risks in the Ganges Basin. Building on water and economic models and social analysis, the Ganges Strategic Basin Assessment seeks to understand the possible futures in the basin and create a tool for information-based dialogue in and between countries. The assessment is coming up with surprising answers to key development questions from a basin-wide perspective: Hydropower development in the basin involves small trade-offs in the nexus and positive co-benefits between countries. Upstream hydropower has significant potential to deliver clean peaking power without harming downstream agriculture.

Flood control in the basin cannot be achieved through upstream storage infrastructure. Immediate benefits can be generated from cooperative regional monitoring and warning systems, coupled with localised flood responses that focus on information and institutions.

Low season flows can be significantly increased through upstream storage. However, groundwater storage can provide similar and possibly more immediate benefits at a lower cost.

The assessment effectively addresses current knowledge gaps in the basin and illustrates the economic nexus trade-offs involved in basin development.

6.3 Communication of science and policy impacts

Improved transboundary understanding is vital to the water, energy and food security nexus approach and this will require better data and information critical for sustainable decision making.

Knowledge generation for water management is a highly debated area. Participation needs to start at the stage of identifying the required knowledge, e.g. by establishing partnerships between the government, science and stakeholders. This is the opposite approach to science or experts providing the information they consider appropriate, with the risk that stakeholders find the information inadequate or not relevant to their needs. This highlights the challenges of the nexus approach to satisfy water, energy and food experts and managers. Participation in a transboundary context is further complicated by differences in legal frameworks, political systems, traditions, practices and cultures as well as language barriers, which can be a serious difficulty for engaging local communities and groups. Another challenge is how to manage uncertainty, including unpredictability of complex systems, incomplete knowledge and multiple knowledge frames – which imply the possibility of more than one interpretation of data and information.

The emphasis of transboundary water management has largely been on the outputs of cooperation, i.e. the agreements, organisations, dialogue platforms, databases, reports, strategies and plans. The outcomes – the implementation of basin plans, use of shared data in basin management, regular meetings of political and technical representatives – are harder to see. And the impacts of transboundary water management, which could include infrastructure developed at a transboundary scale, improvements in the state of the basin, water resource benefits that create wealth for the basin population, improved access to water services and protection of international public good, are almost invisible because they are hard to attribute and measure. The communication between science and policy-makers would benefit from a shift in focus from promoting the outputs of cooperation towards outcomes and impacts.

Science based policy recommendations are required to bridge gaps between policy and civil society; recommendations, however, require adequate information packages according to the communication requirements of the specific stakeholders. Experience from the Murray Darling Basin for example shows that good understanding through science and research is needed to create respect and credibility in engaging stakeholders and convincing decision-makers.

To achieve this in the water, energy and food security nexus context, it is important to support science to improve the capacity to conduct integrated water-energy-food scenarios and develop policy options based on them. Data, information and capacity gaps will become evident in such a process. Stronger support within social and political sciences is needed to identify governance and policy changes, institutional development, and economic frameworks related to the management of integrated systems at the transboundary level, supported by a better understanding of present development trends. This also includes a better understanding on externalities across the nexus and across spatial scales, not least the transboundary basin scale, due to massive investment needs in infrastructure related to water, energy and food as well as changes in trade patterns, regional infrastructure cooperation and foreign direct investment flows.

7. The involvement of stakeholders in management of shared river basins

The water, energy and food security issues need to be addressed through thorough analysis and stakeholder engagement and dialogue.

7.1 River basin organisations engaging stakeholders

Who are the stakeholders when we talk about transboundary river basin management? How they are defined and how they are engaged varies widely between river basins. Stakeholders may be the riparian governments and regional NGOs, which is the approach in the Amazon cooperation or they may be the local communities affected by various developments, as in the cooperation between Brazil and Paraguay managing the Itaipu dam across the River Parana (Box 10). Most international river basin organisations struggle to achieve the balance between maintaining a regional perspective and engaging local populations who will experience the (positive and negative) impacts of regional development. As a result, alternative organisations have been established, which focus on public participation and stakeholder involvement, groups such as the Nile Basin Discourse and various NGO forums, including the Save the Mekong Coalition and the NGO Forum in the Kura-Aras river basin. The aim of these groups is to influence development towards a sustainable and equitable course. The Nile Basin Discourse is a civil society network with 1200 members within the Nile basin region which offers a public platform for dialogue, partnership and cooperation among civil society organisations. It provides information and builds capacity to strengthen the voice of civil society groups. Its networking approach has provided a mechanism for coordinated action and has added value to the work of the Nile Basin Initiative.

Box 10. Cultivating Good Water – engaging local populations around the Itaipu Dam on the River Parana

Itaipu is the world's largest hydroelectric power plant. It is situated on the border of Paraguay and Brazil, has a generating capacity of 14,000 MW and took 18 years to build at a cost of about $US18 billion. The dam is administered by Itaipu Binational, a joint Paraguayan and Brazilian government commission, which has spearheaded extensive community activities in the region around the dam under the slogan 'cultivating good water'.

The Cultivating Good Water program, which operates in 29 municipalities of the Hydrographic Basin of Paraná 3 (BP3) is a project developed in partnership with various local actors, which is related to the conservation of natural resources and focuses on the quality and quantity of water as well as people's quality of life. It is a permanent participation movement in which Itaipu Binacional, besides mitigating and correcting environmental liabilities, works alongside society to change its values. It is so extensive that it includes 20 programmes and 63 projects/actions for socio-environmental responsibility. It involves micro-treaties for environmental restoration (i.e. citizens/local communities committing to reduce their environmental footprint), environmental education through developing 'environmental pedagogics', and livelihood diversification (i.e. organic farming, aquaculture, recycling).

Among these projects is the Outreaching Trash Collection, a project providing people with work collecting waste recyclable material, providing employment and also reducing waste. Another initiative, the Organic Life program encourages about 26,000 farmers in the region to move away from chemical use and adopt organic practices. The Itaipu technicians provide support in the production process, stimulate the transformation of artisanal products, help to market produce and in many cases, promote the property as an agritourist attraction. The activities work with a 1:1 investment policy that requires communities to invest an equal amount of money or labour as the Itaipu for community development projects.

7.2
Dialogues across borders

> “
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> Transboundary multi-stakeholder platforms are important vehicles for integration of development strategies, realisation of mutual benefits and a nexus approach.
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> ”

Transboundary water governance involves a wide range of stakeholders, including political leaders and policy makers, sectoral interests such as water storage and delivery authorities, community based water user associations, farming and fishing communities, navigators, ecologists, urban and rural dwellers, the energy and security sectors, universities, research institutions, international organisations, river basin organisations and the media. An important way of getting all these stakeholders on board for effective water management is through dialogue processes. Regional dialogue is a key instrument for achieving nexus results in a transboundary context. Getting decision-makers out of ‘silos’ and ‘win-lose’ thinking is difficult. Transboundary multi-stakeholder platforms are important vehicles for integration of development strategies (mainstreaming), realisation of mutual benefits and a nexus approach.

River basin organisations already use multi-stakeholder water dialogues, for example the South African Development Community implemented a water dialogue approach in 2007, which has been instrumental in serving as a regional, neutral multi-stakeholder platform linking governance levels, water using and impacting sectors and also linking key knowledge generators (science and academics) with policy makers. National and regional development challenges – to a large extent basically nexus issues – were debated and stakeholders agreed on planned outcomes. Examples of issues tackled by the water dialogues were climate change adaptation, water security and IWRM. The African Ministers Council on Water – the African Union specialised organisation for water related policies – also promotes the concept of regional dialogues in its water vision to reach a broader consensus on implementation of the UN Convention on International Watercourses and the UN Resolution on the Act on Transboundary Aquifers.

There is a large potential for civil society to organise multi-stakeholder dialogues in a region with fundamental water issues by creating cooperation at civil society and researcher levels, building understanding of issues and solutions and trust across borders and across stakeholder groups. Ecosystem for Life, which is a Bangladesh-India initiative organised by IUCN, aims to initiate civil society dialogue processes between Bangladesh and India for sustainable management of transboundary water resources. Dialogues are designed to develop a long-term relationship between various stakeholder groups within the country and between the countries and to support a consensus building process on critical transboundary issues. While the actors in such processes remain outside the government or state apparatus, it is of prime importance to establish and maintain links to government agencies to keep them informed and to feed into governmental processes.

Involvement of media representatives can be very important in view of their role in providing communication opportunities between various stakeholder groups. The Mekong Water Dialogues, also organised by IUCN, is another example with a focus on developing and demonstrating participatory processes for improved decision making in water management in the Mekong region (IUCN et al. 2007). Also in the Mekong, M-POWER organises many national and transboundary round table discussions informed by local research. One of these forums (‘Exploring Mekong Futures’) has a specific focus on water, energy and food security (Molle et al. 2009).

