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# Pipedreams?

**GLOBAL  
FRESHWATER  
PROGRAMME**

Interbasin water transfers and  
water shortages



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## Summary

**The world is increasingly forced to face the challenge of how to ensure access to adequate water resources for expanding populations and economies whilst maintaining healthy freshwater ecosystems and the vital services they provide. One increasingly popular way for governments to pursue in seeking to distribute water more evenly across the landscape is to transfer it from areas with perceived surpluses, to those with shortages.**

Historically, such transfers have generally been restricted to within river basins, but increasingly, large quantities of water are being moved over long distances, from one river basin to another. These interbasin water transfer schemes (IBTs), as they are known, are not a new phenomenon. Like the outbreak of dam building that marked the last half of the 1900s, IBTs are often touted as the quick fix solution to meeting escalating water demands, in order to stoke the fires of economic development, address poverty reduction, and to feed rapidly growing human populations.

The wide range of IBT projects in place, or proposed, has led to the preparation of this review including seven case studies from around the globe. It examines the costs and benefits of large scale IBTs, as well as analysing the lessons learnt from some existing schemes.

The report concludes that while IBTs can potentially solve water supply issues in regions of water shortage, they come with significant costs. Large scale IBTs are typically very high cost, and thus economically risky, and they usually also come with significant social and environmental costs; usually for both the river basin providing and the river basin receiving the water.

From an environmental perspective, IBTs in general interrupt the connectivity of river systems and therefore disrupt fish spawning and migration. They alter natural flow regimes, sometimes with great ecological cost to threatened aquatic species or protected areas, contribute to salinisation and water table lowering in coastal areas

and can also facilitate the transfer of invasive alien species between river basins.

What stands out among the IBT case studies outlined in this report (and elsewhere) are the following:

- 1 Apart from hydropower generation, a common driver of IBTs is a desire to promote agricultural production in water poor areas and, in particular, irrigated agriculture. This can see unsustainable (subsidized) cropping practices promoted by the IBT when perhaps this was unwise;
- 2 There is typically a failure to examine alternatives to the IBT that may mean delaying, deferring or avoiding the costs in every sense of an IBT; and
- 3 There are a range of governance failures ranging from poor to non-existent consultation with affected people, to failing to give sufficient consideration or weight to the environmental, social and cultural impacts of the IBT, in both the donor and recipient basins.

The history of IBTs to date should be sufficient to sound very loud alarm bells for any government contemplating such a plan. Despite the many lessons we should have learnt from past IBT experiences, many decision makers today continue to see IBTs as a technical solution to restore perceived imbalances in water distribution.

The development of IBTs, rather than restoring a water imbalance, usually disturbs the finely tuned water balance in both the donating and the receiving river basin. Regularly overlooked in IBT development are the short, medium and

longer term impacts of moving water from one community (the donor basin) and providing it to another (the recipient basin).

As noted above, weak governance is also symptomatic of IBT development, with poor to non-existent consultation with affected people commonly being witnessed and a lack of consideration at an appropriate management scale. This failure to look at the impacts of the proposed IBT within a river basin management framework considerably elevates the risks of 'collateral damage' from the IBT. Through employing the management model of Integrated River Basin Management, governments and civil society will be much better placed to make well informed decisions in relation to IBTs.

WWF recognises that while local IBTs may, under certain circumstances, fulfil an important role (for example in supplying drinking water to population centres) the benefits of many large scale transfer schemes that are still on the drawing board are doubtful. In the past many IBTs have caused a disproportionate amount of damage to freshwater ecosystems in relation to the schemes' benefits. Social and economic impacts, especially for the donor basin, are in general unacceptable also.

The size of many schemes has meant that a large-scale IBT is rarely the most cost effective way of meeting water demands. Of concern too is that in many cases the introduction of an IBT does not encourage users to use the water more effectively, continuing wasteful practices.

WWF believes that any new interbasin water transfer scheme should be approached in accordance with the principles set out by the World Commission on Dams (2000). First and foremost this means that any scheme under consideration should be subject to a comprehensive 'Needs and Options Assessment', detailed cost-benefit and risk analyses that consider the full suite of potential environmental and social and economic impacts.

As advocated in section 5 of this report, in moving to examine the alternatives to an IBT, WWF recommends the following step-wise approach, ideally considered at a whole-of-river-basin level, through an integrated planning process. The alternatives should be considered in the following order:

- 1 Reducing water demands;
- 2 Recycling waste water;
- 3 Supplementing water supplies locally,
- 4 Considering an IBT, as a last option.

Through the vehicle of this report, WWF calls on all decision makers to follow the steps outlined above when considering how to meet water needs in areas of scarcity. There is a need to recognise that interbasin water transfer are in most cases a "pipedream" and that the taking of water from one river to another usually reflects ignorance of the social and environmental costs and a failure to adequately consider better, local alternatives, such as improved management of local demand.

# 1 Introduction

**As the world faces increasing insecurity about its water supplies – with both droughts and floods on the increase - the world water crisis is more and more frequently in the news. The planet urgently needs to face the dilemma of how to secure access to adequate water resources for expanding populations and economies, whilst maintaining healthy freshwater ecosystems and the vital services they provide.**

To those who see the world's water balance as a score sheet of shortages and surpluses, one of the obvious solutions to meeting water demands is the transfer of water from areas with perceived surpluses, to those with shortages. Over the centuries, such transfers have generally been restricted to within river basins, but increasingly large quantities of water are being transported over long distances, from one river basin to another.

While these so named 'interbasin water transfers' (IBTs) can potentially solve water supply issues in regions of water shortage, they come with significant costs.

Large scale IBT schemes are typically very high cost, and thus economically risky, and they usually also come with significant social and environmental costs, usually for both the river basin providing and the river basin receiving the water.

The wide range of IBT projects in place, or proposed, has provoked the preparation of this review. It examines the costs and benefits of large scale IBTs as a solution to water supply problems in the future, as well as analysing the lessons learnt from some existing schemes.

The report also considers some proposed IBT schemes that have been under consideration for a number of years and that are today in various stages of development. These schemes are examined to establish if they are the best solution for addressing the problems they seek to solve. For each, the economic and environmental risks are identified and

alternatives to the construction of the IBT are considered.

This review concludes by setting out (in section 5) a decision-making hierarchy or step-wise process by which any proposed IBTs can be reviewed to determine if they are truly needed, and to ensure that all other feasible alternatives have been considered before moving to the high risk strategy of constructing and operating an IBT scheme.



## 2 Interbasin water transfers – the context

### 2.1 The World water crisis

Since the launch of the first United Nations World Water Development Report ‘Water for People, Water for Life’ in 2003 the term ‘world water crisis’ has frequently made headlines. The report states “We are in the midst of a water crisis that has many faces. Whether concerning issues of health or sanitation, environment or cities, food, industry or energy production, the twenty-first century is the century in which the overriding problem is one of water quality and management.” (UN/WWAP, 2003).

On the ground, the crisis manifests itself in a variety of hydrological events that affect people all over the world – see Box 1.

#### Box 1: **Hydrological events in August 2006 – a selection**

In **China**, the Xinhua News Agency (29 August 2006) reported that drought in the Sichuan Province and Chongqing areas is affecting the drinking water supplies for more than 17 million people.

In **India**, Barmer district in the Rajasthan Thar desert, usually prone to extensive droughts, was struck by heavy rains in August 2006. Eyewitnesses reported ‘a desert turned into a sea’ and at least 130 people were killed, while thousands were displaced from their homes.

In the **United States**, a severe drought is affecting many of the Plains States, including North and South Dakota, Montana and Wyoming, severely affecting agricultural outputs in these areas and forcing many ranchers to sell off their cattle.

In **Australia**, a severe drought has all major cities in southern Australia on severe water restrictions and governments have agreed on contingency plans in case the Murray River, the major river of south-east Australia, stops flowing in coming months.

The second edition of the World Water Development Report, ‘Water, a shared responsibility’ (UNESCO/WWAP, 2006) focuses on the changing contexts within which water managers have to manage scarce resources. It identifies a number of factors that affect the availability of water as well as its management, including widespread poverty, malnutrition, demographic change, growing urbanization, the effects of globalization and the manifestations of climate change.

## 2.2 The escalating demands for water

Freshwater is vital to human survival and in general people have settled in areas with sustainable, local, water supplies. Growing populations, increasing urbanisation and intensive agriculture result in over-exploitation of water resources and in many places human water use, domestic, industrial and agricultural, exceeds average annual water supplies.

Areas of high water overuse tend to occur in regions that are strongly dependent on irrigated agriculture, such as the Indo-Gangetic Plain in South Asia, the North China Plain and the High Plains in North America.

The urban concentration of water demand adds a highly localized dimension to these broader geographic trends. Where water use exceeds local supplies, society is dependent on infrastructure, such as pipelines and canals, to transport water over long distances. In conjunction with this, there is increasing reliance on groundwater extraction.

The consequences of water overuse include:

- 1 diminished river flows;
- 2 depletion of groundwater reserves;
- 3 reduction of environmental flows needed to sustain aquatic ecosystems and the associated services needed by people; and,
- 4 potential societal conflict

## 2.3 The world water crisis and impacts on freshwater ecosystems

The measures taken to secure adequate water supplies for human populations inevitably affect freshwater ecosystems.

According to the WWF Living Planet Index (WWF, 2004a), populations of freshwater species showed a decline of over 30 per cent from 1970 to 2003.

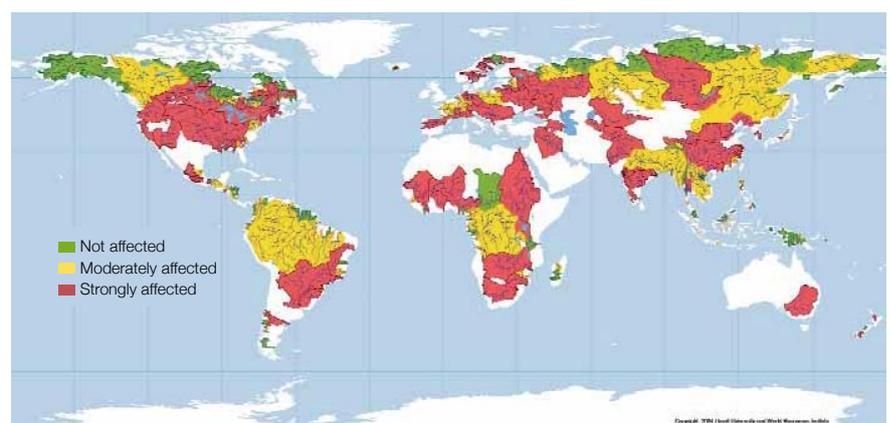
This decline in freshwater species is attributed to factors such as:

- 1 infrastructure development (like dams, inter and intra basin water transfers, canalization, flood-control, river diversions and large-scale irrigation);
- 2 deforestation;
- 3 over harvesting;
- 4 alien invasive species;
- 5 unsustainable agriculture practices (cultivating 'thirsty crops'); and,
- 6 urban and industrial pollution.

These drivers change the characteristic of river basins and their ecosystems in many ways. For example, dams interrupt the connectivity of river systems and therefore disrupt fish spawning and migration. Water transfers alter natural flow regimes, reduce downstream water availability for agriculture and contribute to salinisation and water table lowering in coastal areas. They can also facilitate the transfer of invasive alien species within or between river basins.

The Millennium Ecosystem Assessment (MEA, 2005) states that "dams and other infrastructure fragment 60 per cent of the large river systems in the world". WWF estimates that only one-third of the world's 177 large rivers (over 1,000 km long) remain free flowing from source to sea (WWF, 2006b).

Map 1: **Fragmentation and flow regulation by Large River System (LRS), (Nilsson *et al*, 2005)**



Note: This figure presents the results of the river fragmentation and flow regulation assessment by Nilsson *et al.*, (2005). Of 292 of the world's Large River Systems (LRS), 173 are either

strongly or moderately affected by dams; while 119 are considered unaffected. In terms of areas, strongly affected systems constitute the majority (52 per cent or about 4,367 km<sup>2</sup>) of total

LRS catchment areas. The grey colour represents potential LRS in Indonesia and Malaysia that were not assessed due to lack of data.

### 3 What can we learn from existing interbasin water transfer schemes

**Interbasin water transfer schemes are not a new phenomenon. Like the outbreak of dam building that marked the last half of the 1900s, interbasin water transfer are now widely touted as the quick fix solution to meeting escalating demands for water, to stoke the fires of economic development, and to feed rapidly growing human populations.**

Examining the impacts of existing IBTs is quite instructive. It provides significant lessons we should learn as the pace with which new schemes are being formulated and brought forward for consideration quickens.

Interbasin transfers - planned, completed or being conceived - number in the hundreds. No river basin is immune it seems from the easy attraction of becoming a donor or recipient basin.

Transfer schemes run the gamut: Japan's Totsukawa to Kinokawa River, Chile's Teno-Chimbarango Canal, France's Durance river project, Morocco's Beri Boussa project and on and on.

The diversion of the Aral Sea tributaries with a not so happy ending is one of the best known schemes for all the wrong reasons: salinity, water and fish decline and health problems. Big or small, transfer schemes are often expensive, elaborate, and unsustainable ways that complicate, not solve, water problems. The following pages describe three cases of existing IBTs followed by four cases in the works.



## Case study 1

# Tagus-Segura Transfer - Spain

### About this IBT

The Tagus-Segura IBT in Spain is a 286 km long pipeline connecting three different Spanish river basins; the Tagus, Júcar and Segura. It has been operative since 1978.

Its main objective was to solve an estimated water deficit of 0.5 km<sup>3</sup>/yr in the recipient area and to ensure water supply for 147,000 hectares of irrigation and 76 municipalities in south-east Spain.

The pipeline starts at two dams in the Upper Tagus, with a storage capacity of approximately 2.4 km<sup>3</sup>, and facilitates a transfer of 1 km<sup>3</sup>/yr towards the Talave Dam in the Mundo River.

The actual transfers are variable and depend on the existing resources in the Tagus basin. Usually around 0.2-0.4 km<sup>3</sup> of water is transferred annually. In only a few years in the last decade has the full legal transfer of 0.6 km<sup>3</sup> been transferred.

In drought years, once the water storage in the Tagus dams is lower than 0.24 km<sup>3</sup>, the transfers approach zero.

Once in the Segura basin, the transferred water gets mixed with local desalinated, surface and groundwater in a region-wide network of pipes, dams and storage ponds.

### Analysis

Rather than solving a water shortage in the Segura basin, the extensive water infrastructure has become a driver for unsustainable use of water, fostering the uncontrolled increase of irrigated areas and of urban development on the coast.

According to Arrojo (2001), the original plan was for this IBT to support approximately 50,000 ha of irrigated area. Uncontrolled expansion of irrigation saw this figure grow to nearly 88,000 ha, despite annual flows from the IBT being around one-third of that projected.

Moreover, the construction of the IBT has fostered a proliferation of illegal boreholes, which are significantly contributing to over-exploitation of the aquifers.

As a result, the IBT has multiplied the initial 'water deficit' that it was supposed to solve and has created a strong dependence of the economy in the recipient region on the IBT.

Although the IBT was based on a supposed water surplus, the Tagus basin has experienced substantial environmental impacts from the water diversion. Legal minimum stream flow requirements are often not met and the river is suffering from an increase in pollution.

Another impact is that on endemic fish species. The transfer of species between the basins is threatening, through hybridisation, the minnow (*Chondrostoma arrigonis*) which is endemic in the Júcar River and listed as a critically endangered species (IUCN Red List, 2006).

The IBT has become a major catalyst for conflicts between the donor and benefiting regions. Improved demand management in the recipient area, through the closing down of illegal wells, preventing the creation of new irrigated areas and promoting more sustainable urban landuse, would help to reduce these tensions. However, demand is expected to continue to increase along the Murcia coastline where approximately 50 new golf courses, with 114,850 new flats are planned to be built in an eight year timeframe.

In order to increase water availability in the region, the present Spanish Government is planning to foster desalination, mainly for urban supply, and treated, recycled wastewater.

