International Experiences of Water Tranfers: Relevance to India

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Introduction

Water transfer has and continues to be a complementary water management strategy for promoting socioeconomic development in water-scarce regions. Over 2,500 years ago, the Babylonians, the Roman Empire and the Chinese constructed extensive canal networks, famous aqueducts and the Grand Canal, respectively to support human settlement in water- scarce areas. The Anuradhapura Kingdom of Sri Lanka too, developed major water transfers as far back as 100 AD to support the irrigation civilization needed to feed a growing population (de Silva 2005). In the twentieth century, the phenomenal population growth, economic activities and human settlement in water-scarce regions, advances in science and technology, political will and availability of resources led to the development of many water transfer projects. The global inter-basin water transfer increased from 22 to 56, from 56 to 257 and from 257 to 364 $km^3 yr^{-1}$ during the periods 1900-1940, 1940-1980 and 1980-1986, respectively, and is estimated to increase to 760-1,240 $km^3 yr^{-1}$ by 2020 (Shiklomanov 1999). Most of these transfers took place in Canada, the former USSR, India and the United States of America.

The benefits of these transfers have been considerable. Well-implemented water transfer schemes have supported socioeconomic development by: (a) enhancing total water benefit through the transfer of surplus water to a water-scarce basin/region; (b) facilitating re-allocation of water from a low- to a high-value use; (c) reducing regional inequity by transferring water to promote socioeconomic development in water-scarce regions; (d) facilitating broader cooperation and promoting solidarity between donor and recipient regions; and (e) restoring degraded freshwater ecosystems. However, the poor social, financial, economic and environmental performance of some transfers has contributed to growing criticism. Over the last 2 decades, most of the planned transfers have stalled. Yet, the Comprehensive Assessment of Water Management in Agriculture (CA 2007) concluded that, while improved water management should offset the need for securing new water sources, it cannot do this in all cases. It postulates that calls for water transfers will likely increase and become louder when and where the mismatch between supply and demand continues to grow, and efforts to conserve water have been exhausted. Tumbare (2001) argued that while the proposed inter-basin water transfer schemes in southern Africa seem to be pipe-dreams, they will become a reality in the near future due to continued population and economic growth in the region, and as long as there is scope for a win-win negotiated outcome. He postulated that these schemes will bring closer ties, economic benefits and co-operation between the various countries. Hence the need to address the question: how can future water transfer schemes be planned, implemented and operated cost-effectively and in ways that maximize net benefits and minimize social and environmental costs?

We posit that there are valuable lessons, both positive and negative, to be learned from past experiences, and also acknowledge the fact that the future is likely to present new challenges and opportunities and, hence the need to take a cautious approach. We, therefore, contribute to answering the above question by reviewing global experiences of water transfer and drawing lessons on where, when and how to implement economically, socially, environmentally and politically acceptable water transfer schemes. We specifically address the following questions:

- What are the different types of water transfer systems and under what conditions are they appropriate?
- What are the effects of water transfers on agriculture, food security and poverty?
- What factors facilitate or constrain the effective implementation of water transfer schemes?
- What changes in policy, legal and organizational framework and in approach to project design, planning, implementation and operation are required to facilitate the development of judicious water transfers schemes?
- How can research contribute in informing the debate and in providing solutions to unforeseen problems?

Types of Water Transfers and Case Studies

Types of Water Transfers

Water transfer is a water management strategy aimed at reducing the mismatch between water supply and demand by transferring water to augment local supply in water-scarce areas or reduce damage caused by excess water. Water transfer has three dimensions. First, water can be transferred from one use/user (donor) to another (recipient). Common examples include the transfer of water from agricultural to urban use and the transfer of water rights from one user to another, either through water trading, at the expiry of the water right duration, or where one user simply takes the water with no compensation to the previous user. Second, the temporal dimension in which alternative forms of water storage (groundwater recharge, natural or man-made reservoir) increase water availability in the dry seasons by storing the excess water received during the rainy seasons. Third, the spatial dimension involving the transfer of water from one location to another using groundwater pathways, natural waterways, canals and/or pipelines. These dimensions are not mutually exclusive and in most cases occur in combination.