7.3
The role of the private sector

Private companies are important investors, developers, producers and consumers of water, energy and food related resources. Their behaviour matters for river basin management and river basin management matters for their businesses.

Private investments in e.g. large-scale water infrastructure, biofuels, agriculture and extractive industries may influence food, water and energy security at both the local and transboundary levels. A single plantation or a small-scale hydropower project may only affect the local communities in the immediate neighbourhood. However, a large-scale hydropower development on the mainstream or tributaries or the accumulated effects of private investments in irrigated agriculture in one country may have transboundary nexus impacts. This makes private investments important for management of international river basins and, at the same time, makes private companies important stakeholders and partners for governments to create sustainable development of transboundary resources. Increasing economic activity puts pressure on natural resources and creates competition between traditional and new resource uses in many developing countries, e.g. through the growing trend of foreign land investments (Box 11). Securing access to resources for a broad range of actors is a challenge for private companies, governments and other stakeholders.

> “Dealing with the nexus linkages is important for private actors to secure investments in the long term.”

Governments need to establish long-term policies and plans for sustainable development of water, energy and food resources and implement legislative frameworks that introduce social and environmental safeguards to secure long-term sustainability of private investments. Long-term planning and sound legislative frameworks create value for private companies by reducing politically motivated risks and improving the water, energy and food resource base. However, in a transboundary context, operating at the national level is obviously not enough. Governments must look outside their own borders to establish regional development frameworks that reduce the risks for and impacts of private sector investments and economic transformations.

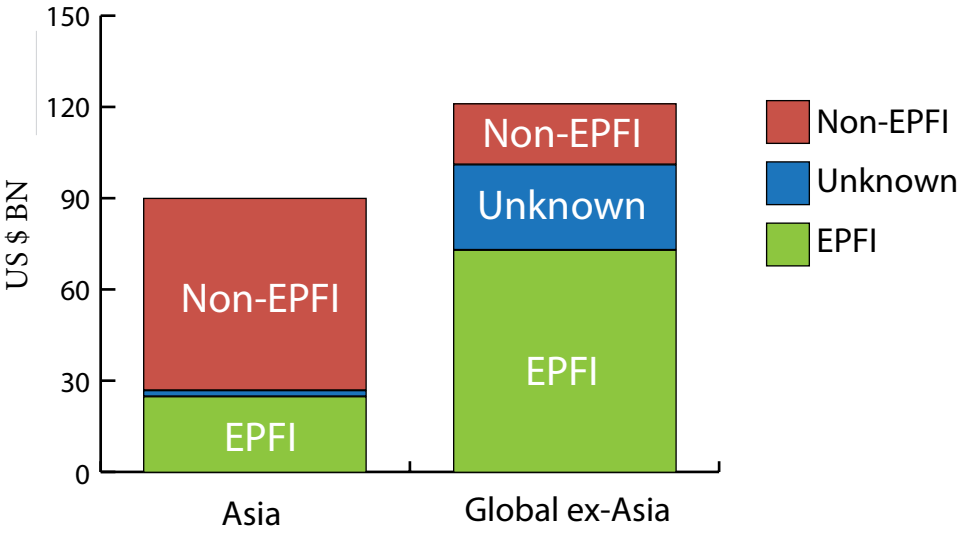

Figure 7. Project finance loans arranged by banks in and outside Asia in 2007. Banks subscribing to the Equator Principles (EPFI) and non-EPFI. (Project Finance International (PFI) 2011 League Tables)

Companies can enhance social and environmental sustainability of investments by applying standards and tools for sustainable investments and corporate social responsibility when engaging governments and local communities in development projects. Several sustainability standards have been designed internationally that focus on different sectors and roles in the value chain. UN-Principles for Responsible Investments and the International Financial Corporation's Equator Principles provide guidance for investors. In the hydropower sector, several guidelines on sustainable hydropower development have been designed in collaboration between governments, civil society and the industry, e.g. the World Commission on Dams guiding principles and the International Hydropower Association's (IHA) 'Hydropower Sustainability Assessment Protocol'. Recently, the Mekong River Commission's Initiative on Sustainable Hydropower has developed the 'Rapid Basin-wide Hydropower Sustainability Assessment Tool', which enables developers and investors to apply a basin perspective to their investment plans. The IHA protocol is also being thoroughly examined in five of the six Mekong countries by local researchers working in partnership with governments and the private sector.

Generally, the number of signatories to such international standards is growing but many 'empty spaces' on the global map remain. Very few Asian banks have signed up to the Equator Principles (Figure 7) and applications of corporate social responsibility principles are generally embryonic in this region. However, some good examples exist that provide confidence that sustainability and benefit sharing principles can be introduced and provide lessons from which others can learn. Dealing with the nexus linkages is important for private actors to secure investments in the long term. Erosion or uncoordinated development of the natural resource base creates financial risks for companies building their business in expectation of a stable supply of water, energy and other natural resources. The private sector is therefore in some cases, e.g. the Danube and Rhine rivers, pushing for cooperation and promoting the work of the transboundary river basin organisation to ensure that appropriate management and regulation secures the basis for their business. Companies adapting to the 'green economy' apply cutting-edge production technologies to improve efficiency and minimise negative impacts. They also engage stakeholders in dialogues on project development and design socially and environmentally responsible management strategies to secure the long-term sustainability of their investments.

Box 11. Foreign land investments and the water, energy and food security nexus

Food security issues are driving investment in foreign land caused by limited land and/or water in the investing country. The rising cost of food, coupled by water scarcity in countries in the Middle East and in parts of Asia has led to an increase in investments in agricultural land in foreign countries to produce food and agricultural goods. Water is often ignored or taken for granted in investment contracts. Also, the purpose of the investment and the water expected with the investment are not clearly stated. This has raised a series of concerns.

Domestic food security in host countries may be under threat and local populations with customary access to land are often evicted or excluded when large-scale agricultural development projects are introduced. As land rights are being put into question, water rights are also coming to the fore. Land investments for agricultural purposes are de facto also water investments. Water needs should be put into the land acquisition contracts in order to clarify the water requirements of the projects and to regulate their water use. This is the only way to consider their role in nexus trade-off discussions. Furthermore, sustainable water use should be acknowledged explicitly in the international standards for responsible agribusiness investments.

Regional Economic Communities and river basin organisations have little or no role in the land acquisitions on record to date. Large land deals will, however, very likely impact their mandate and ability to function.

Source: Jägerskog et.al. 2012.

8. International institutions and their role in management of shared natural resources

Transboundary river basin and aquifer management agencies should be empowered to play their role in influencing national decisions about addressing sustainability challenges, long-term planning and the challenges of making trade-offs visible and benefit sharing.

8.1 Poverty reduction and environmental protection

Sustainable development is a fundamental part of the vision and mandate for transboundary river basin organisations around the world. Against this background, reducing poverty, enhancing livelihoods and delivering environmental protection in addition to economic development are reasonable expectations. Yet short-term economic developments often win over long-term strategic investments with broader sustainability visions. This often comes at a high cost with regards to lost ecosystem service provisions and increasingly uneven wealth distribution. Almost universally, concern is expressed about environmental degradation, ecosystem impoverishment, habitat fragmentation, biodiversity loss and the increasing number of endangered species. Similar concerns are voiced about future developments on vulnerable groups of riparian populations. Huge challenges await the riparian populations in changing these threats into beneficial developments. Results of transboundary water management such as infrastructure developed at a transboundary scale, improvements in the state of the environment, water resource benefits that create wealth for basin populations, improved access to water services and protection of international public goods are the ultimate goals of transboundary river basin management but seem – as demonstrated throughout this publication and elsewhere – difficult to realise.