## Summary

<b>Where</b>	<b>Tagus – Segura Transfer, Spain</b>
<b>When</b>	1978 completed
<b>Receiving basin</b>	Segura basin
<b>Donating basin</b>	Tagus (upstream)
<b>Distance</b>	286 km main pipe
<b>Volume diverted</b>	0.6 km <sup>3</sup> /yr
<b>Structures</b>	5 dams, 286 km pipe, network of post-transfer distribution
<b>Cost</b>	Not known
<b>Purposes</b>	<ul style="list-style-type: none"> <li>• Irrigation</li> <li>• Urban water supply (coastal urban and tourism development)</li> </ul>
<b>Environmental cost/benefits</b>	<ul style="list-style-type: none"> <li>• Reduction in stream flow in donor basin</li> <li>• Increased threat level for critically endangered fish species</li> </ul>
<b>Social cost/benefits</b>	<ul style="list-style-type: none"> <li>• Social conflicts</li> <li>• Increase of water consumption</li> </ul>
<b>Alternatives</b>	<ul style="list-style-type: none"> <li>• Close down illegal wells and irrigation</li> <li>• Promote sustainable urban land use</li> <li>• Restrict construction of golf courses in the Murcia region</li> <li>• Recycle wastewater</li> </ul>
<b>Lessons learnt</b>	<ul style="list-style-type: none"> <li>• Increasing water availability from an IBT can become a driver for unsustainable water use in the receiving area</li> <li>• IBTs should be accompanied by strict measures to curb water demand in the receiving area</li> </ul>

## Case study 2

# Snowy River Scheme – Australia

### About this IBT

The Great Dividing Range in south-eastern Australia is an important source of water, including for the Snowy River, which drains to the south-east. The prospect of damming the Snowy River, and diverting its waters to the western side of the Great Divide into the Murray River basin for the dual purpose of hydropower and irrigation, dates back to 1884.

The scheme was eventually constructed by the national and two state governments (Victoria and New South Wales) at a cost of AUD \$820 million (US \$630 million) between 1949 and 1974 and comprises 16 large dams, seven hydropower stations, over 145 km of tunnels and about 80 km of aqueducts, mostly located in Kosciuszko National Park.

The scheme has a total water storage capacity of 7 km<sup>3</sup> and electricity generating capacity of 3,756 MW, 16% of the total capacity in south-east Australia.

### Analysis

The scheme has yielded substantial economic benefits, as apart from hydropower, it diverts 1.1 km<sup>3</sup>/yr of water into the Murray-Darling Basin for irrigation; resulting in an estimated US \$115 -145 million per year of value added.

The scheme has also facilitated access for recreation and tourism attractions (3 million visitors per year) by roads servicing the scheme (estimated at about US \$118 million a year), as well as associated employment opportunities.

However, the environmental impacts on the Snowy River have been severe. Its flow was reduced by 99% below the Jindabyne dam resulting in a loss of floodplain wetland habitats; silting up of the river channel and invasion by exotic trees, salt water intrusion into the estuary and loss of migratory fish populations.

When the government owners of the scheme moved to corporatise the Snowy Mountains



Hydroelectric Corporation, as a possible prelude to privatization (since abandoned in 2006), residents downstream on the Snowy River demanded that river flows were restored first. They feared that if these flows were proposed after corporatisation the compensation payable to the scheme owners for loss of income from electricity generation, sales of water to irrigators and in renovating infrastructure, would be prohibitive.

The demand to restore the Snowy created conflict with the downstream states and communities along the Murray River, which receives water diverted by the Snowy scheme. The Murray River has 80% of its average annual flow diverted for irrigation. Apart from possible impact on irrigation, any reduction of water threatened to accelerate the environmental collapse of the Murray River and its many services, including a number of Ramsar-listed Wetlands of International Importance.

A vocal community campaign led to a public inquiry. During this, scientists estimated that restoring the Snowy River's flow to 28% was the minimum required to restore the most damaged portion of the river to a more natural condition and re-establish fish populations.

In 2002 the national and state governments signed an agreement to undo part of the water transfers to partly restore Snowy River flows.

The targets are to return flows to 15% (0.14 km<sup>3</sup>/yr) of natural in years 1-7, to 21% (0.21 km<sup>3</sup>/yr) in years 7-10, and, under certain conditions, up to 28% (0.29 km<sup>3</sup>/yr) after year 10.

The governments involved have allocated AUD \$375 million (US\$ 289 million) to the 'Water for Rivers' company to secure 0.28 km<sup>3</sup>/yr water for environmental releases (0.21 km<sup>3</sup>/yr for the Snowy - to restore flows to 21%, and 0.07 km<sup>3</sup>/yr for the Murray). This is being sought through investing in water savings projects to compensate for the reduction of water supply into the Murray-Darling Basin.

In practice these 'water savings' are proving difficult to deliver. The Jindabyne Dam could not release the increased environmental flow to the Snowy River, and so a new outlet, spillway and hydroelectric plant are being retrofitted to the dam at a cost of

AUD 90 million (US \$69 million) (Snowy Hydro, 2006). At present there is a proposal for the national government to assume control of water management across this Basin, representing one-seventh of the Australian landmass, and for AUD\$10 billion to go towards ramping up water efficiency measures in the irrigation sector and to buy back water licences to provide enhanced environmental flows. This should assist with meeting the projected flow return targets for the Snowy River.

Despite the promising political commitment to restoring some environmental flows to the Snowy River, key aspects of the agreement have not been honoured by the governments so far. For example, the Snowy Scientific Committee that is required under the Snowy Hydro Corporatisation Act of New South Wales to supervise the implementation of the agreement and issue an annual, public report has not been established.

## Summary

<b>Where</b>	<b>Snowy River Scheme, Australia</b>
<b>When</b>	From 1949 until now
<b>Receiving basin</b>	Murray-Darling Basin
<b>Donating basin</b>	Snowy River
<b>Distance</b>	Less than 100 km
<b>Volume diverted</b>	1.1 km <sup>3</sup> /yr of water into the Murray-Darling Basin for irrigation
<b>Structures</b>	16 large dams, seven hydropower stations, over 145 km of tunnels and about 80 km of aqueducts
<b>Cost</b>	AUD \$820 million (US \$630 million) to initial construction
<b>Purposes</b>	<ul style="list-style-type: none"> <li>• Hydropower</li> <li>• Irrigation</li> </ul>
<b>Environmental cost/benefits</b>	<ul style="list-style-type: none"> <li>• Snowy River flow reduced by 99% below the Jindabyne dam of its natural flow, resulting in loss of wetland habitat, silting up of the river channel, invasion by exotic trees, salt water intrusion in the estuary and loss of migratory fish populations</li> <li>• Diverted water has helped (in part) to retain ecological values of Ramsar wetlands and the river channel of the recipient river, the Murray; a grossly over-allocated system</li> </ul>
<b>Social cost/benefits</b>	<ul style="list-style-type: none"> <li>• For the communities of the Snowy River the costs were loss of income, amenity values and a natural asset</li> <li>• Communities of the recipient Murray benefited, irrigators especially. The IBT created significant employment locally, was seen as a nation building project, which now has opened up the region to tourism etc</li> </ul>
<b>Alternatives</b>	<ul style="list-style-type: none"> <li>• Electricity generation was possible without the IBT diverting water from the Snowy River, which was seen at that time as expendable in the national interest</li> <li>• More efficient irrigation practices along the recipient river could have allowed an expansion of agriculture without the IBT</li> </ul>
<b>Lessons learnt</b>	<ul style="list-style-type: none"> <li>• Projects that don't adequately consider the full costs and benefits, including on natural assets, and their associated communities, cause conflict for decades</li> <li>• Even partial restoration of diverted flows is very expensive. Upfront provision of environmental flows would have significantly reduced the costs</li> <li>• No consideration was given to demand management (improved water use efficiencies) in the recipient basin at the time the IBT was devised</li> </ul>

## Case study 3

# Lesotho Highland Water Project - Lesotho and South Africa

### About this IBT

The principal natural resource of the land-locked Lesotho is its water, with a number of rivers originating in the Drakensberg Mountains. The largest of these is the Orange River (known as the Senqu in Lesotho).

In 1986, South Africa and Lesotho signed a bilateral treaty establishing the Lesotho Highland Water Project (LHWP). The LHWP aims to reverse the southerly flow of the Senqu/Orange River in Lesotho to the Vaal River in the north through the construction of five dams, 200 km of tunnels and two pumping stations.

By 2020, some 2.5 km<sup>3</sup> of water per year is to be exported to Gauteng, South Africa's most industrialised province. In addition, about 90 MW of power would be generated for use in Lesotho.

The total cost of the project was expected to be about US \$4 billion but recent estimates suggest the final figure will be nearer to US \$8 billion. The LHWP is today the largest infra-structure project in southern Africa and is being implemented in several stages.

Construction of Phase 1A was undertaken between 1989 and 1998 and at present the LHWP transfers more than 0.5 km<sup>3</sup> of water per year into the Vaal River.

Phase 1B of the project began in 1998 and aims to increase the total water transfer rate from 18 m<sup>3</sup>/s to 30 m<sup>3</sup>/s.

In March 2004, the Mohale Dam (Phase 1B) was inaugurated and the final phase of the project is intended to provide additional water and power generation from two more dams. Currently the Government of Lesotho is engaging in two new large-scale water developments: Phase II of the Highlands Water Project (LHWP) and the Lesotho Lowlands Water Scheme (LLWS) (TRC, 2005).

### Analysis

The LHWP began without an environmental impact assessment for the overall project. There is still no such report for Phase 1A, although some 35 baseline studies of the flora and fauna of the area were done after construction began.

A full EIA has been done for Phase 1B, and an environmental action plan prepared, but neither addresses outstanding problems from Phase 1A.

Of concern are impacts of the IBT on remnant populations of the critically endangered Maloti minnow (*Pseudobarbus quathlambae*). Habitats are threatened and the IBT could see trout move into these as well, further increasing the risks of extinction (Swartz *et al*, 2001).

Eventually, some 40% of the flow of the Orange River will be diverted to the Vaal. A diversion of river flow on this scale will reduce the amount of water available to dilute polluting discharges, increasing the risk of de-oxygenation and eutrophication, and disturbing species dependent on rapid flows. Additional flows in the Vaal River may also increase bank erosion and cause alterations in the river bed.

It has been estimated that the cost of mitigating the biophysical and social impacts will be between US \$2.8 million and US \$4.2 million annually. Around 30,000 people have been affected by the construction works and 325 households had to be permanently relocated. More than 2,300 ha of agricultural land and 3,400 ha of pastures were lost and there have been reports of slow and inadequate compensation.

Lesotho has gained immense economic benefits from the project with over US \$80 million in royalties since 1998, amounting to 27.8 per cent of all government revenue.

Lesotho now generates enough electricity to export the excess and there has been a considerable improvement in infrastructure (roads, schools, water supply) and some 7,000 jobs have been created. However, there are concerns that the poorest have still not seen any benefits.

Also, the project has been plagued by corruption and two international engineering firms have been convicted for bribery (TRC, 2005).

There are indications that demand management alternatives to the IBT have not been considered adequately. Gauteng's

water utility Rand Water has calculated that water savings of just 10% could have delayed the need for one of the schemes' dams by several years. Yet, construction of the scheme continues at a rapid pace, and to pay its portion of the capital costs, Rand Water has had to increase prices and needs to sell more water, not less. The new charges are beyond the ability of the poorest families to pay (restricting them to the legal minimum required by the South African Constitution). To supply Gauteng's waterless poor would require just 5% of the water used by middle income South Africans on gardens.

## Summary

<b>Where</b>	<b>Lesotho / South Africa: Lesotho Highlands Water Project</b>
<b>When</b>	Started in 1986 and ongoing; Phase 1 (most important) of 4 completed
<b>Receiving basin</b>	Vaal River system
<b>Donating basin</b>	Orange/Senqu River catchment
<b>Distance</b>	200 km of tunnel
<b>Volume diverted</b>	0.63-0.82 km <sup>3</sup> /yr
<b>Structures</b>	5 dams, 200 km tunnels; hydropower plant (ready: 3 dams; 118.4 km tunnel and hydropower plant)
<b>Cost</b>	First phase US\$ 4 billion (total about US\$ 8 billion by 2020)
<b>Purposes</b>	<ul style="list-style-type: none"> <li>• Water supply for South Africa's Gauteng industry region</li> <li>• Electricity, royalties and infrastructure for Lesotho</li> </ul>
<b>Environmental cost/benefits</b>	<ul style="list-style-type: none"> <li>• Reduced flow rates and less-frequent floods of the Lesotho river basins</li> <li>• Several populations of critically endangered Maloti minnow threatened</li> </ul>
<b>Social cost/benefits</b>	<ul style="list-style-type: none"> <li>• When completed will dispossess more than 30,000 (now about 20,000) rural farmers of assets (including homes, fields, and grazing lands) and deprive many of their livelihoods</li> <li>• The loss of arable land would increase Lesotho's dependence on foreign food imports; indeed, the project would cause the loss of 11,000 hectares of grazing or arable land</li> </ul>
<b>Alternatives</b>	<ul style="list-style-type: none"> <li>• Manage demand better by using mechanisms outlined in South Africa's Water Act 1998 often seen as a global model</li> <li>• Promote water reuse and recycling among leading industry players in the basin</li> </ul>
<b>Lessons learnt</b>	<ul style="list-style-type: none"> <li>• Project failed to examine environmental or social impacts from the outset, and the mitigation costs these would require</li> <li>• The capital costs for these types of projects are frequently much greater than the proponents first claim, as was the case here (World Commission on Dams, 2000)</li> <li>• No consideration was given to demand management as a way to delay construction of IBT</li> <li>• Poor governance can lead to poor decisions and greater costs, as shown by the allegations of corruption</li> </ul>

## Conclusions - summary of lessons learned

The preceding case studies describing IBT schemes from three different parts of the World illustrate well a number of the common, negative impacts of these schemes. Table 1 below

	Case study		
	1 Tagus-Segura Transfer, Spain	2 Snowy River, Australia	3 Lesotho Highlands Water Project, Lesotho and South Africa
Demand management in recipient basin not serious part of pre-planning for IBT, leading to on-going water wastage	✓	✓	✓
IBT became driver for unsustainable water use in recipient basin—irrigation and urban	✓	✓	
Created strong dependence on IBT in recipient community	✓	✓	✓
IBT now seen as inadequate and other water supplementation required (groundwater, desalination, recycling etc)	✓	✓	
Saw proliferation of boreholes to access groundwater – leading to over-exploitation of this resource too	✓		
Donor basin experienced serious environmental impacts through reduced flows especially	✓	✓	✓
IBT created or escalated threats to critically endangered, threatened species etc	✓		✓
Scheme saw economic benefits in recipient basin at the cost of communities in the donor basin	✓	✓	✓
IBT catalyst for social conflict between donor and recipient basins or with government	✓	✓	
IBT has not helped the situation of the poor affected or displaced by it			✓
Post IBT mitigation costs very high, either environmentally or socially	✓	✓	✓
Governance arrangements for IBT weak, resulting in budget blow-out or corruption			✓

From the above there are several key lessons that can be learned, as follows:

- 1 Before progressing to commission an IBT, there should be a comprehensive assessment of the alternatives available for providing the water needed in the proposed recipient basin. Can this water be provided through demand management, water recycling, water harvesting etc, before considering a major (and usually high cost) infrastructure investment with its environmental and social impacts?
- 2 Undertake a cost-benefit analysis of the likely impacts of the IBT on both the donor and recipient basins, considering the full range of environmental, social and economic implications.
- 3 Ensure risks associated with the proposed IBT environmental, social and economic are clearly understood, and if the project proceeds, governance arrangements are adequate to manage and minimise these risks.
- 4 Undertake consultations with the likely directly and indirectly affected people, before a decision is taken regarding the possible IBT (and certainly before it becomes fait accompli) ensuring they understand and have the opportunity to voice views on likely cost, benefits and risks.

Note that the above approach is that advocated as a 'Needs and Options' assessment in the report of the World Commission on Dams (2000).