Water transfer requires that there be a social, environmental, political or economic benefit, which provides the justification to offset: (a) the cost of transferring it; (b) any compensation demanded by the donor; and (c) any other costs associated with the negative externalities that the transfer may generate. Generally, water transfer schemes have multiple complementary objectives that include:

- To increase total water benefit by transferring surplus water to a water-scarce basin/ region,[1] as is described in the Brazil case study included in this paper;
- To facilitate re-allocation of water from a low- to a high-value use;[2]
- To reduce regional inequity by transferring water to promote socioeconomic development in water-scarce regions;[3]
- To meet treaty, agreement or other legal obligations;
- To facilitate broader cooperation and promote solidarity between donor and recipient regions;[4] and
- To restore degraded freshwater ecosystems.[5]

As stated above, there are a wide range of transfers, and a variety of terms associated with them. In this paper, we classify water transfers based on the geographic scope as follows:

- inter-project - transfer within a water project;
- intra-basin – transfer from one subbasin to another in the same basin; and

[1] For example, Egypt plans to promote the use of water saving technologies and transfer the water saved to irrigate 168,420 hectares of reclaimed dessert and provide opportunities for 3 million people (Tafesse 2001).

[2] For example, the experiences in China and western USA, in which large quantities of water are being transferred from agriculture to urban use, agriculture to agriculture, urban to urban and agriculture to environment. These transfers may be by the same user, among users within a water project or from one administrative/hydrologic unit to another.

[3] For example, the Rio-Sao Francisco inter-basin diversions whose objectives are to meet rural water requirements, promote urban and industrial growth and stimulate irrigation development in the drought-prone parts of Sao Francisco Basin, Brazil (Kemper et al. 2002).

[4] For example, planned diversions by Egypt's el-Salam (peace) canal to Israel and Palestine (Dinar and Wolf 1997) and by Turkey (peace pipeline project) to transfer water to Syria, Jordan, Saudi Arabia and other Arabian Gulf states (Rende 2004).

[5] By addressing environmental constraints through the use of transferred water to meet environmental flow requirements; reduce over-use of surface water, groundwater and water in wetlands and thereby sustain freshwater dependent ecosystems; and improve water quality by trading low-quality water for higher quality water and reducing agricultural pollution by transferring water to other non-polluting uses.

- inter-basin[6] - transfer from one basin to another basin. This is further sub-divided into short and long inter-basin transfers. In the case of the former, the transfer is to a basin immediately adjacent to the donor basin, whereas with the latter, it may cross multiple basins.

Other defining characteristics of a water transfer arrangement include:

- *Types of water:* the transfer may involve surface, ground, wastewater (reclaimed, treated, or untreated), brackish and even saline water. For the sake of completeness, it could also include virtual water, that is through trade.

- *Water transfer route:* can be direct (above or below ground pipelines, open or closed canals, and natural waterways) or in-direct[7] as in the case of groundwater flow.

- *Water transfer duration:* these include permanent, long-term and short-term transfers of a water right.

- *Water transfer operation criteria:* that defines the volume, rate and timing (seasonal, constant, pulsed or combination) of the water to be transferred.

- *Planned or unplanned water transfer:* While the focus of this paper is on planned transfers, it is important to recognize that there are also unplanned transfers.

Given the above, there is considerable variation on the form of a given transfer, and generalizations of their appropriateness and/or impacts may be misleading. However, matching water transfer purpose, type and characteristics with the unique site conditions is an important step towards reducing negative impacts.

Case Studies

Water Transfers in the Western United States

Using the Colorado Basin case study, we now illustrate how the western states have put in to practice water transfers.

Sharing Water and Mitigating Negative Impacts: The waters of the Colorado River are shared by Mexico and seven states of the United States of America. The Colorado River Compact of 1922 divided the water among the Upper (Colorado, Utah and Wyoming) and Lower (New Mexico, Arizona, Nevada and California) basin states and also among agricultural and urban uses.