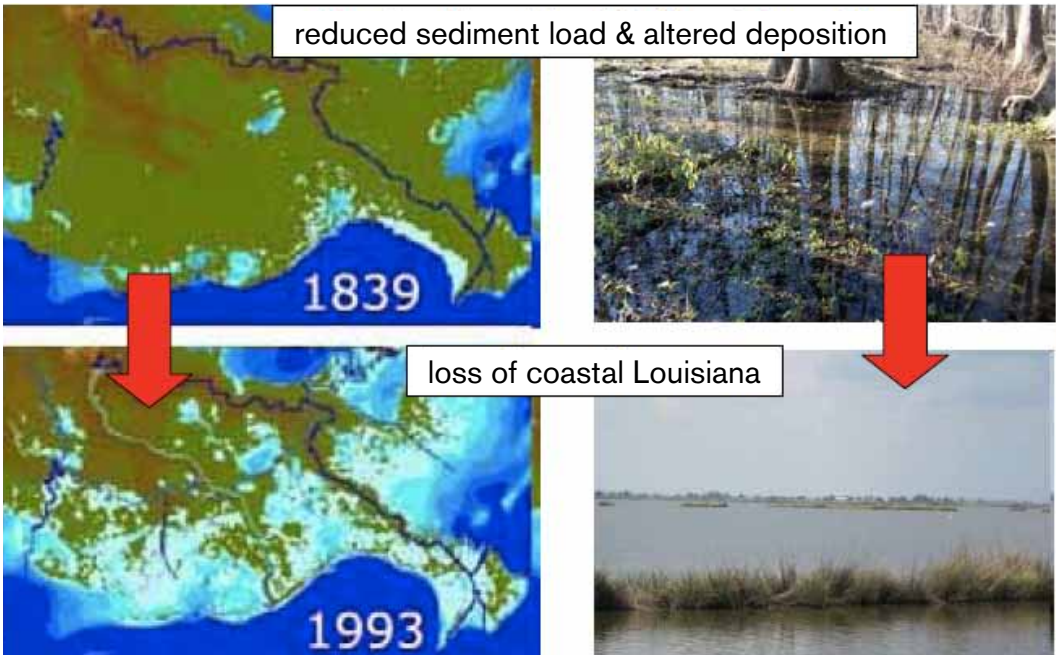

Figure 8. Environmental impacts of development projects include degradation of the coastal zone in the delta areas of the Mississippi river.

It is apparently difficult to learn from past failures. Given the enormous differences between river basins, a fundamental question facing policy makers and managers working on large river systems is what can they learn from the experience of their colleagues working on other rivers? There is a widespread belief that we can learn from each other but how and what? Some technical skills and experiences in using tools, such as modelling techniques, are directly transferable but these are limited in number. There is more prospect of applicability across basins at the level of principles. More generally, there is always a need to base proposals for change on detailed understanding of the particular context where they are to be implemented.

In trying to learn from other basins, analysis of different manifestations of the same type of problem promotes strategic thinking about the range of options available. Cross basin cooperation also helps build a wider international community of analysis and understanding. Perhaps most striking however, is that analysis of other basins helps improve understanding of one's own river system. Central to all these discussions is the importance of developing the capacity for critical thinking within each basin. That is essential if river basin organisations are to make good choices and react appropriately to the vast multitude of competing suggestions that will come their way.

Developed countries with transboundary river basins have, to a large extent, exploited the natural resources of their rivers for high economic outputs but also a high cost to natural ecosystems and livelihoods of basin inhabitants. Examples are the Danube, Columbia and Mississippi rivers, which all face challenges such as pollution abatement, restoration of fish populations and highly degraded deltas and coastal zones (Figure 8). The costs include the loss of original ecosystem services and livelihoods and then the costs of ecosystem restoration, which sometimes include demolition of infrastructure or substantially reduced production. These failures and the associated environmental degradation are clearly documented whereas success stories and alternative solutions and development paths are harder to find – perhaps because people take these for granted and they create limited publicity. In the Mississippi River, for example, flood control measures successfully mitigated impacts of the worst flood ever from occurring in 2011, thereby diffusing most news coverage of the situation.

The processes for evaluating development projects in transboundary river basins entail a range of steps and procedures that can sometimes seem overwhelming. However, the situation they are responding to is very complex from natural, social and institutional points of view and requires thorough consideration and assessment to avoid repeating the failures of the past. The Mississippi River planning process has developed a comprehensive assessment system to assess proposals for development projects which mostly relates to protection of economic assets and urban infrastructure. Only about 10% of the original proposals and ideas are actually realised, which could be regarded as a low success rate. On the other hand, this probably reflects the efforts and rigour of the planning process needed for successful implementation of developments. In this process the role of river basin organisations is to provide the scientific knowledge and information for evidence based decision-making as well as the dialogue and negotiation platform to discuss trade-offs and arrive at mutual decisions.

8.2
Facilitating long-term planning and investment

Transboundary cooperation in river basins has evolved over time. In Africa there are 18 river basin organisations, 17 in Asia and 22 in South America. International support for RBOs is increasing. In their simplest form, there might be an agreement or institutional arrangements that only pertain to the physical river and relate to a single issue – such as navigation, security, information sharing or pollution control, without any allocation of resources. In the second stage, institutions are established to manage and oversee specific resource allocation agreements or joint infrastructure management agreements. The third and most complex level is a river basin organisation with a mandate to execute/propose integrated river basin management.

A river is a classic case where pursuit of interests defined in individual national agendas would lead to an outcome that is not economic and socially optimal from a regional perspective. Integrated river basin management, as promoted by the IWRM approach, includes relevant elements such as coordination, sustainability, equitability and benefit sharing. Setting up an RBO requires countries to forgo a certain level of sovereignty and to some extent curtails the national agenda. Furthermore, the reality is that all countries in a transboundary basin are not equal and not willing to engage at the same level. Other inter-state diplomatic connections may circumvent the RBO and, at worse, make it irrelevant.

There are several ideas about how to tackle these difficulties and establish and maintain relevance. At the one end is to actively assess, promote and implement a portfolio of investment projects, such as infrastructure projects. This is the approach practised by e.g. the Senegal River Development Organization, the Itaipo Binacional (for the Itaipo hydropower project) and articulated by other RBOs such as the Niger Basin Authority. At the other extreme is the 'softer' coordination and capacity development role adopted by ICDPR (Danube River). In between these two extremes are a number of roles and mandates which focus on basin planning and equitable exploration of shared resources, such as the Mekong (Box 12), ORASECOM (Box 13) and the Nile Basin Initiative with its associated investment arms (ENSAP and NELSAP).

A common approach for RBOs is to establish development scenarios, which can be analysed with regards to economic, environmental and social consequences to elucidate benefits and trade-offs. Some basins develop long-term visions, e.g. the Mississippi River Organisation has developed a 200-year vision for the basin, the inhabitants well-being and wealth and the state of the environment. The more common scenarios use a planning horizon of 10–50 years, as is the case in the Mekong, Nile and Southern Africa (SADC) which present the opportunities in the basin based on the riparian state plans and wishes. These planning scenarios and associated impact assessments can serve as the basis for strategy development for the basin as well as for development of sector strategies. The impact assessments also provide a good basis for discussions on benefit sharing. This is considered a very promising concept in transboundary river basin management but has so far proven difficult to implement, i.e. moving away from sharing of water to sharing of benefits. A key issue for the relevance of such scenario and planning exercises – and to some extent of the RBO itself – is the existence of and respect for the clear linkages between regional and national level policies and plans.

Cooperation around the water, energy and food security nexus may help in promoting results. One of the key prerequisites that is constantly repeated is political willingness for true cooperation. Some even believe that the lack of political willingness is the main reason for development being held back. This includes willingness to look beyond national priorities and security considerations for transboundary benefits. Understanding what could be gained or lost becomes very important and underpins the need for improved information and knowledge about trade-offs at the basin scale. Arguments that highlight the water, energy and food security nexus issues may help to raise understanding of potential win-win solutions and hence, hopefully, political will. The scientific community, basin water-user community and political decision-makers all need to be involved. RBOs can play a role linking these various actors, identifying incentives for collaboration and influencing national decisions for transboundary benefits (Box 13). Once cooperation is in place, incentives have to be identified to engage investors in the supply of water, energy, food, navigation and other water-related benefits.

Box 12. Addressing poverty through Procedures for Transboundary Cooperation

The four countries making up the Mekong River Commission (MRC) have agreed on a vision of "An economically prosperous, socially just and environmentally sound Mekong River Basin". The MRC uses a number of tools to help achieve this objective; including environmentally and socially responsible best management practices for hydropower and fish friendly irrigation, a Basin Development Plan, and five agreed procedures. While the shared basin planning process provides a framework within which all four countries outline their plans for economic development, it is the procedures which move transboundary management towards the countries' common goal. Procedures for Maintaining Flows on the Mainstream (PMFM) ensure that sufficient water flows downstream to sustain vital ecological functions on which poor and vulnerable communities depend; sustaining fisheries, and ensuring sufficient dry season flows. Procedures for Water Quality (PWQ) provide a basis for safeguarding water quality, ensuring that it remains fit for human use and aquatic ecosystems; thus protecting communities with limited resources to treat water for potable use.