## 4 In the pipeline – interbasin water transfers in the future

**Despite less than positive experiences with large scale interbasin water transfers, many decision makers are today still looking towards them as a solution to water supply problems.**

Many ambitious projects are under consideration at present. This includes a number of schemes that will transfer water over thousands of kilometres, as well as many other schemes that are less grand in scale.

Globally there is no single source of information on the numbers and kinds of IBTs that are planned and most schemes being developed within countries.

In some countries plans exist to not just transfer water from one basin to another, but to transfer water across several river basins. Plans for IBTs are also not limited to countries that as yet have no negative experiences with them. Proponents in Australia for example, despite the vast amounts of money being spent on restoring some of the flows in the Snowy River system, still have plans for large water supply schemes that involve transfers from river basins in the tropical north to the currently drought stricken southern parts of the continent.



## Case study 4

# Acheloos Diversion, Greece

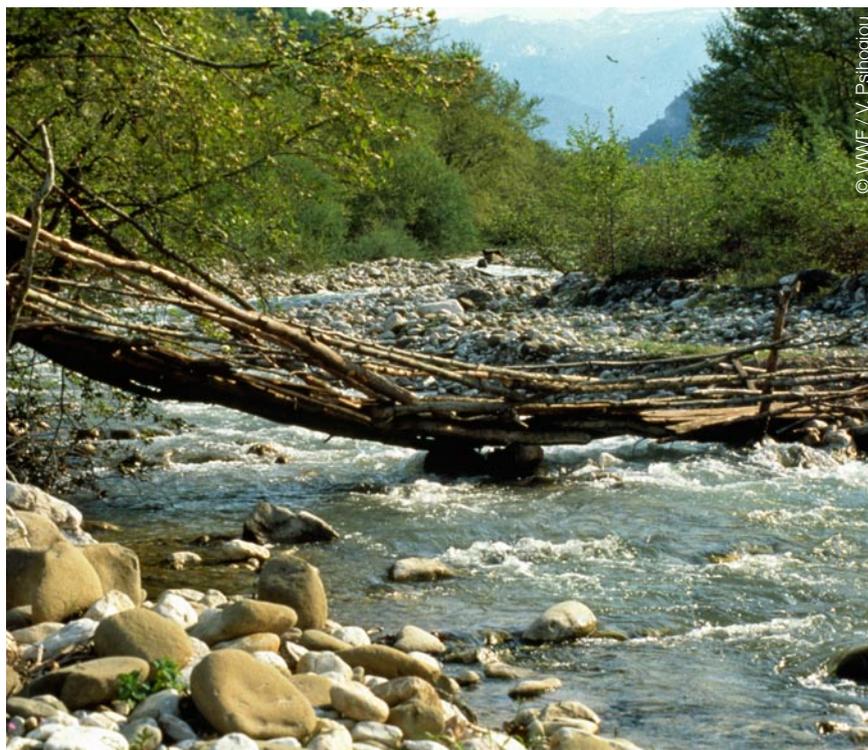
### Why an IBT

The 220 km long Acheloos River originates in the Pindos mountain range and runs southwards through Western Greece to the Ionian Sea. The lower reaches of the river are developed for hydro-electricity at the Kastraki and Kremasta dams, but there are plans to divert its waters eastwards to the Thessaly plains, an important agricultural region.

The diversion plans date back to the 1930s, but concrete proposals were not developed until the 1980s, when the Greek government expressed its intention to implement the Upper Acheloos Diversion Project, designed to transfer up to 0.6 km<sup>3</sup> of water per year to Thessaly.

The government's vision is to bring together two of Greece's most important natural resources - the Acheloos River and the Thessaly plain - for the benefit of the national economy.

A number of decisions by the Council of State (Greece's Supreme Court) in the 1990s and in 2005 declared the project illegal, on the grounds that it violated Greek and EU legislation on water management, Greek legislation on EIA and international legislation on the preservation of cultural heritage. Nevertheless, the diversion is still on the Greek political agenda today and support remains strong. In July 2006 the project was declared a plan of "national importance" and approved by law, thus bypassing the legal obstacle of the Supreme Court rulings.



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### Expected environmental and social impacts

The project is expected to cause irreversible damage to ecosystems of exceptional ecological value and could bring about local extinctions of several populations of endangered and internationally protected species, including otter (*Lutra lutra*), trout (*Salmo trutta*) and dipper (*Cinclus cinclus*).

Populations of other species such as grey wolf (*Canis lupus*), wildcat (*Felis silvestris*) and roe deer (*Capreolus capreolus*) are expected to be seriously disturbed both during and after construction by alterations to the landscape. The pristine forest ecosystems of the area will be seriously damaged through the opening of roads during the construction and operational phases of the dams.

The riverine habitats of the Southern Pindos face the prospect of permanent alterations due to the construction of deep reservoirs.

### ▲ Traditional wooden bridge at upper Acheloos River, Greece

Further downstream, the Ramsar-listed wetlands of the Messolongi Lagoons Complex, a site of global ornithological significance, are expected to suffer from serious reduction in freshwater input. The Acheloos Valley and Delta have also been included in the national Natura 2000 list.

The construction works in fragile mountain ecosystems are also likely to exacerbate soil erosion and landslides and large tracts of land will be inundated by the main reservoirs.

The diversion project is also expected to have serious socio-economic and cultural impacts. These include destruction of important cultural monuments such the 11th century monastery of St George of Myrophyllo, and a number of stone bridges which will be inundated.

## Analysis

Economically, the sustainability of this IBT project is questionable. A cost-benefit analysis done in 1988, on behalf of the Ministry of National Economy, concluded that even if the construction and operational timetables were met, the project was only marginally in the 'black' financially.

The project is driven by the wish to increase agricultural output in Thessaly, but water supply problems in that region can be largely attributed to the mismanagement of its water resources for irrigation, and the widespread cultivation of cotton, a water intensive ('thirsty') crop. In fact, the economic viability of the project is dependant on cotton farming, which is at present heavily subsidised; these subsidies per kilogram of crop being close to the world market price. Cotton subsidies are seriously questioned in the framework of the reformed EU Common Agricultural Policy and are expected to be phased out in the years to come. However, Greece continues to support intensive cotton production and seems unwilling to plan for a smooth shift towards the cultivation of less 'thirsty' crops.

Thessaly is naturally characterised by a rich network of streams and wetlands. However, the use of inappropriate irrigation methods, that result in large quantities of water being wasted, have caused major water problems, including a sharp fall of the groundwater table due to uncontrolled bore hole drilling, and subsequent salinisation of the soil.

Rather than a large scale IBT, the construction of a series of small reservoirs in the rivers of Thessaly would guarantee better distribution of irrigation water and also be more cost effective.



▲ Mouth of Acheloos River in Central Greece

## Summary

Where		Upper Acheloos Diversion Project - Greece
When		<ul style="list-style-type: none"> <li>• Original plan dates to 1930s</li> <li>• Designed in 1980s – currently under construction</li> </ul>
What	Receiving basin	Plain of Thessaly
	Donating basin	Acheloos
	Distance	174 km
	Volume diverted	0.6 km <sup>3</sup> /yr
	Structures	<ul style="list-style-type: none"> <li>• Mesochora mega dam (150 m. high) and Mesochora reservoir (228 m<sup>3</sup> volume)</li> <li>• Mesochora – Glystra tunnel (7.5 kilometres long)</li> <li>• Sykia mega dam (150 m. high) and Sykia reservoir (502 m<sup>3</sup> volume)</li> <li>• Sykia diversion channel to Thessaly (17,400 m. long)</li> <li>• Mouzaki major dam (135 m. high) and Mouzaki reservoir (530 m<sup>3</sup>)</li> <li>• Pyli dam (90 m. high) and Pyli reservoir (47 m<sup>3</sup> volume)</li> <li>• Pyli – Mouzaki tunnel (8 kilometres long)</li> </ul>
	Cost	Not known. Construction cost estimated at €720 million (USD 971 million). However total cost including necessary adaptations of irrigation networks, complementary infrastructures, maintenance and management have never been estimated. In 1996 total cost was estimated at €2.9-4.4 billion (USD 3.9-5.9 billion)
Why	Purpose	<ul style="list-style-type: none"> <li>• Provision of irrigation water for 240,000 ha of land in Thessaly</li> <li>• Hydropower</li> </ul>
Why not	Environmental cost	<ul style="list-style-type: none"> <li>• Serious impacts on rare riverine and forest habitats and landscapes of South Pindos</li> <li>• Destruction of Greece's most important habitat for the trout</li> <li>• Impacts on downstream freshwater habitats, including Ramsar and Natura 2000-listed areas, due to reduced flow</li> <li>• Extensive disruption of fragile mountain landscapes</li> </ul>
	Social cost	<ul style="list-style-type: none"> <li>• Loss of cultural heritage</li> <li>• Disruption of Southern Pindos communities</li> <li>• Use of large amounts of national funding to support unsustainable agricultural practices</li> </ul>
Alternatives		<ul style="list-style-type: none"> <li>• Address mismanagement of water in Thessaly region</li> <li>• Construction of smaller reservoirs in rivers of Thessaly</li> <li>• Reduce production of 'thirsty' crops (cotton in this case)</li> <li>• Improve irrigation efficiency</li> <li>• Take measures to counteract falls in groundwater tables and soil salinisation</li> </ul>

## Case study 5

# São Francisco Basin Interlinking Project, Brazil

### Why an IBT

The São Francisco Basin Interlinking Project is designed to supply water to 12 million people in the semi-arid region of Pernambuco Agreste and the metropolitan area of Fortaleza in north-east Brazil. It is to do so by collecting water from the São Francisco Basin between Sobradinho and Itaparica dams in the state of Pernambuco.

This project involves the construction of canals, water pumping stations, small reservoirs and hydroelectric plants and is part of the Program for Sustainable Development of the Semi-arid and São Francisco River Basin. Costs are expected to be at least USD 2.38 billion and jobs generated, up to 1 million.

Designed in 2000, the Federal Government modified and released the proposal in 2004 and states that the project will benefit 12 million people, irrigate 300,000 hectares, contribute to one million jobs and provide a solution to drought. The São Francisco River Basin Committee, represented by eight states, agrees that supply is important but publicly expressed concern about the approach proposed.

Although the São Francisco River Basin Committee did not approve the project, the National Water Resources Council did in February 2006.

The National Water Agency issued a 20-year authorization for water use to the National Integration Ministry, on September 22nd in 2005, and also issued the Certificate of Sustainability Evaluation for Water Engineering for the project.

Although the project is still being analysed by Environment Ministry technicians, the civil works for the first phase of the project are already out to tender.

Because of the existing controversies the project was not initiated as Brazil went



Source: National Integration Ministry, Brazil

through recent elections. Now the elections are completed, it is expected the project will be re-started with greater pressure by the Federal Government and by groups interested in its implementation.

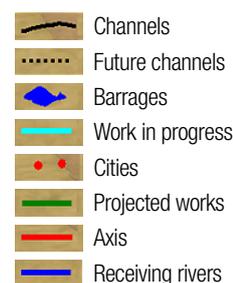
### Expected environmental and social impacts

According to the National Integration Ministry, environmental impacts will be minimal as the amount of water diverted is relatively small.

Despite this view, the project has caused controversy, as opponents (including state government institutions of the proposed donor basins, technical councils, and churches) claimed the main use for the water would be for irrigation, and not just for human supply. Other criticisms cover technical and operational feasibility, national priorities, economics, justice and social value, environmental aspects and legal support, as follows:

- A continuing focus on large, expensive water engineering projects which overlook impacts on freshwater ecosystems and the use of alternative, environmentally friendly and lower cost interventions;

▲ Map 2: Project for Interlinking São Francisco Basin to the North-eastern Basins



- Only 4% of the diverted water will benefit the dispersed population, 26% will be for urban and industrial use and 80% for irrigation;
- Temporary loss of jobs and incomes due to land appropriations;
- A continuation of what is in effect subsidized agriculture without full consideration of the social, economic and environmental costs
- Lack of investments, training and modernization of water management entities;
- Risks of conflict during the construction works.

Specific environmental costs will derive from biodiversity loss, fragmentation of native vegetation, risk of introduced non-native species potentially harmful to people, disrupted fishing due to more dams, siltation, and water loss due to evaporation as the water cycle is disrupted.

The Union's Counting Court (TCU, in Portuguese) concluded that the benefits of the IBT are overestimated and the costs are underestimated. The TCU pointed out that the project's effectiveness depends on the capability of the Federal Government to manage and distribute water to the population on completion of the link. The TCU's audit also recommended that the Federal Government proceed to a full evaluation of the project and requested a plan to show the interlinking processes that will integrate all the actions.

The proposed project presents a very complex situation, with many concerns that go beyond the physical construction issues. There are political rivalries between the State of Bahia (against the construction) and the State of Ceará (in favour); the perception being that the IBT would give the latter more influence.

WWF Brazil has stated that all possible alternatives to the IBT should be taken into account before a decision is taken to construct such enormous hydrological infrastructure.

## Analysis

The possible alternatives were not adequately indicated by the EIR such as, for example:

- 1 Demand management, including more efficient use of water with resultant reduction of losses ;
- 2 Revision of water licences in line with water actually used and needed;
- 3 Federal Government priority in implementing the São Francisco Basin and Brazilian Semi-Arid Integrated Sustainable Development Program, including:
  - Rehabilitation of vulnerable and environmentally degraded basins with a view to improving sanitation services and water supply, recovery of riparian forest, soil conservation and solid waste management;
  - National Action of Desertification Combat and Droughts Effects Mitigation Programme (PAN-Brazil) including plan to reduce the risk of expansion of semi-arid areas;
  - Strengthening capacity building with local institutions; Federal partnerships with states and municipalities, as well as building partnerships with civil society – NGOs and the regional productive sectors;
  - Expand regional partnerships
  - Implementation of Integrated River Basin Management;
  - Provision of water security for the dispersed population;
  - Development of regional economies to allow better quality of life for the river dwelling people;
  - Conclusion of unfinished water development projects.

## Summary

<b>Where</b>		<b>Brazil: Rio Sao Francisco Project</b>
<b>When</b>		<ul style="list-style-type: none"> <li>• This project started during colonial period</li> <li>• It was taken up again by President Lula de Silva in 2000</li> </ul>
<b>What</b>	Receiving basin	States of Ceara, Rio Grande do Norte, Pernambuco and Paraíba
	Donating basin	States of Minas Gerais, Goiás, Distrito Federal, Bahia, Sergipe, Alagoas
	Distance	The river is 2,700km long. The two canals total 720km
	Structures	Public supply and multiple uses, mainly for irrigation. Northern axis: 4 pumping stations, 22 canals, 6 tunnels, 26 small reservoirs, 2 hydroelectric plants of 40 megawatt and 12 megawatt capacity; Eastern axis: 5 pumping stations; 2 tunnels and 9 reservoirs
	Cost	US\$ 2.38 billion
<b>Why</b>	Purpose	<ul style="list-style-type: none"> <li>• Irrigation of about 330,000 hectares</li> <li>• Bring 2,092 km of dry riverbeds back to life</li> <li>• Discharge of 26-127m<sup>3</sup>/sec. Average is 53m<sup>3</sup>/sec.</li> </ul>
<b>Why not</b>	Environmental cost	<ul style="list-style-type: none"> <li>• Reduction in biodiversity of native aquatic communities in receiving basins</li> <li>• Loss and fragmentation of areas with native vegetation</li> <li>• Uncertainty about the adequacy of stream regimen determined</li> </ul>
	Social cost	<ul style="list-style-type: none"> <li>• Reduction of the hydroelectric capacity in the donating basin</li> <li>• Only large landowners and big businesses will benefit from the 3.9% increase in water availability in the receiving states</li> </ul>
<b>Alternatives</b>		<ul style="list-style-type: none"> <li>• Demand management</li> <li>• Revision of water licences</li> <li>• Implementation of the São Francisco Basin and Brazilian Semi-Arid Integrated Sustainable Development Program</li> <li>• Rehabilitation and revitalization of the São Francisco River Basin</li> <li>• Increasing water availability by interlinking existing reservoirs and optimizing their operations</li> <li>• Promote examples as in "Pro-Agua Semi-Arido" helping to reduce water deficit by building canals in NE Brazil</li> <li>• Strengthen negotiations with river basin committees (RBC) – as in case of RBC for the Piracicaba, Capivari and Jundiá Rivers, establishing new rules that reduce volume of water to be transferred in the dry season</li> </ul>

## Case study 6

# Olmos Transfer Project, Peru

## Why an IBT

The prospect of deriving water from the Huancabamba River in the Amazon basin to irrigate the pampas of Olmos was first proposed in 1924. The pampas of Olmos lie on the coastal strip of Northern Peru and are extensive, flat, sparsely populated areas with very little rainfall. The vegetation varies from desert to dry forests.