[6] Inter-basin transfers is the withdrawal of water, more or less continuously over all or part of the year, by ditch, canal, tunnel or pipeline from its basin of origin for use in another river basin (ICID 2006). Further specifications include (Davies et al. 1992): (a) the diverted flow does not return to the stream of origin, or to the permanent stream within 20 km of the point of withdrawal; and (b) the mean annual flow transferred should not be less than 0.5 m3 s-1.

[7] Land and water use and management practices that increase infiltration, groundwater recharge and augmentation of dry season river flow in downstream reaches are a form of indirect water transfer.

The Compact, whose purpose was to allocate the available 17 million acre-feet (21 billion m^3) and protect the water rights of the upper basin, allocated 7.5 million acre-feet (9.2 billion m^3) to each of the two basin areas. Mexico's water issues were addressed 22 years later in the form of the United States and Mexico treaty that guaranteed Mexico 1.5 million acre-feet (1.8 billion m^3) from the Colorado River each year. Initially, the focus was on water quantity, and the water quality issues were revisited later when Mexico threatened to request international sanction for the increased salinity level of the water it was receiving. The United States agreed to limit the salinity level to 1,000 ppm. The water salinity would have been met through reduced water transfers and irrigation return flows. In 1974, to secure that water to the lower basin states, the Federal Government authorized the construction of the Yuma Desalting Plant, a reverse osmosis facility. The plant was commissioned in 1992 and tested at 1/3 capacity until late 1993 when the plant was mothballed as wetter conditions upstream meant that the required salinity levels did not require the plant's operation. Since then, the agricultural drainage water that was intended as the source water for the plant has been discharged to what was to become the Cienega de Santa Clara wetlands in Mexico, and efforts to bring the plant into operation have been resisted on environmental grounds. The recent droughts in the western United States, and the increasing demands of a growing population have increased demand on the waters of the Colorado River, while at the same time there has been increasing awareness of the need to ensure allocations to the environment. Given this, early in 2007 the United State Bureau of Reclamation (USBR) in coordination with a number of stakeholders, including the concerned environmentalists, restarted the plant for a 90-day trial period to, among other things, determine the likely impact on the wetlands.

The lessons that emerge from this section of the case study are that : (a) a government can facilitate fair sharing of water among the partner states; (b) there is need to consider third party interests and implement corrective measures associated with the cumulative negative externalities of water transfers; (c) technological solutions exist but may be too expensive; (d) in a transboundary context a poor downstream country is at the mercy of the rich and powerful upstream country and that international sanctions can play a role in getting the upstream countries to reduce negative impacts on downstream countries; and (e) the future can be very unpredictable as evidenced by changes in the hydrologic regime that in turn resulted in an under-utilization of the desalting plant and a considerable saving in operation costs, and then led to the subsequent requirement to account for the wetlands, which were created as a result of the desalination plant.

Water Transfers from Low- to High-value Uses: The western United States of America has a very rich and well-documented experience in water transfers. Early water developments and transfers were mainly for agricultural purposes. However, as the West grew, urban areas sought a share of the water. In many basins, twentieth century agricultural and urban expansion has eliminated water surplus, most notably in the Colorado-case described above. Because the water resources were initially developed principally for agriculture, agriculture obtained preferential water rights for over 90 % of the available water. In the last 3 decades, water transfer has become a common feature of water management. For example, in all western states permanent long-term lease (up to 35 years) and short-term lease (1 year) are common. Libecap (2005) reported that between 1987 and 2004 the 12 western states made 2,751 transfers. Short-term, long-term and permanent transfers accounted for 25.7 % and 68 %, while agriculture to urban, agriculture to environment and agriculture to agriculture accounted for 55%. 6 % and