Procedures for Water Use Monitoring (PWUM) provide the information necessary to assess how development and use of the water of the basin impacts on mainstream flow and water quality. Procedures for Notification, Prior Consultation and Agreement (PNPCA) help ensure the reasonable and equitable use of water, and that water resources development does not compromise the livelihoods of the poor; while Procedures for Data and Information Exchange and Sharing (PDIES) provide for the free exchange of quality assured data between the countries.

However, the integration of the procedures provides the greatest opportunity for proactive management towards meeting the needs of the poor and vulnerable in the basin. Integrating the procedures in an IWRM-based framework identifies where water is available, or can be made available, to support food production and streamline notification and prior consultation processes to this effect. Pro-poor methods for monitoring water use not only help vulnerable communities monitor and manage their own water resources, but provide the information necessary to support transboundary cooperation towards addressing water, food and energy security. Ultimately, this integrated view of the procedures will help the MRC Member Countries ensure that transboundary water management achieves their mutual vision.

Implementation of these procedures is a continual challenge, reflecting the essentials of the challenges of transboundary cooperation.

Source: MRC, www.mrcmekong.org.

A sweeping curve in the Orange River, Lesotho. Photo by istockphoto/PG-Images.

Box 13. Benefits of transboundary cooperation – ORASECOM and the Orange Senqu River Basin

At almost one million square kilometres the Orange River basin is the largest basin south of the Zambezi. It is also the most developed transboundary river basin in southern Africa, with a variety of water transfer schemes to supply water to municipalities, industries and farms in and outside of the basin.

As the basin contains one of the most industrially developed parts of Africa (the region around Johannesburg, South Africa) and supports a range of commercial and subsistence farmers, basin managers and communities relying on its resources face several challenges.

The Orange River Basin is of great importance to all four of its riparian states. Three of them – Botswana, Namibia and South Africa, are the most economically powerful in southern Africa and future economic development in both Namibia and South Africa to some extent depends on utilisation of the Orange River resources. The fourth basin state, Lesotho, receives a significant amount of its foreign exchange through royalty payments for water exported to South Africa under the Lesotho Highlands Water Project (LHWP). The financial benefits from the project to Lesotho, in the form of royalties, have improved the infrastructure in the country and help to raising the living standards of Lesotho's predominantly poor population. Overall, the project has been well received, with most interest groups agreeing with the need for its construction as well as supporting the efforts made to ensure that the project is socially and environmentally benign.

The ORASECOM agreement reached in 2000 is the first multilateral basin-wide agreement between all riparian states and the Orange-Senqu River Commission (ORASECOM) established by the agreement is seen as a major step towards international cooperation on matters relating to the utilisation and management of the basin. Prior to the establishment of ORASECOM, international cooperation between the riparian states on matters concerning the Orange River Basin was usually bilateral.

ORASECOM is purposefully kept small with limited powers and with no agenda for it to evolve into a development authority. It plays a role in linking various actors, such as NGOs who support institutional development, water resource agencies, local governments, farmers and industry who seek to influence the process and government ministers from the basin states, facilitating basin planning and identifying incentives for further cooperation and benefit sharing.

9. Conclusions

In many areas of the world, projections indicate that increased water demand may outstrip supply. It is inevitable that in areas where the agricultural sector dominates water use, it will have to become more efficient to accommodate increasing demands from other sectors such as energy, while at the same time meeting the requirements of environmental flows to sustain ecosystem functions and livelihoods. These pressures coincide with requirements to produce more food for growing populations who wish to eat more food and a diet with a greater proportion of meat. The resultant need for increased productivity and reduction of waste poses major challenges, not least in river basins and aquifers shared between states. The global push for greening of economies coincides with increasing demands for energy and calls for moves towards transition to a low carbon economy, diversification of energy supply and investments in energy efficiency. However, the choice of energy mix can have transboundary implications for water and food security. Transboundary cooperation can, in this context, enhance a broader set of benefits and opportunities than unilateral country approaches.

The systematic analysis of the linkages between water, energy and food security as suggested through the nexus approach assists in identification of necessary trade-offs and, even more importantly, synergies and win-win solutions, which can be presented to senior policy makers in the three sectors. In a transboundary context, additional issues arise for identifying solutions and synergies across state boundaries and analysing and agreeing on trade-offs for decision making. New solutions for water, energy and food security can be found by the three sectors working together and a regional perspective can provide mutual benefits. Upstream plentiful resources can supply downstream areas with high demands and/or resource scarcity while delivering economic benefits to the upstream providers. A multi-purpose approach for dams may increasingly be used to provide solutions to food security problems through increased irrigation, and at the same time provide water supply, energy, flood protection, jobs and economic development. However, sustainability challenges still remain, as does the challenge to actually agree upon and implement benefit sharing. In anticipating the influence of climate change on nexus considerations, it should be realized that the adaptation responses made for each part of the nexus can affect the others negatively or positively and hence need to be assessed in this context. Furthermore, policy coherence between regional basin-wide analysis of climate change impacts and adaptation responses and national adaptation strategies is vital.

The nexus approach, building on integrated water resources management (IWRM), highlights the need for dialogue and real engagement between sectors on water, food and energy security issues at all levels, from the local to the transboundary level. Water, energy and food are key strategic resources for the individual riparian countries that adopt policies and make decisions at the national level. This may on the one hand create barriers to cooperation, but on the other hand a nexus approach can contribute to regional stability if countries can agree to cooperate. Any action to consider the transboundary dimension of the water, energy and food security, through decisions at national level, depend entirely on the awareness by decision-makers in the concerned sectors, and the political will to engage in dialogue across sectors and across boundaries. In this context water management needs to respect the basin and aquifer as the basic management unit, from the smallest catchment to the major transboundary basins. Hence, the opportunities and trade-offs need to be addressed at the basin or aquifer level, and transboundary basin management entities should be empowered to play their role in influencing national decisions. Achieving water, energy and food security in a transboundary context calls for an expansion of basin management to include a broader array of politicians, government agencies and other stakeholders. The collaborative framework of transboundary river basin management entities provides a platform for such dialogues. Some modification or flexibility in interpretation of the current frameworks may be needed to ensure full engagement of the relevant stakeholders, including public and private sector and civil society.

The predominant paradigm on economic development in many countries needs to change towards a more balanced nexus approach, which recognizes the importance of investment in and protection of natural capital and the need to maintain ecosystem functions and livelihoods in the move towards greener economies. The lessons learned from past experiences in river basins where pollution and ecosystem degradation prevail suggest that clean-up and restoration are much more costly than pollution abatement and ecosystem protection. However, the value and productivity of ecosystems are often overlooked and many examples demonstrate how this can negatively affect the expected benefits of investments in water, energy and food security. Some of these impacts may be indirect and cover a large geographical area, which potentially make them particularly relevant in a transboundary context.

The rural poor in many countries depend on basic food production such as rice and fish, and they are very vulnerable to any changes in access to water for their basic livelihoods. Wild fish is one of the natural resources that is vulnerable to major habitat changes and for rural poor provides important nutritional value which would be difficult to replace. Infrastructure development for large-scale energy and food production in transboundary basins needs to address this issue through thorough analysis and stakeholder dialogue, including mitigation considerations.

The analysis on which the nexus approach is based needs scientific evidence of the gains to be made, and hence an added focus on research and development, including decision support systems. Basin scale decision support systems building on modeling systems and monitoring data and other sources of information covering aspects of water, energy and food provide opportunities for informed decision making at transboundary level. While providing no guarantee of a sustainable outcome, a publicly accessible and shared decision support system increases the transparency of decision-making and focuses attention on conflicts of interest, distributional impacts and venues for compromise when riparian countries negotiate on the development of nnatural resources. This requires sharing of data and information between countries, not only on water, but also on energy and food production and policies and dissemination of results through a stronger transboundary science-policy dialogue.

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Annex I.
River basin organisations represented at the conference

Amazon River Basin

The Amazon River Basin is the largest river basin in the world. It stretches over nine countries – Bolivia, Brazil, Colombia, Ecuador, French Guyana, Guyana, Peru, Suriname, and Venezuela. It provides riparian states with important opportunities for agricultural and industrial use (including the generation of hydropower) as well as the means for navigation. Boasting over 2100 species of fish and more than one-third of the world's total species population, the river basin holds immense ecological value. But, socio-economic development is to a large extent, responsible for the basin's environmental degradation. Water resources management challenges in the basin are addressed through the Amazon Cooperation Treaty Organization (ACTO). Established in 1978, ACTO unites its signatories - Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela. Its mission is, "to undertake joint actions and efforts to promote the harmonious development of their respective Amazonian territories in such a way that these actions produce equitable and mutually beneficial results and achieve also the preservation of the environment, and the conservation and rational utilization of the natural resources of those territories" (Amazon Cooperation Treaty). ACTO is organized around a Meeting of Ministers of Foreign Affairs, the Amazon Cooperation Council, a Secretariat as well as Permanent National Commissions. Special Commissions focus in depth on the different sectors. The organisation works primarily in the sectors of development, transport, communication and infrastructure, tourism, science and technology and health.