After numerous delays, a private-public partnership was signed between the regional government of Lambayeque and ProlInversion (Peruvian Agency for Promotion and Investment), and in late 2005 drilling commenced on the 19.3 km long tunnel through the Andes mountains to irrigate 150,000 ha of land.

It is expected to take two further years to complete the tunnel and four more years to finish the first phase, including a dam and conversion of an oil pipeline to carry water.

The second phase involves a hydropower installation and the third the irrigation system.

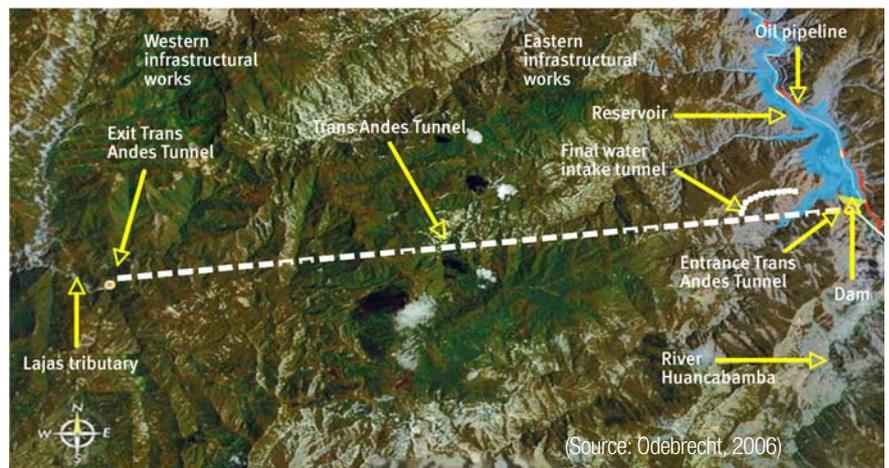
## Expected environmental and social impacts

The estimated cost of this IBT is US\$ 185 million, however no estimates of the potential benefits are known.

The environmental and social damage however is likely to be substantial. The present Environmental Impact Assessment only addresses the first phase and as such does not address impacts in the Olmos region.

During the dry months (July-September) there is usually very little supply flow available. At this time no IBT water should be taken, and only the reservoir provide water for electricity and irrigation.

A resolution was passed in May 2006 to maintain discharge at 1.7 km<sup>3</sup>/yr. It is debatable whether this is a sufficient environmental flow.



According to Zegarra *et al* (2006), no measures have been taken so far to avoid the inevitable logging of the valuable dry forest. No less than 66,000 ha of these forests are going to be converted into irrigated fields.

A critical aspect of the Olmos Transfer Project is the status of the lands that will be converted to irrigation. To make the project attractive for private investors the government claimed a certain area of land. This was done in the 1990s. The state reserved 110,000 ha; 80,000 ha of the Santo Domingo de Olmos community and 30,000 ha of the Mórrope community. The expropriation of these areas from the community of Santo Domingo de Olmos was done without consultation, and has been disputed by the community (Zegarra *et al*, 2006).

### ▲ Olmos Project Plan, first phase

### ▼ Start Trans Andes Tunnel



Of interest will be who are the buyers of the new lands suitable for irrigation when the project is ready to proceed? People from outside the region, who have sufficient resources to buy the land and the water? What will they produce? High quality products for export to the capital Lima or abroad? If so, this will mean no extra access to goods for this poor region itself. It will also likely to create social conflicts between locals and the new inhabitants.

This issue also relates to the future of the carob tree forest in this territory. This forest type is valuable for the local people and their way of living. They use it as food for their livestock, for apiculture, to produce carob and ultimately they use the wood to make charcoal (Zegarra *et al*, 2006).

An additional social impact of this proposal will be the forced re-location of the village of Pedregal, with its 200 inhabitants, in the IBT donor basin of Huancabamba. While compensation has been given for this relocation, no information is available on how this new situation has affected the ways of life of these people.

## Analysis

The key question is “is this project needed at all?” However, this now seems pointless as the first nine metres of the dam have been built, and a giant drill was scheduled to arrive in December 2006 to complete the tunnel.

While this first phase of the project is underway, the second and third phases have not yet been put out to tender, meaning that there may still be time to recommend adjustments and avoid environmental and social impacts. The development of an independent, integrated and comprehensive Environmental Impact Assessment (EIA) study should be a priority.

To solve the social conflict relating to communal lands and the absence of land titles, a Social Impact Assessment should also be done.



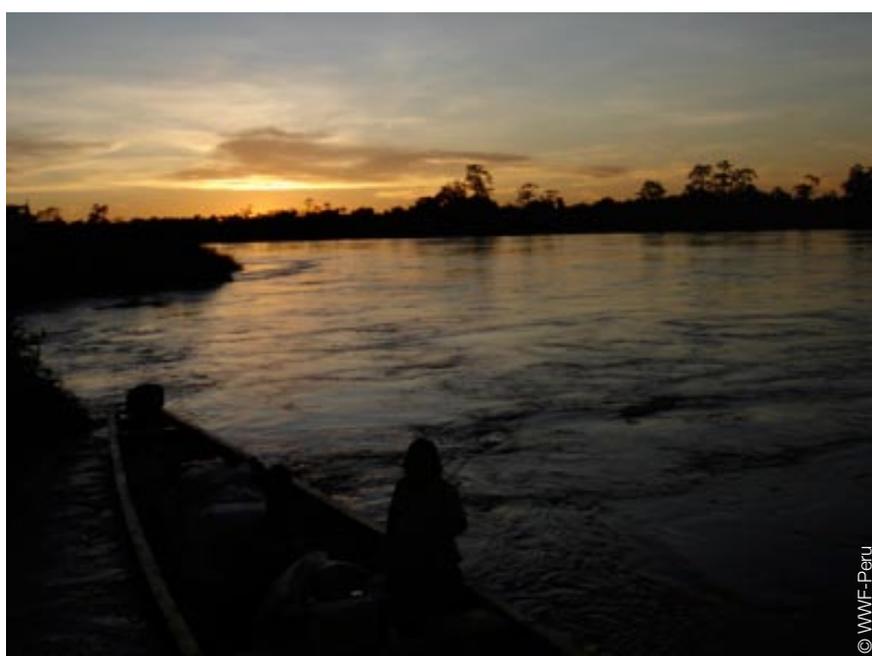
If there is to be conversion of some lands to irrigated fields, as per the proposal, then this should avoid areas with valuable dry forest. In this way the local community members will retain their forests and so at least a part of their communal grounds will be safe (Zegarra *et al*, 2006).

Given the climate and landscape, a preferable alternative to total reliance on irrigated cropping may be to blend this with cattle breeding. By promoting irrigated agriculture through the IBT it is potentially making the agricultural sector very vulnerable. Irrigation is also likely to see trees removed, high rates of evaporative water loss, and possibly salinisation problems.

### ▲ Rice paddies near the river Huancabamba

## Summary

<b>Where</b>		<b>Peru: Olmos Transfer Project</b>
<b>When</b>		July 2004 contract was signed
<b>What</b>	Receiving basin	Olmos
	Donating basin	Huancabamba
	Distance	19.3 km long tunnel
	Structures	2 tunnels , 1 dam of 43 m (phase 1), 2 hydropower plants and 1 dam (phase 2), irrigation system (phase 3)
	Cost	US\$ 185 million (phase 1)
<b>Why</b>	Purpose	<ul style="list-style-type: none"> <li>• Irrigation</li> <li>• Energy supply</li> </ul>
<b>Why not</b>	Environmental cost	<ul style="list-style-type: none"> <li>• Logging of dry forest in favour of new irrigation grounds</li> <li>• Deterioration of ecosystems in the donating basin</li> </ul>
	Social cost	<ul style="list-style-type: none"> <li>• Loss of communal grounds and no ratification of communal land rights of the farmers</li> <li>• Relocation of 200 people in donating basin</li> </ul>
<b>Alternatives</b>		<ul style="list-style-type: none"> <li>• Introducing water saving methods</li> <li>• Change from luxury, export products to “non-thirsty” crops</li> <li>• Save the carob dry forest by avoiding conversion of these lands to irrigation</li> <li>• Blending irrigated cropping with stock breeding</li> </ul>



## Case study 7

# South-North Water Transfer, People's Republic of China

### Why an IBT

The ongoing water shortage in north China – especially in the agricultural and industrial areas of the densely populated north China plain – is by any measure, very severe. Always fairly arid, the region's water resources have been heavily drained by intensive agriculture, rapid population growth, and an expanding industrial sector.

As incomes rise, China's per person water demand for residential use is also increasing.

About 40 % of China's cultivated area and 31 % of its gross industrial output depends on only 10 % of China's water resources. The result is falling water tables, pollution and dry rivers.

In every year of the 1990s, the Yellow River, China's second largest river, experienced periods when there was no run-off to the sea. The worst case happened in 1997, when there was no runoff to the sea for 226 days.

While China's government cannot be criticised for providing its citizens with water in deficit areas, critics believe alternatives to the South-North Transfer Project, with better socio-economic outcomes and lower environmental impacts, were not adequately considered before the project was approved (Sharma, 2005).

The studies on the South-to-North Water Transfers started in the 1950s and resulted in three water transfer projects; the Western Route Project (WRP), the Middle Route Project (MRP) and the Eastern Route Project (ERP) being proposed.

The project will take water from the Yangtze basin and transfer it more than 1,000 kilometres to the Yellow, Huaihe and Haihe river basins in the north (Government China, [www.nsb.gov.cn](http://www.nsb.gov.cn)).

China's State Environmental Protection Administration (SEPA) has completed EIAs of the Eastern and Central Routes of the SNWT Project, and has approved the projects for construction. The Western Route is currently being assessed.

### Expected environmental and social impacts

#### Eastern Route Project

The main challenge associated with the Eastern Route Project is environmental clean up, rather than impact. Agricultural run-off, sewage, factory waste, river transport pollution, and intensive aquaculture already heavily pollute the existing waterways along the route. Pulp and paper factories are the biggest point source polluters, but agricultural run-off is also quite severe.

The Eastern Route Project will mainly refurbish, expand and upgrade the already existing infrastructure, including the old Grand Canal (US Embassy, 2003). For these reasons the Eastern Route Project may have some substantial environmental benefits.

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#### Central Route Project

The main social problem with the Central Route Project will be the displacement of approximately 250,000 people.

The reduction in water flow along the middle and lower reaches of the Han River, between the Route intake and Wuhan (where the Han River flows into the Yangtze) will have a major impact on the ecosystems of the area.

According to experts the short-term strategy for dealing with the drain on the Han River is to seasonally adjust the volume of water diverted. The long-term solution being discussed is to extend the diversion to the Three Gorges Reservoir farther south (US Embassy, 2003).

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## Western Route Project

For the Western Route Project, work is scheduled to begin in 2010 to 2015. Here, the upper stretches of the Yangtze and the Yellow River will be linked through more than 300 km of tunnels built in remote and mountainous terrain with an altitude of 4,000 metres.

Three dams are needed in the Yalong River (175m), Tongtian River (302m) and the Dadu River (296m). There will be geological difficulties with regional earthquake levels of about 6-7 even 8-9 locally.

Because the elevation of the bed of the Yellow River is higher than that of the corresponding section of the Yangtze (by 80-450 meters), pumping stations will be necessary to move the water into the Yellow River. This infrastructural work is estimated to cost US\$ 37.5 billion for a supply of about 15 km<sup>3</sup>/yr. The total water needed for the whole of north China is 52 km<sup>3</sup>/yr.

While the Eastern and Central Routes are aimed directly at supporting China's burgeoning and prospering eastern cities, the Western Route would direct very expensive resources to further subsidizing with cheap water the grain farmers of China's middle and north west. Farmers in that region already draw large volumes of low-cost water from the Yellow River in Gansu, Ningxia, Inner Mongolia, Shanxi and Shaanxi, in producing low-value crops.

Pressure to promote economic development in China's poorer western provinces appears to be compelling central planners to promise the construction of the Western Route Project (US Embassy, 2003).

## Analysis

China needs a change of water management philosophy and this is already happening through improved water laws and policies adopted in recent years.

The SNWT scheme is expensive and with fewer benefits compared to the alternatives. At an estimated cost of over US\$62.5 billion it is not only costly to taxpayers, but also to the environment, especially for the Western Route.

There are alternatives at hand for saving water without damaging the environment, such as:

- Enhancing distribution efficiency by reducing transmission losses;
- Improving water use efficiency, particularly in agriculture, and reducing demand with higher water prices;
- Increasing water reuse, including better pollution prevention and control and large-scale investment in water treatment facilities; and
- Recharging groundwater reserves and help in conserving water that can be later used in drought conditions.

## Summaries

Where		<b>China: Eastern route</b>
<b>When</b>		Started in December, 2002
<b>What</b>	Receiving basin	Yellow River Basin, Hai River Basin
	Donating basin	Lower reaches of Yangtze
	Distance	1156 km, discharge of 14.8 km <sup>3</sup> /yr
	Structures	Canal, tunnel, pumping stations
	Cost	US\$ 8.2 billion
<b>Why</b>	Purpose	<ul style="list-style-type: none"> <li>• Irrigation</li> <li>• Municipal water supply</li> </ul>
<b>Why not</b>	Environmental cost	<ul style="list-style-type: none"> <li>• Sediment loss will affect riparian and coastal wetland maintenance</li> <li>• Less dilution of pollutants</li> <li>• Invasive biota and chemicals in the passing lakes (Hongze, Luoma, Nansi, Dongping)</li> <li>• Change of river patterns and in natural flow cycles of the rivers, disturbing the wildlife and ecosystems</li> </ul>
	Social cost	<ul style="list-style-type: none"> <li>• About 10.000 people displaced</li> </ul>
<b>Alternatives</b>		<ul style="list-style-type: none"> <li>• Better distribution efficiency</li> <li>• Water use efficiency and higher water pricing</li> <li>• Increasing water reuse (meaning better pollution prevention and control and large-scale investment in water treatment facilities)</li> <li>• Recharging groundwater reserves and help in conserving water that can be later used in drought conditions</li> </ul>

Where		<b>China: Middle route</b>
<b>When</b>		<ul style="list-style-type: none"> <li>• Started in 2003 and in 2007 they expect to have one part completed (according to China Daily 12/10/2005)</li> <li>• Completion is due by 2012 (according to US Embassy, 2003)</li> </ul>
<b>What</b>	Receiving basin	Yellow River Basin, Hai River Basin
	Donating basin	Middle reaches of Yangtze (from Danjiangkou Reservoir on the Han River, the longest tributary of the Yangtze)
	Distance	1273 km
	Structures	Canal, aqueduct, tunnel
	Cost	US\$14.7 billion
<b>Why</b>	Purpose	<ul style="list-style-type: none"> <li>• Municipal and industrial water supply</li> <li>• irrigation</li> </ul>
<b>Why not</b>	Environmental cost	Reducing water flow of donating basins
	Social cost	Relocation of 320.000 inhabitants due to increase in size of Danjiangkou Reservoir and along the route itself
<b>Alternatives</b>		<ul style="list-style-type: none"> <li>• Better distribution efficiency</li> <li>• Water use efficiency and higher water pricing</li> <li>• Increasing water reuse (meaning better pollution prevention and control and large-scale investment in water treatment facilities)</li> <li>• Recharging groundwater reserves and help in conserving water that can be later used in drought conditions</li> </ul>

<b>Where</b>		<b>China: Western route</b>
<b>When</b>		Still doing preliminary studies because of complex area
<b>What</b>	Receiving basin	Yellow River Basin
	Donating basin	Tongtianhe - the Upper reaches of Yangtze; Yalongjiang and Daduhe rivers -the tributaries of the Yangtze
	Distance	317 km of tunnels, 20 km <sup>3</sup> /yr may be the discharge
	Structures	Dams, tunnels, pumping stations
	Cost	37 billion US\$ (only preliminary costs)
<b>Why</b>	Purpose	<ul style="list-style-type: none"> <li>• Municipal and industrial water supply</li> <li>• irrigation</li> </ul>
<b>Why not</b>	Environmental cost	<ul style="list-style-type: none"> <li>• Vulnerable and fragile area</li> <li>• Part of Tibetan mountainous ecoregion</li> <li>• Water availability is not inexhaustible, especially in light of climate change with glaciers receding</li> <li>• Real danger of earthquakes and landslides during construction</li> </ul>
	Social cost	Relocation of people, including minorities
<b>Alternatives</b>		<ul style="list-style-type: none"> <li>• Better distribution efficiency</li> <li>• Water use efficiency and higher water pricing</li> <li>• Increasing water reuse (meaning better pollution prevention and control and large-scale investment in water treatment facilities)</li> <li>• Recharging groundwater reserves and help in conserving water that can be later used in drought conditions</li> </ul>

## Conclusions - summary of lessons learned

As was the case with the long established IBTs, there are many common themes running through the four case studies of prospective transfer schemes reviewed here and summarised in table 2.