16 %, respectively. In volumetric terms, the transfers from agriculture to urban, agriculture to environment and agriculture to agriculture amounted to 3.4, 3.3 and 6.8 million acre-feet (4.2, 4.1 and 8.4 billion m^3), respectively. A further 11.6 million (14.3 billion m^3) is classified as miscellaneous (urban to agriculture, urban to urban, urban to environment, environment to urban and environment to environment). These water transfers are driven mainly by market correction of water allocation failures. Griffin and Boadu (1992) illustrated this by highlighting the differences in what new water users were paying to acquire additional water—300-2,300 and 6,500-21,000 US$/acre-foot (243.3 to1,865.3 and 5,271.6 to 17,031.6 US$/1,000 m^3) in the Grande Valley of Texas for agricultural and urban uses, respectively (Trans-Texas Water Program 1998). The difference between use value in agriculture and urban indicated the significant social gain from re-allocating water from agriculture to urban. Libecap (2005) reported that the annual mean per acre-foot prices for agriculture to urban, agriculture to agriculture and other water trades were US$ 615,152 and 283, respectively. They also reported that the price differences between agriculture to urban and agriculture to agriculture has rose from US$111 in 1993 to US$1,362 in 2003.

According to Lund and Israel (1995), a series of institutional changes have facilitated the evolution of innovative water transfer arrangements. They report that the period from 1980-2000 was marked with many changes that started with the amendments of state and county laws to ensure that third parties, i.e., water users who are not a party to the transfer and fish and wildlife, are shielded from the negative impacts of the transfer. Water market and water banking are two institutional mechanisms that facilitated the efficient re-allocation of water resources. The four main types of water markets are: (a) open water market in which water rights are traded on a free market with no administrative control and interference; (b) spot markets which facilitate temporary transfers of water in times of shortages; (c) administrative water trading in which the water trade is regulated to exert some control over the spatial, sectoral, price and equity consideration; and (d) informal water markets. A water bank is an institution that offers to buy and sell water. It serves as an intermediary in the water market that encourages market activities, potentially lowers transaction costs and presents opportunities for regulating undesirable social and environmental impacts. Water markets and water banks require strong oversight to ensure that there is good governance, accountability and public trust. They also require clearly defined and secure water rights and strong water resource management organizations that can monitor the use and enforce the water rights systems.

The Colorado Big Thompson (C-BT) water project of the Northern Colorado Water Conservation District (NCWCD) is a good example of how water transfers are managed in the United States of America. The C-BT project has an extensive water storage and conveyance network that delivers water to 29 cities and towns and 607,000 hectares of irrigated land. Water is computer-controlled and an effective communication system provides real or near-real time information to water users and system managers.

The C-BT project and its water resources are owned by the US Government. The NCWCD is granted the perpetual right to use all the water available for recreational, irrigation and urban uses, and is therefore, the repayment entity, the operator of facilities and distributor of the water. These operations are overseen by the Board of Directors who have the power to make and enforce reasonable rules and regulations for the management, control and delivery of water. Irrigated land owners served by the project pay an annual levy on acreage under irrigation.

This money is used for the repayment (to the government) of the fixed cost of providing the infrastructure and for management, operation and maintenance.

Transfers of water are subject to approval by the NCWCD Board of Directors. Irrigation to urban transfers is routinely approved after examination of the need by the new user, for additional water. The transfer from one tract of irrigated land to another can be approved upon determination that the recipient land has an existing base of supply of water and that supplemental water is needed. Transfer of ownership takes 2 to 3 months after NCWCD has received and recorded all transactions. There are also brokers who facilitate water transfers at a fee. To enhance transparency, regional newspapers carry information on sale and lease opportunities (Nieuwoudt 2000). Non-profit organizations, mutual ditch companies owned by the farmers, manage delivery of water from the NCWCD operated infrastructure to the farmers' intakes. They facilitate market transactions by performing monitoring, distribution and enforcement functions. Ditch companies serve as intermediaries between the NCWCD and the irrigators. Water lease within a ditch company can be arranged by phone. Ditch companies compile their water orders and forward them to dispatch offices operated by the NCWCD, which receive and process daily orders.