Columbia River Basin

The Columbia River Basin is more than 1900 km long and covers an area of more than 660,000 km2. About 15% of the basin is in Canada and the remainder in the US. It is shared by the Canadian Province of British Columbia and six US states, the most prominent Washington and Oregon. With more than 100 tributaries, the Columbia River Basin is a water-rich basin that provides many opportunities to riparian states and people. The salmon industry and sustainable hydropower development are the river's primary revenue sources, and are guiding the Colombia towards its prosperous future. Many dams have been built along the river to capture that potential, turning the Columbia River into a highly regulated basin. River transportation is important and navigability has been improved over the past centuries through considerable hydromorphological alterations, causing a number of environmental problems for the basin. The International Joint Commission (IJC) was established in 1961 by the USA and Canada under the Columbia River Treaty. The IJC is based on the 1909 Boundary Water Treaty signed by Canada and the USA as well as the 1961 Columbia River Treaty. The IJC is responsible for assisting the governments of Canada and the United States to find solutions to problems that relate to shared rivers between the two countries. This includes the coordination of water resources development plans, the exchange of information on hydropower generation and flood control activities, the establishment and operation of a hydrometeorological system, the investigation of water quality and other issues that concern the use of the river's resources.

Congo River Basin

With 4700 km of flowing waters, the Congo River is the second longest river on the African continent, shared by 13 riparian states – Angola, Burundi, Cameroon, Central African Republic, Congo, Democratic Republic of Congo, Gabon, Malawi, Rwanda, Sudan, Tanzania, Uganda and Zambia. Water resources management issues focus on water quality, invasive species and navigation. The Commission Internationale du Bassin Congo- Oubangui-Sangha (CICOS) – International Commission of the Congo-Oubangui-Sangha Basin was established in 1999 through the Agreement Establishing a Uniform River Regime and Establishing the CICOS. As of today, CICOS has four member states – Cameroon, the Central African Republic, Congo, and the Democratic Republic of Congo. The commission's goal is to improve regional cooperation among riparian states through the coordination of river basin management. While the organisation originally focused exclusively on navigation, its mandate expanded in 2007, and now also includes non-navigational issues. Within this mandate, it covers issues such as water quantity and quality, invasive species as well as regulations on the river's flow regime in order to ensure navigability.

Danube River Basin

Located in Central and Eastern Europe, the Danube River Basin is the most international river basin in the world, shared by 19 countries: Albania, Austria, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Italy, Macedonia, Moldova, Montenegro, Poland, Romania, Serbia, Slovakia, Slovenia, Switzerland, and the Ukraine. More than 80 million people live in the basin, which stretches from Central into Eastern Europe. After a 2800 km journey through a vast and ecologically important delta, the river empties into the Black Sea. Since the 16th century, riparian communities have altered the river's flow for navigation, flood defence and hydropower generation. Exploitation of the river's resources provides many benefits to riparian states but, at the same time, the basin is suffering from these pressures. Water pollution is a major challenge and hydromorphological alterations have led to the disconnection of wetlands and floodplains as well as to changes in hydrological flow. Furthermore, floods pose a great threat to people and economies in the basin. In order to cooperatively manage the Danube River Basin, signatories of the Danube River Protection Convention established the International Commission for the Protection of the Danube River (ICPDR) in 1998. Its members are 14 out of the basin's 19 riparian states – Austria, Bosnia-

Herzegovina, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Moldova, Montenegro, Romania, Serbia, Slovakia, Slovenia, and the Ukraine. The ICPDR aims to promote and coordinate sustainable water management for the benefit of all people of the Danube River Basin by implementing the 1994 Danube River Protection Convention and the European Water Framework Directive. Its work focuses, in particular, on improving water quality and the overall ecological state of the basin. For instance, measures for reducing pollution have been identified jointly and required programmes have been implemented. In order to prevent harm to the river basin through accidental spills, a Danube Accident Emergency Warning System (AEWS) was established. To improve flood resilience, an Action Programme on Sustainable Flood Protection has been adopted. Moreover, the ICPDR prepares a Danube River Basin Management Plan that includes a Joint Programme of Measures to improve water quality. The next Management Plan will be available in 2015. Organizationally, the ICPDR consists of a Meeting of the Contracting Parties to the Convention and a Secretariat. ICPDR's work is supported by and implemented through Expert Groups, each of them focusing on specific river basin management topics, namely pressure and measures (including pollution), monitoring and assessment, information management and GIS, river basin management, and public participation. The ICPDR collaborates closely with different stakeholders, including civil society, the scientific community and the private sector.

Ganges River Basin

The Ganges-Brahmaputra River Basin covers areas of Bangladesh, Bhutan, China, India, Myanmar and Nepal. The Brahmaputra River, originating in Western Tibet, and the Ganges River, coming from Eastern Tibet, join forces in India before continuing to the Bay of Bengal. The basin is one of the key basins in South Asia. Agriculture dominates water use patterns in the river basin, although the river also serves other uses such as navigation, fisheries, hydropower generation and tourism. High population growth and density in India and Bangladesh are constantly increasing the riparian population's dependency and pressure on the river's resources. The Ganges is one of the world's most polluted rivers and suffers from a number of other environmental problems. The India-Bangladesh Joint River Commission was established in 1972 between India and Bangladesh as an international bilateral RBO. It has the task to foster cooperation over the river by ensuring joint efforts in the areas of flow monitoring, flood control, flood warning, mutual information on national projects and coordinated research. It consists of commissioners from both Member States. Within India, the Ganges-Brahmaputra is managed by the National Ganga River Basin Authority, which was established in 2009 and led by the Prime Minister. The NGRBA's objective works towards the effective reduction of pollution in the river and the conservation of the river and its basin through integrated and comprehensive planning and management.

Indus River Basin

The Indus River Basin is part of the great river system flowing from the Himalayas into South Asia, depending largely on glacier melt and monsoon rains. It is shared by five countries – Afghanistan, China, India, Nepal, and Pakistan. From Tibet, it flows over 3100 km through China, Afghanistan, Pakistan and India before emptying into the Indian Ocean. Its waters are highly important to riparian countries, especially in areas further downstream, providing water resources for irrigation and thus feeding these countries' growing populations. The main challenge in the Indus River Basin concerns water allocation between riparian states, most notably India and Pakistan. Both states have established a number of water resources development projects along their stretches of the river but are also concerned about the consequences of co-riparian developments (dams and water diversion projects). In addition, floods pose a major threat to populations in the basin. The Permanent Indus Commission (PIC) was established under the 1960 Indus Water Treaty between India and Pakistan, aiming to jointly manage water quantity and allocation problems between its members. Activities in this field include the maintenance of cooperative arrangements required for the successful implementation of the Treaty, studies and reports about the development of water resources on shared rivers, study tours and inspections for ensuring compliance with the Treaty, as well as dispute-settlement for issues arising between Member States on treaty-related questions. PIC brings together the commissioners from each state and ensures their regular meetings as the Commission. This reflects its role as a coordination mechanism between India and Pakistan.

Mekong River Basin

The Mekong is the tenth largest river in the world. Its basin drains a total land area of 795,000 km2 from the eastern watershed of the Tibetan Plateau to the Mekong Delta. The Mekong River flows approximately 4909 km through three provinces of China, continuing into Myanmar, Lao PDR, Thailand, Cambodia and Viet Nam before emptying into the South China Sea. Upstream flow contributes only a small portion of the 3total annual flow of the Mekong River. Most of the total flow volume is delivered to the Mekong from tributaries in the Lower Mekong Basin (see Table 1); however, the importance of upstream flow should not be underestimated as dry-season snow melt from China contributes to over 24% of the total flow. The flood season in the Mekong River Basin lasts from June to November and accounts for 80 to 90% of the total annual flow (MRC 2010). The annual flood season is especially important in the Lower Mekong Basin where it has shaped the environment and its inhabitants. Many of the Mekong's key ecosystems have developed as a result of seasonal flow fluctuations. The area's extensive wetland habitats would not exist without the annual flood. Likewise, the life-cycles of many Mekong fish species depend on it. Fish migrate to deep pools in the mainstream to seek refuge during the dry season; later, during the flood season, they migrate back to spawning and nutrient-rich feeding grounds on floodplains. At present, only 10% of the estimated hydroelectric potential in the Lower Mekong Basin is developed. The issue of hydropower development in the basin is very controversial with many dams proposed on the Mekong mainstream and many more planned or under construction on its tributaries. The Mekong River Commission was founded in its current form with the signing of the 1995 Mekong Agreement, which established the rules and procedures of the organisation. It has its origin in the Mekong Committee, and the Interim Mekong Committee, which were in force between 1957 and 1995. The role of the MRC is to ensure the sustainable use and management of water and related resources of the Lower Mekong Basin (LMB). The MRC is governed by its four member countries: Cambodia, Lao PDR, Thailand and Viet Nam through the Joint Committee and MRC Council. Technical and administrative support is provided by the

MRC Secretariat. The upstream Mekong countries, the Peoples Republic of China and the Union of Myanmar became Dialogue Partners with the MRC in 1996.