It seems that despite the well-documented problems associated with the earliest IBTs, the lessons have not yet been learned and that decision makers continue to repeat the same errors when contemplating and then moving forward to initiate new schemes.

Table 2: **Process weaknesses or expected negative impacts of IBT**

	Case study			
	4 Acheloos Diversion, Greece	5 São Francisco Basin Interlinking Project, Brazil	6 Olmos Transfer Project, Peru	7 South-North Transfer, PR of China
Demand management in recipient basin not serious part of pre-planning for IBT, potentially supporting on-going water wastage	✓	✓	✓	✓
IBT expected to become driver for unsustainable water use in recipient basin– irrigation and urban	✓	✓	✓	✓
Will create strong dependence on IBT in recipient community	✓	✓	✓	✓
Donor basin likely to experience serious environmental impacts through reduced flows especially	✓		✓	✓
IBT expected to create or escalate threats to critically endangered, threatened species, Ramsar sites, Natura 2000 sites etc	✓		✓	
Scheme likely to see economic benefits in the recipient basin at the cost of communities in the donor basin	✓	✓	✓	✓
Inadequate consultations with those likely to be affected either directly or indirectly	✓	✓	✓	✓
IBT may become catalyst for social conflict between donor and recipient basins or with government	✓	✓	✓	✓
IBT is not expected to help the situation of the poor affected or displaced by it		✓	✓	✓
Post IBT mitigation costs expected to be very high, either environmentally or socially	✓	✓	✓	✓
Governance arrangements for IBT appear weak		✓	✓	

## 5 Alternatives to interbasin water transfers

The preceding sections have focussed on established or proposed interbasin water transfers and strongly illustrate the case that in most instances these water infrastructure proposals come with a range of generally unacceptable or unnecessary social, economic and environmental costs.

To reiterate, established IBTs are typically characterised by the following negative attributes:

- Demand management in the recipient basin was not a serious part of pre-planning for IBT, leading to on-going water wastage there;
- The IBT became a driver for unsustainable irrigation or urban water use in the recipient basin;
- The scheme created strong dependence on the IBT in the recipient community, thus promoting unsustainable activities, and removing the need to improve water use efficiencies or find alternative water sources/supplies;
- The IBT is now seen as inadequate and other water supplementation approaches have been required such as groundwater extraction, desalination, recycling etc;
- The donor basin experiences serious environmental impacts through reduced flows especially;
- The IBT created or escalated threats to critically endangered species, Ramsar-listed wetlands and protected areas;
- The transfer scheme saw economic benefits in recipient basin at the cost of communities in the donor basin;
- The IBT served as a catalyst for social conflict between the donor and recipient basins or with government;
- The IBT has not helped the situation of the poor affected or displaced by it;
- Post IBT mitigation costs have proven very high, either environmentally or socially; and,
- Governance arrangements for some IBT's are weak, resulting in budget blow-outs or corruption (in some cases).

In section 3 it was noted that the lessons we can learn from existing IBTs are as follows:

- 1 Before progressing to commission an IBT, there should be a comprehensive assessment of the alternatives available for providing the water needed in the proposed recipient basin. Can this water be provided through demand management, water recycling, water harvesting etc, before considering a major infrastructure investment with its possible environmental and social impacts?
- 2 Undertake a cost-benefit analysis of the likely impacts of the IBT on both the donor and recipient basins, considering the full range of environmental, social and economic implications.
- 3 Ensure risks associated with the proposed IBT; environmental, social and economic are clearly understood, and if the project proceeds, governance arrangements are adequate to manage and minimise these risks.
- 4 Undertake consultations with the likely directly and indirectly affected people, before a decision is taken regarding the possible IBT (and certainly before it becomes fait accompli) ensuring they understand and have the opportunity to voice views on likely cost, benefits and risks.

## Addressing the key weaknesses in IBT planning

What stands out among the IBT case studies documented in this report, and elsewhere, are the following:

- 1 Apart from hydropower generation, a common driver of IBTs is a desire to promote agricultural production in water poor areas, and, in particular irrigated agriculture. This can see unsustainable cropping practices promoted by the IBT when perhaps this was unwise;
- 2 There is typically a failure to examine alternatives to the IBT that may mean delaying, deferring or avoiding the costs (in every sense) of an IBT; and
- 3 There are a range of governance failures ranging from poor to non-existent consultation with affected people, to failing to give sufficient consideration or weight to the environmental, social and cultural impacts of the IBT, in both the donor and recipient basins.

In the following section each of these is examined more closely.

### 5.1 IBTs promoting agricultural production in water poor areas

Globally agriculture consumes around 70% of the water diverted for human use, and up to 80% of this water does not reach the plants it was intended to sustain. A massive growth in demand for agricultural expansion, driven by growing wealth in many countries, poverty reduction programs and increasingly the growth of crops for biofuels, threatens to consume even more water. The International Water Management & Stockholm International Water Institutes forecast that eradicating malnutrition by 2025, with current productivity, requires additional diversions “close to all the water withdrawals at present” (IWMI & SIWI, 2004). As key rivers, ranging from the Rio Grande/Bravo, to the Nile and the Indus, increasingly fail to reach the sea, this poor water management is a source of tension between countries.

With many IBTs being driven by agricultural water demands, it is important to assess the economic viability of agricultural practices in the proposed recipient basin. As several of the case studies documented here reveal, the creation of an IBT can (or will) stimulate expansion of agricultural activities, especially irrigation, in areas that may not be suited to this climatically or otherwise. It can also foster the establishment of such agricultural activities with a reliance on under-priced (meaning subsidised) IBT-sourced water; such a reliance not being sustainable in the long-term.

As seen in the situation of the Upper Acheloos Diversion project in Greece (see case study 4 in section 4), the IBT is justified (in large part) on the premise that it will sustain the agricultural industry, and in particular the cotton production in the Thessaly plains. It is however highly questionable whether cotton production here would be economically viable without the large subsidies it receives.

Within the EU, only Spain and Greece have sizeable cotton production and in 2001 together they accounted for 2.5% of cotton production and 6% of world exports in cotton. At the same time they received 16% of world cotton subsidies. In 2002/03 it is estimated that under the EU's common agricultural policy (CAP), subsidies exceeded US\$900 million (Gillson *et al*, 2004).

Another way to consider the merit of IBTs for promoting agriculture is through the concept of 'virtual water'. As developed by Professor Tony Allan, this term is used to describe the amount of water used in the production process of goods and services (Hoekstra, 2003). For example, the production of 1kg of beef requires 16,000 litres of water. As goods and services are traded across the globe, or between regions within countries, virtual water is also transferred. According to Hoekstra, this virtual water trade can be an important instrument in achieving water security and efficient use of water, and some authors argue that virtual water trade between or within nations can be a feasible alternative to the actual transport of water through interbasin transfer schemes.

A review of food flows, and subsequently virtual water trade, in China (Ma *et al.*,

2006) found that there is a food surplus in north China, and a food deficit in South China, which is balanced on a national scale through import of agricultural products from the north to the south. In 1999, south China imported (amongst other commodities) 17 million tons of grain, 23 million tons of vegetables and 2.4 million tons of dairy products from north China. Together with imports of eggs, meat and fruit this represented a virtual water import of nearly 52 km<sup>3</sup>/yr. In comparison, the maximum amount of water transferred under the three routes of the South-North transfer (see case study 7 in section 4) is in the order of 38-43 km<sup>3</sup>/yr. These figures raise the question whether the physical transfer of water from south to north over such long distances, and at such expense makes economic sense, when even larger amounts of virtual water are transported back from north to south. Other examples of 'virtual water' as a consideration in IBT development are given in Box 2.

There are no easy answers to these questions, but it does indicate the need for more research into whether some of the water shortages in north China can be addressed by increasing agricultural production on existing crop lands in the water-rich south, rather than through IBT.

#### Box 2: **Examples of where 'virtual water' is a factor in IBT-related decision making**

##### **Southern Africa:**

The trade in virtual water can potentially offer an alternative to expensive water transfer schemes in Southern Africa. Earle and Turton (2003) pose that there are a number of states in the Southern Africa Development Community, such as Angola, DR of Congo, Zambia and Mozambique, that are well suited for grain production and have the potential to become surplus producers. These surpluses could then be exported to the richer, water stressed nations within the region, such as South Africa, thus reducing the need for physical transfers of water there. To achieve this would require substantial investments in agriculture and grain transfer systems, but this could well be both more economically, as well as environmentally sustainable, particularly if productivity of existing crop lands can be enhanced.

Continued overleaf

### Morocco and Europe:

WWF undertook an assessment on virtual water transfers from water scarce Morocco in July 2006.

Morocco's horticulture sector has established links to European markets because of its favourable location, growing climate and francophone history. Tomato farms in Souss Massa boast a modernised industry with a high degree of technical expertise and tools. Technology transfer occurs in this sector with workers and business people travelling between Spain and Morocco, returning and applying the latest advances in crop production techniques. If EU quotas are eventually lifted, then Morocco will take advantage of much lower labour costs to concentrate on more high-value products.

Economic development in Morocco has been stimulated in part by the rise of export intensive irrigated agriculture and is seen as a vital employment sector for the country's future. Currently agriculture represents 80% of rural employment and more than 40% of national employment. Intensive export-led agriculture has increased pressures on the environment and the natural resource base, but most profoundly on freshwater. If current water use patterns were to remain constant, water availability per capita would be halved by 2020. Trade restrictions, tax exemptions, price support and water subsidies are designed to protect the cereal-dominated agricultural sector, which uses huge amounts of scarce water resources inefficiently.

Virtual water experts point out that this problem could be averted by relying on cereal crops from international markets, produced in areas with favourable growing conditions for wheat. However, a national desire for food self sufficiency often over-rides any rational discussion as to the optimal allocation of water.

Irrigated agriculture currently uses 83% of all diverted water in Morocco, where recent droughts have aggravated water shortages. This highlights the need for new approaches in national and local water management. This would require a more balanced distribution of water use, including adequate pricing measures, to ensure long term sustainability (Orr, 2006).

## 5.2 IBTs that fail to examine alternatives

Examining the alternatives to IBTs should be considered before embarking on engineering-based solutions to regional water shortages. Such alternatives may reveal that the development of an IBT can be delayed, deferred for several years, or perhaps avoided altogether. Global experiences show that all too often the decision is taken to proceed with an IBT before these alternatives are fully considered. While these alternatives may take longer to analyse, and even implement, if they avoid the environmental, social and economic costs of the typical IBT then they are clearly worth the investment.

In moving to examine the alternatives to an IBT, WWF recommends the following systematic and step-wise approach. As considered further in section 5.3, ideally these options are considered at a whole-of-river-basin level, through an integrated planning process. The alternatives should be considered in the following order:

- 1 Reducing water demands;
- 2 Recycling waste water; and only then,
- 3 Supplementing water supplies locally, and only then,
- 4 Considering an IBT, as a last option.

Below, each of these options are examined more closely and in many cases illustrated with real life examples or tools that can be used to see them applied.

### 5.2.1 Reducing water demands

Demand management simply means manipulating or adjusting water demands so they don't exceed supplies. Demand management is fundamentally about finding water use efficiencies wherever they are available across the many ways that society uses water. Demand management is, to use financial terms, 'living within ones means', or 'not overspending the budget'. Such water efficiencies exist in almost every facet of water use and the task is to identify them, raise awareness of them, and find ways, means and incentives to see these water savings achieved.

#### Domestic and urban water users

Globally, households use only about 10% of water diverted (Turton & Henwood, 2002), and some of the water saving practices available in the home are:

- Reducing water application on the garden (for example, through planting species that require less water, mulching around plants, using 'grey water', installing more efficient watering systems etc);
- Closing taps while brushing teeth;
- Installing low-flush-toilets;
- Repairing leaking taps;
- Washing the car, motorbike or bike with a bucket instead of a garden hose;
- Washing dishes in a tub instead of under running water; and
- Installing low-flow shower heads.

An example of where these types of measures have been promoted successfully is in south-east Queensland on the eastern seaboard of Australia – see Box 3.

#### Box 3: Household water efficiency measures promoted in a region of Australia

South East Queensland (Australia): Water demand management is in part about increasing public awareness of water issues and encouraging more efficient use of water, without diminishing quality of life. Society needs to treat water as a valuable resource.

There needs to be a focus on educating the community so that they are able to gain an understanding of the economic and ecological benefits of reducing water consumption.

An example of such management is in south-east Queensland where there has been a reduction of water demand by up to 18% in some local government areas (AWA, 2005).

Examples of some of the initiatives used include:

- User-pays pricing and universal water metering;
- Encouragement of the installation of water efficient devices using rebates/ discounts, for example, dual flush toilets and low flow shower heads;
- Routine restrictions on garden watering;
- Incentives for plumbing efficiency 'check-ups';
- Educational campaigns; and
- Lowering water pressure in districts where this is feasible.

#### Education programs - a key tool in demand management

To create a better understanding of water issues and help resolve water resource problems, educational programs are highly recommended. Community, industry and school education programs raise awareness about the need to conserve water and to bring about long term changes in water consumption behaviour. This is only possible if the targeted community is able to obtain the necessary

knowledge and gain understanding of water management that can then be adapted to their own needs and local circumstances (AWA, 2005).

Most successful are education programs that are 'selling' practical solutions. Water education programs for primary and secondary schools are encouraged so as to promote awareness in the next generation of decision makers.

Important aspects of such programs are that they provide the person with some real life examples to point him/her in the right direction including simple water saving ideas which do not change their way of living and that are geographically relevant at local, regional and national levels.

In general, water costs are not well reflected in the price of products due to the subsidies in the water sector, particularly for agricultural users. The general public is, although often aware of energy requirements, much less aware of the water requirements in producing their goods and services (Chapagain & Hoekstra, 2004). This presents an opportunity to change water use-related purchasing behaviour through education.

### **Agricultural water users**

Currently, 16% of global cropland is irrigated, producing 40% of all food. This makes irrigated agriculture about 3.6 times more productive per unit-area than non-irrigated agriculture (Orr, 2006).

The International Water Management Institute has estimated that the world's irrigated area would need to increase by 29 per cent from 1995 onwards to meet food and other nutritional requirements by 2025 (Molden *et al* 2001). Such an increase would need to be supported by a number of measures. These include the construction of additional storage and diversion facilities to develop an additional 17 per cent of the world's primary water supplies, while yields from irrigated crops would have to increase from 3.3 to 4.7 tonnes per hectare.

A more appealing first option, however, must be to implement measures for conserving and making more efficient use of the water already allocated to agriculture. This is especially so given that current overall water-use efficiency is low: only some 20-50 per cent of diverted waters actually reach the crops for which they are intended.

The many opportunities that exist for improving water efficiency, in both irrigated and rain-fed agriculture, mean that more food could be grown without increasing existing levels of water use.