Mississippi River Basin

The Mississippi River is part of the largest river system in Northern America, covering the states of Minnesota, Wisconsin, Iowa, Illinois, Missouri, Kentucky, Tennessee, Arkansas, Mississippi, and Louisiana. It is more than 7300 km long including its tributaries and drains over parts of more than 30 states. Ten states are direct tributaries to the Mississippi. The river has a history as an important axis for transport in the US. In order to improve navigability, it has undergone massive hydromorphological alterations, significantly changing the river's ecosystem. Aside from navigation, river control works are also largely justified by the constant threat of the river changing its channel and overflowing inhabited areas while drying up in other areas where people are equally dependent on its resources. For decades, the river has faced a number of environmental problems, most notably pollution from agricultural sources, affecting not only the river, but also the Gulf of Mexico. Established in 1879, the Mississippi River Commission aims to develop recommendations for water resources management, flood control, navigation and environmental projects, and to study the river's systems and assess the necessity for engineering works for both navigation and flood control. Based on these assessments, the US Army Corps of Engineers implements the required projects. The Mississippi River Commission consists of representatives of the US Army Corps of Engineers, the National Oceanic and Atmospheric Administration as well as civilians, all nominated by the US President.

Murray-Darling River Basin

Australia's Murray-Darling River Basin covers an area of more than 1 million km2, representing 14% of Australia's land area. It includes the states of New South Wales, Victoria, the Australian Capital Territory, Queensland and South Australia and generates 39% of Australia's agricultural income. Products cultivated in the basin include grains, fruits, vegetables and livestock. Water availability varies greatly throughout the year and inter-annually. Therefore, large water storage schemes have been developed. Some of these storages also provide hydroelectric power. The Murray-Darling Basin Authority (MDBA) was established under the 2007 Water Act and is a statutory authority of the Australian Government, unlike its predecessors that were authorities established by an agreement between riparian states, territories and the Australian Government. The MDBA aims to promote and coordinate planning and management for the sustainable use of the basin's land, water and environmental resources. These functions include advising the Minister on accreditation of state and territory plans; facilitating water trading; constructing and managing River Murray assets such as dams and weirs; measuring, monitoring and undertaking research; and engaging the community in basin management. The MDBA is embedded in a broader water governance network within Australia, including the Commonwealth Water Minister and the Ministerial Council. It consists of two permanent and four part-time members appointed by the Australian Governor General.

Niger River Basin

The Niger River flows over 4000 km through Western Africa. The Niger River Basin, which covers more than 2 million km2, is shared by nine countries (Benin, Burkina Faso, Cameroon, Chad, Cote d'Ivoire, Guinea, Mali, Niger, Nigeria), covering more than 7% of the African continent. It is an important lifeline for riparian populations and states, especially against the region's poverty challenge. Water resources management is closely linked to socio-economic development and poverty alleviation. The river's resources provide important opportunities for agriculture, fisheries, food supply and navigation. At the same time, the basin is threatened by various environmental problems, most notably land degradation and erosion, deforestation, water pollution from agriculture and households, biodiversity loss and the intrusion of invasive species. These issues hamper water resources development opportunities for riparian states. The Niger Basin Authority (NBA) was established in 1980 under the Niger Basin Convention, but relies on a long history of cooperation, dating back to 1964 with the establishment of the Niger River Commission. Its Member States include Cameroon, Chad, Benin, Burkina Faso, Cote d'Ivoire, Guinea, Mali, Niger, and Nigeria. Its goal is to promote cooperation between Member States and ensure integrated development of the river basin. Its focus is thus largely on socio-economic development and its work covers a large number of sectors, including agriculture, energy, fisheries, forestry, transport, industry and communication. In order to achieve its goal, the NBA is mandated to undertake a number of activities, including the gathering, standardization and dissemination of data, the development of joint plans for infrastructure development and transport, the establishment of norms and activities for preventing and reducing environmental threats, especially in the field of water pollution, and the promotion of agricultural, forestry and fisheries activities through joint programmes and projects.

Nile River Basin

Running through 10% of the African continent for 6700 km, the Nile is the world's longest river. It brings together a considerable number of riparian states – Burundi, Central African Republic, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda. Riparian states and populations are highly dependent on often very scarce water resources, making sustainable water resources management a key focus for the basin. Egypt is highly dependent on the Nile's water resources and has so far benefited from a very favorable water allocation regime that was established in 1959 with Sudan. With increasing socio-economic development in upstream states, water demands and abstraction in these regions have increased, igniting disputes on water allocation. Established by Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda in 1999, the Nile Basin Initiative (NBI) is a transitional and informal mechanism. Over the last decade, a Cooperative Framework Agreement was developed, which was signed in 2010 by seven riparian states. This aims at transforming the NBI into a full RBO. Egypt and Sudan, two of the key players in regional water management, have still not formally joined the cooperation. The NBI has the goal to achieve sustainable socioeconomic development through the equitable utilization of and benefit from the common Nile Basin water resources. In order to achieve this goal, a number of activities are undertaken, focusing on capacity building; water resources management activities such as regional policy development and basin-wide planning; data and information management; and the provision of technical

support to Member States for strengthening national water policies. The NBI is governed by the Nile Council of Ministers (Nile-COM), and is assisted by the Nile Technical Advisory Committee (Nile-TAC) and its Secretariat, based in Entebbe, Uganda. In addition, specific programme management bodies have been established, which include the Eastern Nile Subsidiary Action Programme (ENSAP) and the Nile Equatorial Lakes Subsidiary Action Program (NELSAP).

Parana-LaPlata River Basin

The Parana-LaPlata River Basin is more than 4500 km long and is shared by five countries – Argentina, Bolivia, Brazil, Paraguay and Uruguay. The basin supports regional inland navigation, and delivers water supply and hydropower generation to millions that rely on it. Intensive use of the basin and its resources has led to a number of river basin management challenges, namely water quality problems, as well as issues related to navigation and the environment. One of the central hydraulic structures on the river is the Itaipu Dam. The dam is one of the world's largest hydropower facilities with a capacity of more than 10,000 MW, generated on the basis of 20 turbines. Initiated in the 1970s, the project was jointly developed between Brazil and Paraguay. Today, Itaipu's mission is to provide quality electricity through socially and environmentally responsible practices, and to foster a sustainable economy, tourism industry and technological development. In addition to Brazil and Paraguay's bilateral treaty on the basin, a number of institutionalized political cooperation mechanisms exist: the Administrative Commission for the Rio de la Plata (CARP), the Comision Technica de Mixta de Salto Grande (CTMS) and the Comision Binational Puente Buenos Aires Colonia (COBACIO) established by Argentina and Uruguay; the Trilateral Commission for the Development of the Riverbed of the Pilcomayo, bringing together Argentina, Bolivia and Paraguay; and the Administrative Commission of the River Uruguay (Comision Administradora del Rio Uruguay, CARU) for the tributary Uruguay, established by Argentina and Uruguay in 1975. The Parana-LaPlata Basin is thus characterized by a high density of institutionalized cooperation, indicating riparian states' strong commitment to the cooperative management of their shared resources.

Southern African Development Community – Protocol on Shared Watercourses

The Southern African Development Community (SADC) has 15 member countries – Angola, Botswana, the Democratic Republic of Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, the Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. Together, this region is home to more than 250 million people. Established in 1992, SADC aims to establish a regional community that fosters economic well-being, improves the living standards of people, and promotes freedom, justice and peace. It therefore engages in promoting sustainable growth and development through regional cooperation and integration. The SADC region includes 13 transboundary river basins. Every SADC member state – except for the islands of Madagascar, Mauritius and the Seychelles – shares a part of its water resources with neighbouring countries. The SADC Water Division was established to better manage these shared river basins. Its goal is to ensure that water in southern Africa becomes a sustainable resource through the coordinated management, protection and equitable use of shared waters. It is in charge of coordinating and facilitating the implementation of regional activities in the SADC region. This includes development and consolidation of water policies, implementing activities and strengthening the institutional environment for cooperative water resources management. A number of RBOs exist under the SADC framework, namely the Inco-Maputo Tripartite Permanent Technical Committee, managing the Incomati and Maputo Rivers between Mozambique, South Africa and Swaziland; the International Commission of the Congo-Ubangi- Sangha Basin (CICOS); the Kunene Permanent Joint Technical Commission, bringing together Angola and Namibia to jointly manage the waters of the Kunene River; the Lake Tanganyika Authority (LTA), managing Lake Tanganyika, which is shared by Burundi, the Democratic Republic of Congo, Tanzania and Zambia; the Limpopo Watercourse Commission (LIMCOM) which manages the waters of the Limpopo River between Botswana, Mozambique, South Africa and Zimbabwe; the Orange-Senqu River Commission (ORASECOM), which unites Botswana, Lesotho, Namibia and South Africa over the Orange- Senqu River; the Permanent Okavango River Basin Commission (ORASECOM) established between Angola, Botswana and Namibia; the Ruvuma Joint Water Commission established by the governments of Mozambique and Tanzania; and the Zambezi Watercourse Commission (ZAMCOM), bringing together seven riparian countries of the Zambezi River.

Yellow River Basin

The Yellow River (Huang He in Chinese) is the second largest river in China, stretching more than 5,400 km. It flows through nine provinces – Qinghai, Gansu, Ningxia, Inner Mongolia, Shaanxi, Shanxi, Sichuan, Henan and Shandong, forming a basin of more than 742,000 km2. More than 100 million people inhabit the basin, many of them depending considerably on the river's resources. At the same time, the river basin faces a number of environmental challenges, including water shortages which could affect the agricultural and industrial potential of the river, as well as water quality problems. Another challenge for riparian people is frequent floods, which often have devastating effects for riverine communities and their livelihoods. The Yellow River Conservancy Commission was established in 1999 by the government of China's Ministry of Water Resources. The Commission is responsible for the administration of water resources management among its riparian provinces. This includes tasks such as the implementation of the Chinese water law in the Yellow River Basin, the development of a management plan for the basin, the evaluation of water resources planning and management activities, the monitoring of soil erosion, the protection of water resources and the development of a flood management plan.

The above information was taken from the websites of respective river basin organisations and only includes basic information.

Annex II.
Mekong2Rio Message

Mekong$_2$Rio:
International Conference on Transboundary River Basin Management
1-3 May 2012, Phuket, Thailand

Mekong$_2$Rio Message

BACKGROUND

With an expected addition of two billion people on the planet by 2040, and the added challenges from climate change and rapid urbanization, the pressure on water, energy and food is growing, and the world faces increasing challenges to resource availability, management and sustainability. When these resources cross international and state boundaries, their management becomes more complex, calling for greater cooperation and involving a wider range of actors.

Set to be a contribution on the road to Rio +20, the UN Conference on Sustainable Development, to be held in June 2012 in Rio de Janeiro, and beyond, the Mekong River Commission (MRC) convened the "Mekong2Rio - International Conference on Transboundary River Basin Management" in Phuket, Thailand, 1-3 May 2012, hosted by the Royal Thai Government. The objective of the Conference was to address "the transboundary dimension of the water, energy and food security nexus, with particular emphasis on the challenges that rapid human-made developments and environmental change pose to the sustainable management of transboundary river basins". In addressing this objective the Conference recognized and built on the outcome of the Bonn2011 Nexus Conference, highlighting the interconnectivity of the decisions taken in one sector on another.

A wide range of stakeholders from local, national and international settings world-wide were represented among the more than 350 participants, including 14 transboundary river basins from six continents of the World1, two regional economic communities, and 16 international organisations who contributed to the Conference as Sponsoring Partners2.

MESSAGES

In many areas of the world increased water demands may outstrip supply, and the traditionally dominant agricultural water use will need to become more efficient due to the growing demand from other sectors, as e.g. energy, and at the same time meeting the requirements of environmental flows to sustain ecosystems functions and livelihoods. This calls for innovative solutions through a nexus approach. The resultant need for increased productivity poses major challenges, not least in river basins and aquifers shared between states. Transboundary cooperation can enhance a broader set of benefits and opportunities than individual country approaches.

The nexus approach is not entirely new, but the recent systematic focus on it brings it to the attention of senior policy makers in the three sectors, helps identify the linkages between sectors in a transboundary setting, and assists in the analysis and identification of necessary trade-offs and possible win-win solutions.

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[1] The transboundary basins represented were Columbia, Mississippi, Amazon, Itaipu/La Plata, Danube, Niger, Congo, Nile, Aral Sea, Indus, Ganges, Yellow River, Murray-Darling and the Mekong, along with the UN-ECE and Espoo Conventions and GWP Southern Africa.

[2] The Conference was convened in collaboration with the following sponsoring partners: Asian Development Bank (ADB), Challenge Program on Water and Food (CPWF), Danish International Development Agency (Danida), German Agency for International Cooperation (GIZ) on behalf of the German Government, International Union for Conservation of Nature (IUCN), International Water Management Institute (IWMI), Mekong Program on Water Environment and Resilience (M-POWER), World Wide Fund for Nature (WWF), Stockholm International Water Institute (SIWI), Stockholm Environment Institute (SEI), International Center for Integrated Mountain Development (ICIMOD), United Nations Environment Programme (UNEP), the World Bank, the DHI Group, the Mississippi River Commission and Global Water Partnership (GWP).

The nexus approach, building on Integrated Water Resources Management (IWRM), highlights the need for dialogue and real engagement between sectors on water, food and energy security issues at all levels, from local to transboundary levels.

Some key messages from the Conference were:

1. Water, food and energy are key strategic resources for the individual riparian countries that adopt policies and make decisions at the national level. This may on the one hand create barriers to cooperation, but on the other hand a nexus approach can contribute to regional stability if countries can agree to cooperate.

2. In addressing the nexus it is recognized that water management needs to respect the basin and aquifer as the basic unit, from the smallest catchment to the major transboundary basins. Hence the opportunities and trade-offs of the nexus need to be addressed at the basin level, and transboundary river basin and aquifer management entities should be empowered to play their role in influencing national decisions.

3. Solutions to food, water and energy security issues are being found by the three sectors working together, as shown in many transboundary basins throughout the world.

4. The predominant paradigm in many countries on economic development needs to change towards a more balanced nexus approach which recognizes the importance of investment in and protection of natural capital and the need to maintain ecosystems functions and livelihoods, and move towards greener economies.

5. Operationalizing the nexus in a transboundary setting calls for sharing of data and information between countries, not only on water, but also on food and energy production.

6. Nexus thinking needs to be based on scientific evidence of the gains to be made, and hence an added focus on research and development, including in decision support systems, along with the dissemination of results through a stronger transboundary science-policy dialogue

7. A multi-purpose approach for dams may increasingly be used to provide solutions to food security issues by increased irrigation, and at the same time provide water supply, energy, flood protection, jobs and economic development illustrating the water, food and energy linkages. However, sustainability challenges still remain, as do the challenge to implement benefit sharing.

8. The rural poor in many countries depend on water-related food production such as rice and fish, and they are very vulnerable to any changes in access to water for their basic livelihoods. Infrastructure development for large-scale energy and food production in transboundary basins need to address this nexus issue through thorough analysis and stakeholder dialogue, including mitigation considerations.

9. In anticipating the influence of climate change on nexus considerations, there needs to be policy coherence between regional basin-wide analysis and national adaptation strategies.

Any action to consider the transboundary dimension of the nexus, through decisions at national level, depend entirely on the awareness by decision-makers in the concerned sectors, and the political will to engage in dialogue across sectors and across boundaries.

TO RIO AND BEYOND

It is hoped that this message will receive attention among the participants and negotiators assembled at Rio+20 in June 2012.

In order to further disseminate and promote the outcome of this conference in addressing future challenges a Mekong2Rio publication will be produced by MRC, and the international Sponsoring Partner organizations to convey the messages from the conference to relevant stakeholders world-wide. This paper will be launched at the Stockholm World Water Week in August 2012.