There are two basic means by which water-use efficiency can be improved:

- 1 increasing the share of the water actually taken up by plants, and
- 2 producing more crop per unit of water (WWF, 2003a).

Water-saving practices in agriculture (WWF, 2003a):

- Broad bed cultivation is a useful method, particularly in irrigated wheat;
- Alternate furrow cultivation of beans and maize is an alternative to save water (up to 50% in Pakistan);
- Cultivation of aerobic rice varieties;
- Drip and sprinkler irrigation for sugarcane, cotton and wheat;
- Use of the no-tillage approach;
- Growing different crops that require less water; and
- Change to organically grown crops.

To further improve water use efficiency within the production of crops the accurate measurement of water use on a crop and farm scale is the first step.

### **5.2.2 Recycling waste waters**

To some water management practitioners, recycling waste or used water falls within the realm of demand management. Here it is considered separately to draw attention to the potential that it offers as part of the alternatives to the construction of an IBT scheme.

The reuse of waters has been an accepted global practice for centuries. Settlements downstream drew their potable water from rivers and groundwater that had circulated upstream through multiple cycles of withdrawal, treatment and discharge.

Treatment and then reuse of water from irrigation and stormwater drainage, sewage and other effluents, industry and utilities can greatly supplement local water supplies. The annual reclaimed water volumes total about 2.2 billion m<sup>3</sup>, based on 2000 and 2001 figures from the World Bank. (UNESCO/WWAP, 2006)

On a global scale, non-potable water reuse is currently the dominant means of supplementing supplies for irrigation, industrial cooling, river flows and other applications. Due to increases in potable water consumption, the total volume of these recycled resources is likely to increase by 3-5% per year based on current water use patterns (UNDP, 2004).

Yet in some cultures, reuse of water has not yet been publicly accepted. According to surveys, the best water reuse projects in terms of economic viability and public acceptance are those that substitute reclaimed water in lieu of potable water for use in irrigation, environmental restoration, cleaning, toilet flushing and industrial uses.

The volume of water available for reuse is considerable, with the advantage being that there is a guaranteed supply, which is not dependant on weather patterns.

Some forms (and mechanisms) of water reuse include (AWA, 2005 and Shelef, 2001):

- Indirect reuse via river or water storage;
- Aquifer storage and recovery of reused water or stormwater. Recharge of groundwater to create a barrier to seawater intrusion;
- Industrial reuse;
- Dual reticulation supply of reused water;
- Grey water reuse (for example, toilet flushing in hotels, office buildings and high-rise buildings, using dual water distribution systems);

- Augmentation of recreational bodies of water;
- Irrigation of public parks, sport fields, etc.;
- Street washing;
- Car and train washing;
- Water for fire hydrants; and
- Concrete mixing.

### 5.2.3 Supplementing water supplies locally and a look at the Godavari-Krishna link

#### Rainwater harvesting

Rainwater management, also known as harvesting, is receiving renewed attention as an alternative to, or a means of, augmenting water supplies.

Intercepting and collecting rainwater where it falls is a practice that extends back to pre-biblical times. It was used 4,000 years ago in Palestine and Greece and in South Asia over the last 8,000 years. In ancient Rome, paved courtyards captured rain that supplemented the city's supply from aqueducts and as early as 3000 BC, in Baluchistan, farming communities impounded rainwater for irrigation.

Recently in India, harvesting has been used extensively to directly recharge groundwater at rates exceeding natural recharge conditions. Reports from other international organizations focusing on this area indicate that eleven recent projects across Delhi resulted in groundwater level increases of from 5 to 10 metres in just two years. In fact, the application of rainwater management in India is likely to be one of the most modern in the world.

The site [www.rainwaterharvesting.org](http://www.rainwaterharvesting.org) provides links to cases where rainwater management has been successfully applied in different nations in both urban and rural settings.

An advantage of rainwater harvesting is that its costs are relatively modest and that individual or community programs can locally develop and manage the required infrastructures (collection devices, basins,

storage tanks, surface or below-ground recharge structures or wells).

Larger scale rainwater harvesting schemes, which intercept runoff using low-height berms or spreading dikes to increase infiltration, have also been introduced in upstream catchments where deforestation has decreased water availability (UNESCO/WWAP, 2006). A word of caution is warranted here however, as in some parts of Australia (for example) the large scale interception of overland run-off flows to support irrigated 'thirsty crop' agriculture in arid and semi-arid areas has denied this water from other downstream users, notably graziers. Large, shallow impoundments are used to store this water, from which evaporation rates are very high. Downstream rivers are suffering, including significant wetlands areas. Rainwater harvesting such as this is highly inefficient and not in the best interests of the majority of those downstream within the basin.

### **Restoring traditional water management structures**

The restoration of traditional water harvesting technologies is proving to be a beneficial means of improving modern water supplies in some countries. An example, are the traditional water storage systems, known as tanks, found in the mid-Godavari basin of India. These tanks have a history of 1500 years with some of the systems built in 1100 AD perfectly functioning even today in the Warangal district.

These systems were designed and built to meet several social, economic and ecological functions. Primarily they store monsoon rain to meet the agricultural, fisheries, religious, grazing, groundwater recharge, washing and drinking water needs of the people as well for livestock water supplies. Every village in the southern parts of India and Sri Lanka has more than one traditional tank.

Using GIS techniques within the Maneru sub-basin of India (an area of 13,033 sq.km), WWF recently identified 6,234 traditional water tanks, with an area of 58,870 ha. This represents about 5% of the geographic area. Of these, 57 tanks are more than 100 ha in area. If restored to 5 metres average depth, these 6,234 tanks could hold about 3 billion m<sup>3</sup> of water, by just capturing 15-20% of the rainfall.

The restoration of these tanks has three major benefits:

- 1 the silt and clay removed from the tanks can be spread on fields to improve the fertility and water holding capacity of farm soils, reducing the need for artificial fertilisers, improving crop productivity immediately, and recovering the costs;
- 2 most of the restoration work can be done by the community, thus generating local employment; and
- 3 restoration will recharge the extensive areas of depleted groundwater aquifers, restoring use of many existing wells that have dried up.

In this way the water needs of the local communities can be met without resorting to expensive water infrastructure. Presently, the irrigated area in the Maneru sub-basin is around 400,000 ha. Through renovating the traditional tanks this irrigated area can be provided with more assured water and also support an increase in area for irrigated crops of another 200,000 ha. An estimate of the finances required to renovate all the tanks is in the order of US \$4 billion over five years. This represents about 50% of the costs associated with construction of large dams to serve the same purpose. For example, the large dam proposed on the Godavari River at Polavaram – part of the Indian Government's proposed interlinking of rivers scheme - is expected to irrigate only 290,000 ha and has a cost of US \$3.5 billion. The dam will also remove more than 300,000 people from their traditional homes and submerge more than 60,000 ha of productive land and forest.

## The Godavari-Krishna link

in the world's largest water transfer scheme, India's Interlinking of rivers

**The Godavari-Krishna link is one of 33 links proposed by the government of India in the world's largest water transfer scheme, the Interlinking of Rivers project. The Godavari is the second largest river basin in India with about 320,000 km<sup>2</sup> of catchment area. The Godavari river basin has been termed the surplus basin for transferring water to the Krishna river basin.**

In order to divert the water, a dam is proposed near Polavaram on the Godavari river. This dam is embroiled in one of the country's bitter controversies. About 300,000 mostly tribal people would be displaced due to land submergence; the dam would also submerge large tracks of pristine forest including part of a wildlife sanctuary that is tiger habitat, along with cultural symbols important to the region (Gujja, 2006). About 5325 million cubic meters of water would be diverted to the Krishna river through a 186 km canal running from the Ramsar wetland of international importance, the Kolleru Lake. Farmers whose land is already irrigated will use all this additional, diverted water to cultivate even more rice, a highly water-consumptive crop. Such excessive irrigation will lead to salination, water logging and will ultimately reduce productivity.

### Implications of Interlinking of Rivers

There are national guidelines and norms established for implementing irrigation schemes. These guidelines are related to forest submergence, wildlife protection, environmental protection, rehabilitation and resettlement policies, and protection of tribal people from displacement from their traditional lands. Most of these guidelines look relatively good on paper but a poor track record of implementing them in earlier large water infrastructure projects has raised several concerns. Millions of people have lost their land and livelihood due to earlier water infrastructure projects and are still waiting for proper compensation and land rehabilitation. The Interlinking of Rivers project is likely to add further misery to the poorest of the poor and therefore needs to take into consideration the various impacts on people and ecosystems. Fortunately, for at least four years this Interlinking of Rivers project has been the subject of intense national debate.

### Civil society committee

The scale of the proposed Interlinking of Rivers project has the potential to alter everything: geography, economy, forests, wildlife, social fabric, and customs in India. WWF organized a national dialogue in February 2003 by inviting experts, top government policy



makers, NGOs and other stakeholders in Delhi. This initial meeting concluded that there is a need for establishing a national civil society committee to review the Interlinking of Rivers project. The committee consisted of fourteen eminent persons serving in an individual capacity with their respective areas of expertise. Some of the members are known to be publicly opposing or supporting the Interlinking of the Rivers project and this encourages dialogue and debate. The committee has raised the following questions:

- Is it the most cost effective option?
- Will India's food security critically depend on it?
- Will it make any difference to floods and droughts?
- Will it increase or decrease the water conflicts between various state governments?
- Have the calculations to arrive at the deficit and surplus of water in each river taken all aspects into consideration including climate change?
- Are there any better alternatives to meet the same objectives?

The civil society committee is an experiment in Indian policy debate and helps to engage diverse viewpoints. Rivers are not just pipelines to divert surplus water to deficit areas and it is not possible to manage floods

Continued overleaf

### ▲ Desilted water tank, India

and droughts by simply connecting the rivers; in fact it might aggravate the situation in certain areas and bring new problems. India has a long tradition of respecting its rivers and there are also many examples of such large inter basin transfers in the world that have not worked elsewhere. The Committee Chairman has also stated that the government has an obligation to prove to the nation that the Interlinking of Rivers is not going to damage ecosystems and will not cause further misery to people before any work on the ground begins. (Alagh et al., 2006)

### Alternatives

#### Restoring traditional water management structures

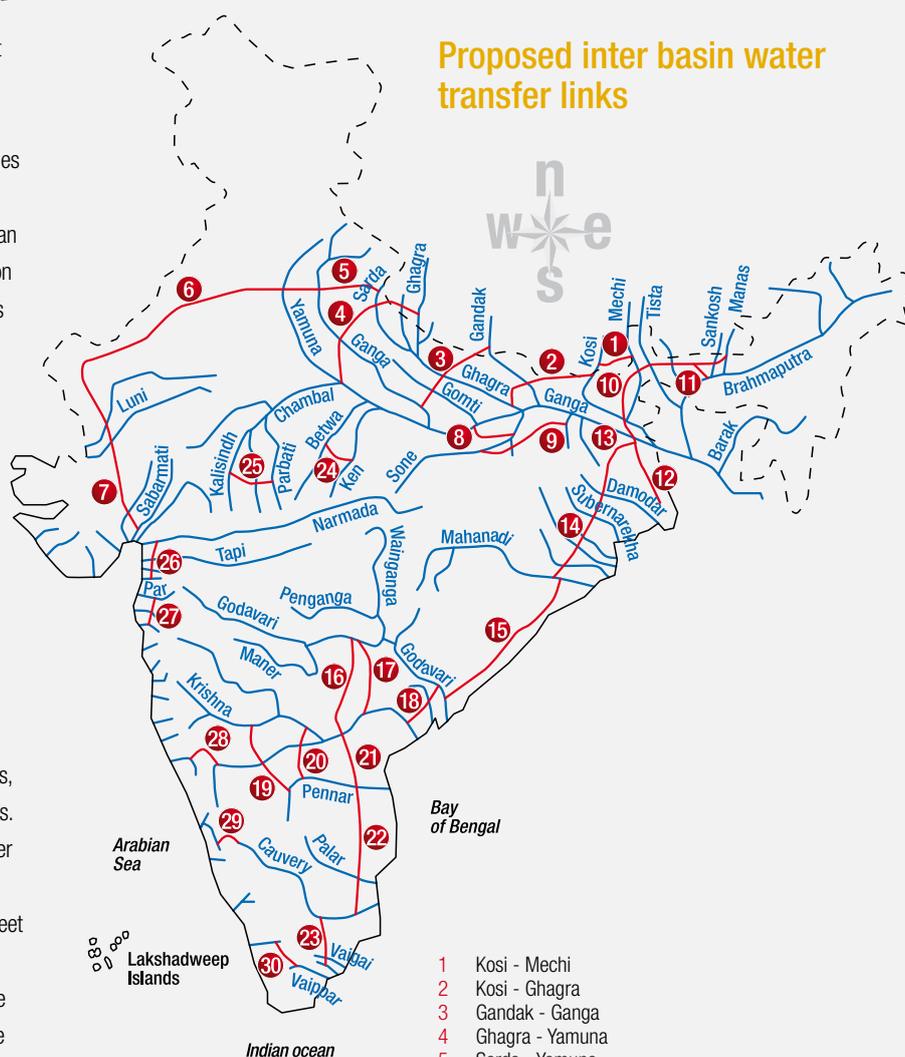
In the mid-Godavari basin there are many traditional water storage systems known as tanks going back some 1500 years. Some of the systems built in 1100 AD are perfectly functioning even today in the Warangal district. These systems are used to store water for various functions: agriculture, rural fisheries, cattle needs, recharge of groundwater, cultural needs. These systems are small but cumulatively meet water needs of large rural populations. Investing in these systems to store around 16% of the rainfall could meet water needs for the people of this semi-arid region for the production of food and drinking water and the tanks help in recharging groundwater. Further, as the tanks are widely distributed in the landscape, they can be managed by village-based committees, and employ unskilled labour for maintenance, thus enhancing the livelihoods of many more poor people compared to the large scale 'lift irrigation' scheme proposed in this Deccan Plateau region.

#### Reducing water input to grow rice and other thirsty crops.

Rice cultivation increases water demand in India. More than 70% of the water allocated to agriculture is for this single crop. WWF is working with local institutions and farmers to test the method known as the System of Rice Intensification (SRI). This farm-based method could produce 20% more rice with 30% less water.

These are just two examples which can avoid expensive schemes without compromising economic and ecological goals.

### Proposed inter basin water transfer links



- 1 Kosi - Mechi
- 2 Kosi - Ghagra
- 3 Gandak - Ganga
- 4 Ghagra - Yamuna
- 5 Sarda - Yamuna
- 6 Yamuna - Rajasthan
- 7 Rajasthan - Sabarmati
- 8 Chunar - Sone Barrage
- 9 Sone Dam - Southern Tributaries of Ganga
- 10 Manas - Sankosh - Tista - Ganga
- 11 Jogighopa - Tista - Farakka (alternative)
- 12 Farakka - Sunderbans
- 13 Ganga (Farakka) - Damodar - Subernarekha
- 14 Subernarekha - Mahanadi
- 15 Mahanadi (Manibhadra) - Godavari (Dowlaiswaram)
- 16 Godavari (Inchampalli) - Krishna (Nagarjunasagar)
- 17 Godavari (Inchampalli) - Krishna (Pulichintala)
- 18 Godavari (Polavaram) - Krishna (Vijayawada)
- 19 Krishna (Almatti) - Pennar
- 20 Krishna (Srisaillam) - Pennar
- 21 Krishna (Nagarjunasagar) - Pennar (Somasila)
- 22 Pennar (Somasila) - Palar - Cauvery (Grand Anicut)
- 23 Cauvery (Kattalai) - Vaigai - Gundar
- 24 Ken - Betwa
- 25 Parbati - Kalisindh - Chambal
- 26 Par - Tapi - Narmada
- 27 Damanganga - Pinjal
- 28 Bedti - Varda
- 29 Netravati - Hemavati
- 30 Pamba - Achankovil - Vaippar

### **Nepal case on IBT alternatives (BothENDS, 2006)**

In Nepal, local Civil Society Organizations (CSOs) are developing alternatives for the high cost Melamchi Water Supply Project financed by the Asian Development Bank and Japan.

This project involves diverting the Melamchi River through a 26 km long tunnel to the Kathmandu Valley in order to supply drinking water at market prices to the urban population, leaving farmers and rural ecosystems in great distress.

The CSOs are developing cheaper pro-poor alternatives to the IBT based on age old traditional water systems. These are readily available systems and involve the use of groundwater, surface water and rainwater harvesting, and the rehabilitation of hundreds of culturally and religiously valued traditional ponds.

Through professional cost-benefit analysis they hope to prove the feasibility of this project and find financial support.

### **Desalination**

Use of desalination is increasing, especially in water-scarce coastal areas, including the USA, Mediterranean basin and the Middle East, India, China, Australia and small island states. There is even a desalination proposal for London.

Criticised as 'bottled energy', desalination could provide a reliable source of potable water without being reliant on rainfall. However, desalination is an 'energy hungry' process and critics point to this as a negative of this option when it relies on energy derived from fossil fuels.

Environmental problems associated with desalination include disposal of the waste brine solution and biocides used to wash the plant membranes.

In spite of major advances in energy efficiency, these major problems remain an obstacle to the wider use of desalination technologies (AWA, 2005).

WWF notes that desalination could be one alternative to water scarcity problems, but more work is necessary to adequately manage the environmental impacts of the energy consumption, brine and biocide effluents.

### **5.2.4 Consider IBTs as a last option**

Any proposal for an IBT should be placed under the decision making microscope before a decision is taken to proceed. Too often the very viable alternatives to an IBT are not given sufficient attention in such decisions. The evidence is clear that these schemes can offer solutions to water shortage problems that are less costly, less damaging to the environment and less disruptive and divisive in society. Frequent environmental omissions in the pre-planning and execution of IBTs are the provision of adequate environmental flows within the donor basin, and the management of invasive species transferred with the water between basins. Decision makers owe it to their constituents to undertake comprehensive cost-benefit and risk assessments as part of reaching a decision in relation to any proposed IBT, as proposed by the World Commission in Dams (2000).

### 5.3 Governance failures in river basin level planning

It was noted in the introduction to this section that one of the attributes evident in the IBT case studies documented in this report (and elsewhere also) is the failure of governance arrangements to ensure that comprehensive cost-benefit and risk assessments form part of IBT-related decision making.

Weak governance is also indicated by the commonly witnessed poor to non-existent consultation with affected people resulting in insufficient consideration or weight being afforded to the environmental, social and cultural impacts of the IBT, in both the donor and recipient basins.

Yet another signal of poor governance is the lack of consideration at an appropriate management scale, meaning failure to look at the impacts of the proposed IBT within a river basin management framework. Without this, the risks of 'collateral damage' from the IBT are very much higher. Through employing the management model of Integrated River Basin Management (IRBM) governments and civil society will be much better placed to make well informed decisions in relation to IBTs.

A report prepared in October 2004 for the IRBM Task Force of the China Council on International Cooperation for Environment and Development, proposed a way forward for China to move in establishing an IRBM framework for the management of its extensive river systems. Some extracts from that report (below) help explain the concept of IRBM and the rationale behind it (report at [www.harbour.sfu.ca/dlam/04riverbasin%20rpt.htm](http://www.harbour.sfu.ca/dlam/04riverbasin%20rpt.htm)).

"A key factor that undermines efforts to deliver sustainability outcomes is sector-based governance; the organization of public administration that segregates, rather than integrates, economic, social and environmental policy, laws and administration. With pressure on water

resources intensifying in all parts of the world, integrated river basin management (IRBM) is rapidly being introduced in many countries as a management framework that can help draw together economic, social and environmental aspirations.

IRBM is a process of coordinating the management and development of the water, land, biological and related resources within a river basin, so as to maximize the economic and social benefits in an equitable way while at the same time conserving freshwater ecosystems and species.

IRBM is also a participatory mechanism for solving conflicts and allocating water among competing users, while recognizing that natural ecosystems are in part the suppliers of that resource and the fundamental 'natural infrastructure' that delivers it to human users. Natural ecosystems are also key providers of a range of ecosystems services (flood mitigation, water quality improvement and fish production for example) which previously were overlooked in water resource management.

"Many of the problems with river and water resource management being encountered by China ...today are also found in other countries. In many of these, IRBM is being applied as the administrative framework to see enhanced integration of economic development, community well-being and environmental sustainability into decision-making. Table 3 below summarises both the key problems that other countries have encountered with managing rivers and water resources and how IRBM offers solutions to these problems."

Table 3: **Summary of international experiences in relation to river basin management and how IRBM offers solutions to these problems**

The problems	The solutions IRBM offers
<b>Institutions and legislation</b>	
<p><b>Sector-based approaches</b></p> <p>Historically governments and societies have failed to appreciate the intrinsic linkages between economic growth, societal well-being and environmental sustainability, and have established decision-making, legal and administrative systems that serve to isolate, rather than integrate these pillars of sustainable development.</p>	<p>IRBM fosters a change in the way governments do business; moving away from sector-based institutions, policies and laws, to more integrated approaches.</p>
<p><b>Institutional weaknesses and lack of integration and coordination</b></p> <p>Sector-based management and decision-making is a product of sector-based institutions, policies and laws. Without addressing these fundamentals, the implementation of IRBM cannot succeed. Poor coordination among ministries is a strong signal of this form of institutional failure. Allied to this are laws and policies that promote sector-based management.</p>	<p>IRBM is as much about social and economic policy reform as it is about moving to manage the environment for long-term sustainability. For this reason the implementation of IRBM must be mandated by the highest level of government and be supported by appropriate legal and administrative coordination tools.</p>
<p><b>Inappropriate management scale</b></p> <p>River basins provide a convenient and appropriate management scale; yet historically management has been allowed to operate at small scale without due consideration for downstream and broader impacts.</p>	<p>The paradigm shift to IRBM needs to draw into river basin level planning and management all government Ministries and stakeholders, at all levels; national, provincial and local. Decentralisation of management responsibility to river basin commissions, provincial and local governments is the key to successful IRBM.</p>
<b>Stakeholder and public participation</b>	
<p><b>Unsustainable land and water uses fostered by ignorance</b></p> <p>Unless the principles of IRBM and sustainability are understood by both the government sector and civil society, and then applied at the local, provincial and river basin levels, the capacity of ecosystems to support livelihoods will continue to decline.</p>	<p>Stakeholder and public participation can enhance the quality of IRBM decisions and help implementation by reducing costs and delays. In order to empower local stakeholders it is necessary to invest in education and public awareness programs and activities that target all sectors of society.</p>
<p><b>Lack of transparency and consultation in decision making</b></p> <p>The failure of governments to inform and consult local people about development and river/water resource management proposals that may impact on them is strongly counter-productive to the ethos of IRBM, breeding conflict and resentment among stakeholders.</p>	<p>Opportunities to participate in decision-making and providing access to management-related data are key aspects of gaining the support, involvement and commitment of stakeholders for implementing IRBM.</p>
<b>Economic measures and financial incentives</b>	
<p><b>Failure to consider all costs (economic, environmental and social) of development activities</b></p> <p>Where economic cost and benefits are the primary consideration of impact assessment processes, then unsustainable land and water use practices are promoted when external costs – both environmental and social – are excluded from resource allocation decisions.</p>	<p>The global trend in impact assessment is to consider the full range of environmental, social and economic cost and benefits, and this is now supported by robust methods for valuing the services provided by ecosystems within these assessment processes.</p>
<p><b>Failure to provide economic incentives and remove disincentives to sustainability</b></p> <p>Not valuing the full range of services provided by ecosystems has contributed strongly to their widespread degradation. Unsustainable land and water management practices have unwittingly been encouraged and even subsidized by governments, both through their ignorance of the broader social and environmental costs, and through the promotion of an economic development agenda as a priority.</p>	<p>There is now a vast array of economic measures and financial incentive options being applied in China and internationally that are proving highly successful in transforming land and water management into sustainable development enterprises. Two of several keys to their successful application in a Chinese context are to tailor the measures to fit local situations and to combine measures together in creative ways.</p>
<b>Applying IRBM-related technologies</b>	
<p><b>River management problems not being addressed through available technologies</b></p> <p>Typical river management problems are flooding, pollution, water scarcity and loss of biodiversity. Associated with these are escalating human health costs, damage to urban, rural and industrial infrastructure, food and water shortages, and lost opportunities for economic development and poverty reduction.</p>	<p>An IRBM approach helps to mobilize these technologies in a strategic and carefully planned way. This leads to a reduction in these impacts, while not compromising development and social betterment aspirations.</p>

Where it is being applied, IRBM differs markedly from basin to basin and is strongly dependent on the complexity of the basin's socio-economic and political environment. Most basins face similar hurdles, such as:

- Gaining political agreement between governments (on provincial, national and international level);
- Bringing together competing stakeholders to share their knowledge, learn, appreciate new perspectives and reach agreements on sustainable solutions;
- Overcoming the perspective that water and aquatic biodiversity are a common resource that can be used without limit;
- Gathering high quality, up-to-date data;
- Getting proper assessment of 'needs and options' for development proposals;
- Providing incentives for more efficient use of diverted waters;
- Planning for the exploitation of a Basin's resources without undermining their sustainability; and
- Ensuring safety for populations from recurring floods and their relationships with land use change in the basin (watershed and floodplain especially).

An IRBM plan can focus on various topics, but a basin organisation is necessary to coordinate, integrate, promote and/or even enforce decisions regarding the use and management of natural resources on a basin-wide scale. By undertaking Options and Needs assessments, possible alternatives to develop the basin in a more sustainable way will be identified. Tools for better water management that may be applied include payments for environmental services (see Box 4), mimicking natural water flows as far as possible - environmental flows (Tilders, 2002).

To better integrate water use and conservation in river basin management, appropriate water laws are needed. To maximise conservation and socio-economic outcomes, these laws should:

- Define the water basins or the transboundary water basins the law is designed for;

#### Box 4: **Payments for environmental services (PES) – an incentives tool that aligns with IRBM**

It is now widely recognised that natural ecosystems produce a wide range of environmental services. These include carbon sequestration of forests, regulation of water quantity and quality by watersheds, scenic beauty and biodiversity conservation. Proponents of payments for ecosystems services argue that the failure of society to compensate land managers for these services is a key contributory factor to the rapid and negative changes in land-use that is being witnessed globally.

PES mechanisms are market-based instruments that arose as a response to remedy market failures associated with environmental services. The basic principle of PES is that those who provide environmental services should be rewarded for doing so. This means mechanisms are put in place that transfer rewards from those who benefit from the environmental service to those who manage it. For example, land managers have the choice to sustainably manage the natural resources on their land that provide environmental services, or to allocate their land and natural resources to other alternative uses such as agriculture. In many cases, however, the services provided by natural resources are not restricted and the benefits they provide accrue beyond the people who manage them. For example, upstream watershed protection services typically benefit downstream stakeholders, including drinking water companies, bottling companies and hydroelectric companies. In most cases, however, these beneficiaries have not compensated upstream land managers for the provision of these services, and the result is that beneficiaries have been "free-riding" - deriving benefits at someone else's expense.

PES aims to change the incentives for land use in order to maintain or restore the desired environmental service. Payment mechanisms assume that decisions on land use and land use change are largely based on the net economic benefits that accrue to the land manager. Maintaining land in its natural state that provides environmental services is seldom a more attractive option than its conversion. The main reason for this is that benefits of environmental services often accrue to stakeholders other than the land manager, ranging from downstream stakeholders in the case of the regulation of quality and quantity of water of upstream forests and wetlands, to international stakeholders in the case of carbon sequestration of forests. To be effective, the payment to the land manager must effectively change the net benefits, making the maintenance of the natural resources and the environmental services derived thereof greater than alternative land uses (WWF, CARE and IIED, 2005).

- Ensure water dependent environmental values are identified and adequate water flows are allocated for their conservation;
- Define water rights and apportion the available water resource;
- Define and install a method to make users pay for their water use;
- Treat water rights separately from land titles; and

- Enable water rights to be traded, so more efficient water users can buy water and produce more, and employ more people, by purchasing water rights from less efficient users.

An example of where an IRBM framework has helped in relation to the operation of an existing IBT is with the recent renewal of the Water Use Licence to the São Paulo Basic Sanitation Company (Sabesp) responsible for the water supply to the Metropolitan Region of São Paulo, and for the management of the Cantareira System. For the first time, there has been a negotiation with the River Basin Committee for the Piracicaba, Capivari and Jundiaí Rivers in order to establish new rules for the water transfer. One of the positive results of this negotiation was the reduction of the volume of water to be transferred during the dry seasons to minimise environmental impacts. This dialogue strengthened the water resources management processes and implemented IRBM tools. This dialogue solved conflicts and reduced the risk of scarcity in one basin whilst attending to an important water use for human supply within another basin.

To be effective, IRBM also requires strong legal mechanisms to provide the management and enforcement framework, but also to clarify roles and responsibilities. As indicated above, ideally, IRBM within each basin is guided by an organisational body or commission, which also has its roles and responsibilities specified in law. A key role of such commission's is to plan for sustainability and to do this in consultation with stakeholders. In this way, knee-jerk, quick fix decisions, such as those relating to IBTs can be avoided and be replaced with more considered, consultative and balanced decision making.

## **Transboundary watersheds or basins**

IRBM, and its associated legal instruments, also has a key role with the management, regulation and conservation of transboundary watersheds or basins. Globally there are

263 transboundary rivers that drain 45% of the Earth's surface, are home to 40% of the world's people and contain 60% of global runoff. Unilateral action by one country in a basin, such as withdrawing too much water through an IBT, can seriously impact on other countries and the environment of the basin. Multi-national river basin management agreements and institutions are needed for sustainable management of these rivers. Two treaties provide a framework for such agreements and WWF advocates that all relevant countries support their implementation;

- 1 The 1997 UN Convention on the Law of Non-Navigational Uses of International Watercourses provides a global framework for the sustainable, cooperative and equitable management of shared rivers. WWF urges governments to ratify this Convention as 20 more ratification are required for the treaty to enter into force.
- 2 The 1992 Convention of the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) within the United Nations Economic Commission for Europe (UN/ECE) has more effective provisions and is intended to strengthen national measures for the protection and ecologically sound management of transboundary surface waters and groundwater. The Convention obliges parties to prevent, control and reduce water pollution from point and non-point sources. The Convention also includes provisions for monitoring and research and development (UN/ECE, 1992). WWF urges UN ECE countries to complete ratification of the 2003 amendment to the convention that would enable non-European countries to join this treaty.

In addition, WWF is urging national governments to complete negotiations in the United Nations General Assembly for adoption of the draft articles on the law of transboundary aquifers as a protocol to the 1997 UN Watercourses Convention in order to promote sustainable management of shared groundwater systems.

## 6 Conclusions and recommendations

**The history of interbasin water transfers (IBTs) to date should be sufficient to sound very loud alarm bells for any government contemplating such a development. However, despite the many lessons we should have learnt from past IBT experiences, many decision makers today continue to see IBTs as a technical solution to restore perceived imbalances in water distribution. To illustrate this point, an article in the Hydrological Sciences Journal of 2005 states that “interbasin transfer of water in India is a long-term option to correct the spatial and temporal mismatch of water availability and demand, largely owing to the monsoon climate” (Jain *et al.*, 2005).**

This is a simplistic point of view based on the false notion that moving water from places regarded as having ‘water surpluses’, to water scarce areas, can be undertaken without significant social and environmental impacts. This is the “pipe dream” that gives this publication its title.

The development of IBTs, rather than restoring a perceived water imbalance, usually disturbs the finely tuned water balance in both the donating and the receiving river basin. Regularly overlooked in IBT development are the short, medium and longer term impacts of moving water from one community (the donor basin) and providing it to another (the recipient basin).

There is no escaping the fact that for large parts of the human population, water scarcity is a serious problem and this is increasingly exacerbated by a changing climate. Water shortages can be a product of a range of factors apart from drought. These include overpopulation of naturally water-poor areas, over-exploitation of local water resources, inappropriate agricultural practices, water wastage etc. Thus, the question of how to meet the demand for water in water-stressed areas remains an urgent one to be answered.