Phuket, 2 May 2012

Annex III. Speakers, panellists and facilitators

Speakers and panellists

- Mr. Sanusi Imran Abdullahi, Executive Secretary, Lake Chad Basin Commission
- Dr. Ram Chandra Bastakoti, Senior Research Specialist, Asia Institute of Technology
- Ms. Ruth Beukman, GWP Southern Africa Regional Coordinator, GWP Southern Africa
- Ms. Francesca Bernardini, Secretary to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes, United Nations Economic Commission for Europe the Convention
- Dr. Kampanad Bhaktikul, Dean, Faculty of Environment and Resources Studies, Mahidol University
- Dr. Lilao Bouapao, Coordinator, M-Power, Lao PDR
- H.E. Mr Watt Botkosal, Deputy Secretary General, Cambodian National Mekong Committee
- Dr. Colin Chartres, Director General, International Water Management Institute
- Dr. Tomas Chiramba, Head, Freshwater Ecosystem Unit, United Nations Environment Programme, Nairobi, Kenya
- Mr. Wesley Chirchir, Vice Chairperson, The Nile Basin Discourse
- Mr Kongneun Chounamountry, Assistant Director General, Department of Water Resources, Ministry of Natural Resources and Environment, Lao PDR
- Dr. Olivier Cogels, SDC Senior Advisor, SDC Water Initiatives Division
- Dr. Daniel Connell, Researcher, Australian National University
- Ms. Pianporn Deetes, Thailand Campaign Coordinator, International Rivers, Thailand
- Mr. Peter Degen, Chief Technical Advisor, Fisheries Programme Mekong River Commission (MRC) Secretariat
- Mr. Anton Earle, Director, Capacity Building Programmes, Stockholm International Water Institute
- Dr. Tracy Farrel, Senior Technical Director, Greater Mekong Programme, Conservation International, Cambodia
- Mrs. Sun Feng, Deputy Director General, Department of International Cooperation Science and Technology, Yellow River Conservancy Commission
- Dr. Nelton Friedrich, Director, Itaipu Binacional
- Mr. Timothy Stephen Gambrell, Executive Director, the US Army Corps of Engineers /Mississippi River Commission
- Ambassador Alejandro Gordillo, Secretary General, Amazon Cooperation Treaty Organization
- Dr. Anthony Green, Senior Modelling Advisor, Information and Knowledge Management Programme, MRC Secretariat
- Ms. Meena Gupta, Retired civil servant of Government of India
- Mr. Hans Guttman, Chief Executive Officer, MRC Secretariat
- Dr. Phoumin Han, Programme Coordinator, Mekong-Integrated Water Resources Management Project , MRC Secretariat
- Prof. Phillip Hirsch, Professor of Human Geography, Mekong Research Group, University of Sydney
- Dr. Fritz Holzwarth, Deputy Director-General, German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Directorate Water Management
- Mr. Gu Hongbin, Secretary General, Ecosystem Study Communication of International Rivers
- Mr. Collins R.U. Ihekire, Executive Secretary, Niger Basin Authority
- Dr. Anders Jägerskog, Director, Stockholm International Water Institute
- Mr. Prasong Jantakad, Programme Coordinator, Agriculture and Irrigation Programme, MRC Secretariat
- Mr. Anthony Jude, Director, Energy Division, Southeast Asia Regional Department, Asian Development Bank
- Mr. Robert Kay, Executive Vice President, GMS Power
- Dr. Wael Khairy, Executive Director, Nile Basin Initiative Secretariat
- Ms. Kaing Khim, Deputy Director General of Fisheries Administration, Ministry of Agriculture, Forestry and Fisheries, Cambodia
- Dr. Timo Koivurova, Director and Research Professor, The Northern Institute for Environment and Minority Law, University of Lapland, Espoo Secretariat
- Mr. Simon Krohn, Chief Technical Advisor, Initiative for Sustainable Hydropower, MRC Secretariat
- Mr. Johan Kuylenstierna, Executive Director, Stockholm Environment Institute
- Mr. Henrik Larsen, Chief Technical Advisor, Environment Programme, MRC Secretariat

- Mr. Nicolas Le Clerc, Director, Project and Structured Finance Team, ANZ Bank
- Mr. James Ligh, Chief Business Management, US Army Corps of Engineer/Mississippi River Commission
- Dr. Phillip Magiera, MRC – GIZ Programme Coordinator, GIZ, Lao PDR
- Dr. Peter McCornick, Assistant Director General, International Water Management Institute
- Mr. Khalid Mohtadullah, Senior Advisor GWP/ Country Director IWMI, Global Water
- Ms. Bushra Nishat, Project Manager, IUCN
- Mr. Phonechaleun Nonthaxay, Director of the Secretariat of the Nam Ngum River Basin Committee, Ministry of Natural Resources and Environment, Lao PDR
- Ms. Rutmanee Ongsakul, Challenge Programme for Water and Food
- Mr. Ganesh Pangare, Head Water Programme, International Union for Conservation of Nature
- Dr. Guna Nidhi Paudyal, Team Leader Water Resources Department, DHI Group
- Dr. Nguyen Huong Thuy Phan, Programme Coordinator, Climate Change and Adaptation Initiative, MRC Secretariat
- Sub. Lt Preecha Phetwong, Deputy Director General, Marine Department, Ministry of Transport of Thailand
- Dr. Daovong Phonkeo, Director General of Energy Policy and Planning, Ministry of Energy and Mining, Lao PDR
- Mr. Voradeth Phonekeo, Task Leader, Initiative on Sustainable Hydropower, MRC Secretariat
- Dr. Jamie Pittock, Director of International Programme for the UNESCO Chair in Water Economics and Trans-boundary Water Governance, Australian National University
- Dr. Ajay Pradhan, Regional Director, DHI, India
- Ms. Neera Shrestha Pradhan, Hazard and Community Adaptation Specialist, International Centre for Integrated Mountain Development
- Mr. Gavin Quibell, Chief Technical Advisor, Mekong-Integrated Water Resources Management Project, MRC Secretariat
- Mr. Ajay Raghav, Deputy Director, National River Conservation Directorate, Ministry of Environment & Forests, Government of India
- Mr. Chaminda Rajapakse, Natural Resources Management Professional, Global Water Partnership
- Dr Claudia Sadoff, Lead Economist, The World Bank
- Mr. Simon Sakibede, General Secretary, International Commission for Congo-Ubangi-Sangha Basin Congo
- Dr. Sonali Senaratna Sellamuttu, Senior Researcher – Livelihoods, International Water Management Institute, Lao PDR
- Dr. John Shurts, General Counsel, Northwest Power and Conservation Council
- Ms. Gauri Sing, Director, Knowledge Management and Technology Cooperation, International Renewable Energy Agency
- Mr. Chaiporn Siripornpibul, Deputy Director General, Department of Water Resources, Ministry of Natural Resources and Environment, Thailand
- Dr. Mark Smith, Global Water Coordinator, International Union for Conservation of Nature
- Dr. Vadim Sokolov, Regional Coordinator, Scientific-Information Center of the Interstate Coordination, Water Commission of the Central Asia
- Mr. Robert Speed, Water Security Advisor, World Wildlife Fund
- Prof. Wolfgang Stalzer, President, International Commission for the Protection of the Danube River
- Dr. Chaiyuth Sukhsri, Head of Water Resources Engineering Department, Chulalongkorn University
- Mr. Sadar Muhammad Tariq, Regional Chair, Global Water Partnership – South Asia, Indus Basin 'Track 2' Process
- H.E. Mr. Navuth Te, Secretary General, Cambodia National Mekong Committee
- Dr. Troung Houng Tien, Viet Nam National Mekong Committee
- Dr. Dechen Tsering, Deputy Regional Director for Asia and the Pacific, United Nations Environment Programme
- Mr. Nguyen Van Bang, National Coordinator for Fisheries Programme, Viet Nam National Mekong Committee
- Mr. Frank van der Valk, Project Director, Bangladesh-India Initiative, International Union for Conservation of Nature
- Mr. Nguyen Van Duyen, Programme Coordinator, Environment Programme, MRC Secretariat
- H.E. Mr. Viraphonh Viravong, Deputy Minister, Ministry of Energy and Mining, Lao PDR
- Dr. John Ward, Senior Researcher, CSIRO Ecosystem Sciences
- Mr. Yue Zhang, Minister Counsellor, Permanent Representative of People's Republic of China to UNESCAP, Permanent Mission of China to UNESCAP

Facilitators

Conference Facilitators: Dr. Torkil Jønch Clausen, Chief Water Policy Advisor, DHI Group.
Sessions Facilitators: Mr. Jeremy Bird, International Consultant, Incoming Director General, International Water Management Institute; Mr. Kurt Mørck Jensen, Senior Analyst, Danish Institute for International Studies; and Prof. Aaron Wolf, Department Chair Geosciences, Oregon State University.

The Mekong2Rio International Conference on Transboundary River Basin Management was held 1-3 May 2012 in Phuket, Thailand

Mekong2Rio was the first of a series of biennial conferences of its kind convened by the Mekong River Commission

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