WWF recognises that while local interbasin transfer schemes may, under certain circumstances, fulfil an important role, for example in supplying drinking water to population centres, the benefits of many large scale transfer schemes that are still on the drawing board are doubtful. In the past many IBTs have caused a disproportioned amount of damage to freshwater

ecosystems in relation to the schemes’ benefits. Social and economic impacts, especially for the donor basin, are in general unacceptable also.

The size of many schemes has meant that a large-scale IBT is rarely the most cost effective way of meeting water demands. Of concern too is that in many cases the introduction of an IBT does not encourage users to use the water more effectively, continuing wasteful practices.

WWF believes that any new interbasin water transfer scheme should be approached in accordance with the principles set out by the World Commission on Dams. First and foremost this means that any scheme under consideration should be subject to a comprehensive needs and options assessment; detailed cost-benefit and risk analyses that consider the full suite of potential environmental, social and economic impacts.

As advocated in section 5 of this report, in moving to examine the alternatives to an IBT, WWF recommends the following step-wise approach, ideally considered at a whole-of-river-basin level, through an integrated planning process. The alternatives should be considered in the following order:

- 1 Reducing water demands;
- 2 Recycling waste water; and only then,
- 3 Supplementing water supplies locally, and only then,
- 4 Considering an IBT, as a last option.

WWF believes that in many cases the above steps will be sufficient to ensure water security within a river basin.

## 7 References and further reading

### Cited references:

Alagh *et al.*, 2006

Arrojo Agudo, P., 2001. *Análisis económico del Plan Hidrológico Nacional: de la inconsistencia a la prevaricación técnica. Informe sobre el Proyecto de Plan Hidrológico Nacional*. (Economic analysis of the National Hydrological Plan: about the inconsistency of the technical misconduct. Report about the Project of the National Hydrological Plan in Spain). pp. 19-20.

AWA (Australian Water Association), 2005. *Status of water in South East Queensland*, The Courier Mail.

BothENDS, 2006. *The return of the giants. The politics of large-scale infrastructure: ecological impacts and social exclusion. An analysis of the experiences of South-Asia and South-America*. Amsterdam, Netherlands, 20 pp.

Chapagain, A.K. and Hoekstra, A.Y. 2004. *Water footprints of nations Volume 1: Main Report*. UNESCO-IHE Delft, Netherlands. 80 pp. Available online: <http://www.waterfootprint.org/Reports/Report16Vol1.pdf>

Earle, A and A Turton, 2003. *The virtual water trade amongst countries of the SADC, in: Virtual water trade – proceedings of the international expert meeting on virtual water trade*. IHE Delft, Netherlands. Available online: <http://www.waterfootprint.org/Reports/Report12.pdf>

Gillson, I., Poulton, C., Balcombe, K. and Page, S., 2004. *Understanding the impact of cotton subsidies on developing countries*. Working paper Overseas Development Institute. Available online: [http://www.odi.org.uk/IEDG/Projects/cotton\\_report.pdf](http://www.odi.org.uk/IEDG/Projects/cotton_report.pdf)

Government China. Website of the South-to-North Water Diversion. <http://www.nsb.gov.cn>

Hoekstra, A.Y., 2003. *Virtual Water: An introduction, in: Virtual water trade – proceedings of the international expert meeting on virtual water trade*. IHE, Delft, Netherlands. Available online: <http://www.waterfootprint.org/Reports/Report12.pdf>

International Commission on Irrigation and Drainage (ICID), 2006. *Revised draft report of the ICID task force on Inter Basin Water Transfers*. India. 161 pp.

International Water Management Institute and Stockholm International Water Institute, (2004). *Water – More Nutrition Per Drop: towards sustainable food production and consumption patterns in a rapidly changing world*. Working document produced for CSD-12.

IRBM Task Force of the China Council on International Cooperation for Environment and Development (CCICED) & WWF., 2004. Unpublished report available at: [www.harbour.sfu.ca/dlam/04riverbasin%20rpt.htm](http://www.harbour.sfu.ca/dlam/04riverbasin%20rpt.htm)

IUCN – the World Conservation Union, 2006. *Red list*. Available on-line: <http://www.iucnredlist.org/>

Jain, S.K., Reddy, N.S.R.K. and Chaube, U.C., 2005. *Analysis of a large inter-basin water transfer system in India*. Hydrological Sciences Journal, pp 125-137. Available online (with subscription): <http://www.atypon-link.com/IAHS/doi/abs/10.1623/hysj.50.1.125.56336>

Lasserre, F., 2005. *Les transferts massifs d'eau*. University of Quebec, Canada. 36 pp. ISBN 2-7605-1379-3. Available online (in French): [http://www.puq.quebec.ca/produits/D1379/D1379\\_INT.pdf](http://www.puq.quebec.ca/produits/D1379/D1379_INT.pdf)

Liang, C. 2005. 'Contracts signed for water diversion project', China Daily, 12 Oct p.2.

Liang, C., 2006. 'Severe drought leaves 17 million parched', Xinhua News Agency, 29 Aug.

Ma, J.A., Hoekstra, H., Wang, A., Chapagain, A.K. and Wang, D., 2006. *Virtual versus real water transfers in China; in: Philosophical transactions of The Royal Society*. London B. 361 (1469): 835-842. Available online: [http://www.waterfootprint.org/Reports/Ma\\_et\\_al\\_2006.pdf](http://www.waterfootprint.org/Reports/Ma_et_al_2006.pdf)

MEA (Millennium Ecosystem Assessment), 2005. *Ecosystems and human well-being: Wetlands and water Synthesis*. World Resources Institute, Washington, DC. Available online: <http://www.millenniumassessment.org/proxy/Document.358.aspx>

Molden, D., Shaktidavel, R. and Habib, Z. 2001. *Basin – Level Use and Productivity of Water: examples from South Asia*, IWMI Research Report 49

Nilsson, C., Reidy, C.A., Dynesius, M. and Revenga, C. 2005. 'Fragmentation and flow regulation of the world's Large River Systems', Science, Vol. 308. pp. 405-408.

Odebrecht, 2006. *Interview with Mr. F. Takahashi Ventura (responsible for security, health and environment at the project site) and Mr. E. Arfelli (contract director)*.

Orr, S., 2006. *Virtual water trade*. Draft version. WWF–UK.

Sharma, D. 2005. *Linking Rivers in China: Lessons for India*. Observer Research Foundation. Available online: <http://www.observerindia.com/analysis/A032.htm>

Shelef, G. 2001. *Wastewater treatment, reclamation and reuse in Israel*. Available online: <http://www.biu.ac.il/soc/besa/waterarticle3.html>

Snowy Hydro, 2006. Available online: [www.snowyhydro.com.au](http://www.snowyhydro.com.au)

Swartz, E., Skelton, P. and Rall, J., 2001. 'Conserving the Maloti minnow in Lesotho - a reality check' at: [http://www.waternet.co.za/rivercons/skuk\\_present.html](http://www.waternet.co.za/rivercons/skuk_present.html)

Tilders, I. 2002. *WWF College: Integrated River Basin Management Module*. WWF and Cap-Net. 64 pp.

Transformation Resource Centre, Lesotho, 2005. Available online: <http://www.trc.org.ls/water.htm>

Turton, A. and Henwood, R. (eds), 2002. *Hydropolitics in the developing world: a Southern African perspective*. African Water Issues Research Unit, Centre for International Political Studies (CIPS), University of Pretoria, S. Africa, 269 pp.

UN/WWAP (United Nations/World Water Assessment Programme), 2003. *1st UN World Water Development Report: Water for People, Water for Life*. UNESCO (United Nations Educational, Scientific and Cultural Organization) and Berghahn Books. Paris, New York and Oxford. <http://www.unesco.org/water/wwap/1/pdf/chap1.pdf>

UNDP, 2004. *Water Resources of Kazakhstan in the new millennium*. 124 pp. Available online: <http://europeandcis.undp.org/WaterWiki/images/a/ad/KazakhstanWater.pdf>

UN/ECE, 1992. *Convention on the Protection and Use of Transboundary Watercourses and International Lakes*. Available online: <http://www.unecce.org/env/water/welcome.html>

UNESCO/WWAP, 2006. *The United Nations World Water Development Report 2: Water – a shared responsibility*. UNESCO/Berghahn Books.

US Embassy, 2003. *Update on China's South-North Water Transfer Project*. 5 pp. Available online: <http://www.usembassy-china.org.cn/sandt/SNWT-East-Route.htm>

World Commission on Dams, 2000. *Dams and development, A new framework for decision making*. WCD

WWF, 2003a. *Agricultural water use and river basin conservation (summary)*. 40 pp. Available online: <http://assets.panda.org/downloads/agwaterusefinalreport.pdf>

WWF, 2004a. *Living Planet Report*. 44 pp. Available online: [http://assets.panda.org/downloads/living\\_planet\\_report.pdf](http://assets.panda.org/downloads/living_planet_report.pdf)

WWF, 2006b. *Free-flowing rivers: Economic luxury or ecological necessity?* Available online: <http://assets.panda.org/downloads/freeflowingriversreport.pdf>

WWF, CARE and IIED, 2005. *Equitable Payments for Watershed Services: Phase 1, Making the Business Case*. A Joint WWF, CARE and IIED Programme. 52 pp.

Zegarra, E., M. T. Oré and M. Glave, 2006 (in press). *Recursos, gobernanza e impactos del Proyecto Olmos en un territorio árido de la costa peruana*. Investigadores de Grade, Peru. Parte del Programa Colaborativo de Investigación Movimientos Sociales, Gobernanza Ambiental y Desarrollo Territorial Rural.

## Other background sources and further reading:

- Alagh, A.K., Pangare, G. and Gujja, B., 2006. *Interlinking of rivers in India: Overview and Ken-Betwa Link*. Academic Foundation, New Delhi, ISBN 8171885209,
- BothENDS, 2003. *Both ENDS Information Pack nr. 4: Dams and the Environment*, Amsterdam. Netherlands. 23 pp. Available online: <http://www.bothends.org/service/ip-dam.htm>
- Brochure Proyecto Olmos, 2004. *Gobierno Regional Lambayeque, ProInversión, Odebrecht, Concesionaria Tránsito Olmos*.
- Gujja, B., 2006. 'Dam may drown a Temple town', Deccan Chronicle, October 4th, 2006.
- International Rivers Network. Available online: <http://www.irn.org/programs/lesotho/>
- International Water Law Project (IWLP). Available online: <http://www.internationalwaterlaw.org/>
- Israeli Foreign Ministry, 2002. *Israel's Chronic Water Problem*. Available online: <http://www.israel-mfa.gov.il/MFA/Facts%20About%20Israel/Land/Israel-s%20Chronic%20Water%20Problem>
- Lesotho Highlands Development Authority. Available online: <http://www.lhwp.org.ls>
- Ma, Jun, 2004. China's Water Crisis. Yang Liu, N. and Sullivan, L.R. (translators). *An International Rivers Network Book. Voices of Asia*. EastBridge. 242 pp. ISBN 1-891936-27-1 (pb).
- Miller, K.A., 2000. 'Managing Supply Variability: The Use of Water Banks in the Western United States', in D.A. Wilhite (ed.), *Drought: A Global Assessment, Volume II*, Routledge, London, pp.70-86.
- Murray-Darling Basin Commission. Available online: <http://www.mdbc.gov.au>
- National Integration Ministry (Ministério da Integração Nacional). Available online: <http://www.mi.gov.br/saofrancisco>
- National Water Agency (Agência Nacional de Águas). Available online: <http://www.ana.gov.br>
- National Water Development Agency, Government of India. *Million revolts*. Established and supported by WWF as part of 'Dialogue on water, food and environment'. Economic and Political Weeks (pub). Available online: <http://nwda.gov.in/index2.asp?sublinkid=46&langid=1>
- New York Times, 2006. 'India Struggles to tap the monsoon'. October 2nd, 2006.
- Novaes, W., 2004. *Lá vem a transposição – atropelando, O Estado de São Paulo*, Brazil.
- Plano Diretor para o Desenvolvimento do Vale do São Francisco – PLANVASF, CODEVASF/SUDENE/OEA, (1989).
- Programa Integrado de Desenvolvimento Sustentável da bacia Hidrográfica do Rio São Francisco e do Semi-Árido Brasileiro – Sumário Executivo, Ministério do Meio Ambiente, (2004).
- Projeto de Integração do Rio São Francisco com Bacias Hidrográficas do Nordeste Setentrional, Relatório de Impacto Ambiental – RIMA (2004).
- Queensland Government, 2006. *Press releases of Premier Beattie about the South East Queensland Regional Water Supply Strategy, Australia*. Available online: <http://www.nrw.qld.gov.au/>
- Resolução no 411, de 22 de Setembro de 2005, Agência Nacional de Águas, 2005.
- Resolução no 412, de 22 de Setembro de 2005, Agência Nacional de Águas, 2005.
- San Francisco Hydro-electrical Company (CHESF – Companhia Hidroelétrica do São Francisco). Available online: <http://www.chesf.gov.br>
- Schiffler, M., 2004. 'Perspectives and challenges for desalination in the 21st century'. *Desalination*, Vol. 165, pp. 1–9.
- Schouten, M., 2003. *Development in the drought -The incompatibility of the Ebro water transfer with sustainable development in the Southeast region of Spain*, WWF, 31 pp.
- Schouten, M. and Soria, M.A.H, 2003. *El trasvase Tajo-Segura. Lecciones del pasado*, WWF, 24 pp.
- Snaddon, K. and B. Davies, 2000. 'An analysis of the Effects of Inter-Basin Water Transfers in Relation to the New Water Law'. Submission to the WCD. University of Cape Town, S. Africa, 49 pp.
- Soffer, A., 2001. 'Mapping special interest groups in Israel's water policy'. Available online: <http://www.biu.ac.il/SOC/besa/waterarticle7.html>
- Suassuna, J. *Recursos Hídricos no Nordeste: o problema não é a falta*. É distribuição.
- The Commonwealth of Australia, The State of New South Wales & The State of Victoria, 2002. 'Snowy Water Inquiry Outcomes Implementation Deed'.
- The National Integration Ministry (Ministério da Integração Nacional), <http://www.mi.gov.br/saofrancisco>
- The National Water Agency (Agência Nacional de Águas), <http://www.ana.gov.br>
- Vidal, J., 2006. 'Running on empty', in *Guardian Weekly: Every last drop. Focus on the world's looming water shortage* September 29 – October 5 2006.
- Watts, Jonathan (2006). 'Cracks appear in China's boom', in *Guardian Weekly: Every last drop. Focus on the world's looming water shortage*, September 29 – October 5 2006.
- Wikipedia at: [http://en.wikipedia.org/wiki/Lesotho\\_Highlands\\_Water\\_Project](http://en.wikipedia.org/wiki/Lesotho_Highlands_Water_Project)
- Workshop sobre a transposição de águas do rio São Francisco, Sociedade Brasileira para o Progresso da Ciência, Centro de Estudos e Projetos do Nordeste, (2004).
- World Bank, Government of Kazakhstan, Committee for Water Resources of the Ministry of Natural Resources and Environmental Protection, 2002. 'Identification of priority issues in seven major river basins in Kazakhstan. Problem identification and prioritisation workshop in Karaganda for the Nura-Sarysu river basin'. 11 pp.
- WWF, 2006c. *Illegal water use in Spain. Causes, effects and solutions*. WWF, 20 pp.
- WWF, 2006d. *Milestones in water conservation. Global Freshwater Programme*. WWF, 14 pp. Available online: [http://assets.panda.org/downloads/milestones\\_in\\_fw\\_wwf\\_july\\_06.pdf](http://assets.panda.org/downloads/milestones_in_fw_wwf_july_06.pdf)
- WWF, 2006e. *Perspectives on dam Polavaram. (Case study India)*, WWF.
- WWF Pakistan et al., 2006. *Better Management Practices for Cotton and Sugarcane. Crop management review manual*. Draft version.

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- conserving the world's biological diversity
- ensuring that the use of renewable resources is sustainable
- reducing pollution and wasteful consumption

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