The main lessons learnt from this section include: (a) administrative approaches to water allocation are gradually being replaced by market approaches that facilitate the transfer of water from low- to high-value uses; (b) administrative water trading and water banks may be required to facilitate the achievement of spatial, sectoral, price and equity objectives of water transfers; (c) effective water and communication infrastructure reduce the cost of water transfer and improve transparency, thereby enhancing public trust and confidence in the system; and (d) innovative financing arrangement comprising government financed infrastructural development, a water fee to facilitate government recovery of its finance, a cost sharing system in which by having water users and water distribution companies partially finance the infrastructural costs, public investment in water transfers can become more financially acceptable.

The Aral Sea Basin Case Study

The Aral Sea basin was formerly part of the USSR but is now made up of the five Central Asia Republics namely, Kazakhstan, Kyrgyzstan, Tadjikistan, Turkmenistan and Uzbekistan. The two main rivers Amu Darya and Sry Darya rise from the mountainous countries (Tajikistan and Kyrgyzstan) and flow northwestwardly through the arid plains and desert areas of Turkmenistan and Uzbekistan (Amu Darya River) and of Kazakhstan (Syr Darya River) and eventually flow into the Aral Sea. During the Soviet Era, 39 major reservoirs were constructed to regulate flows, generate hydropower and facilitate irrigation diversions.

The High Cost of Ignoring Negative Externalities:

Water transfers in the Aral Sea basin were mainly driven by the potential economic gains from hydropower and irrigated agriculture. During the period 1960 to 1987, the irrigated area rose from 4.5 to 8.0 million hectares and the annual irrigation diversion increased from 60 to 105 km^3 leaving less than 10 % of the natural runoff to flow into the Aral Sea (McKinney 2003). Consequently, the Aral Sea's water level dropped by 13 m and the surface area and volume decreased by 60 % and 70 %, respectively (Micklin 1988). Reduced water inflow, surface area and volume resulted in desiccation of 40 % of the wetland area, disappearance of 24 native fish species, collapse of the fishing industry and the loss of livelihoods for millions of people. Inadequate drainage in the irrigation schemes contributed to waterlogging and salinization problems in approximately 5 million hectares of irrigated land.

From this section of the case study we note that the environmental disaster, which followed from the original large-scale intra-basin transfer (from the environment to agriculture and hydropower) was enormous, and while the benefits of the irrigated cotton and wheat, and the hydropower were also significant, these negative impacts have been at an unprecedented scale. Inter-basin water transfers did not yield a high total basin wide benefit, but rather an increase in one part at the expense of another. The situation is further compounded by the fact that, unlike in the Colorado Basin case study where sufficient resources were deployed to implement mitigation measures, these cash strapped economies could not mitigate the problems. Hence, the need to critically assess environmental flow requirements and to secure these flows, particularly where many people depend on the livelihoods from such ecosystems.

From Imposed to Negotiated Cooperation of Riparian States:

Under the 'Soviet Era', water allocations and transfers were planned centrally resulting in some form of imposed cooperation among the riparian states. The three key features of this cooperation were: (a) water allocation among the five states—the mountainous republics (Tajikistan and Kyrgyzstan) could only utilize 25 % of surface and groundwater originating in its territory and had to pass on 75 % of the resource downstream; (b) oil producing downstream republics provided upstream republics with free oil to produce energy for winter heating so that they could secure summer flows to sustain irrigation development; and (c) upstream reservoirs were operated in a way that optimized downstream irrigation during the summer growing season rather than hydropower during the winter, and provided storage for drought security. The high potential for irrigating cotton production was the major justification for water transfers and economic cooperation (IWMI 2006).

After the break up of the USSR, new independent republics were created. With no binding interstate legal framework, some of the cooperative arrangements came under pressure as each newly independent country sought to meet their national level needs. Competition for irrigation water between the arid regions of Uzbekistan and Turkmenistan intensified, and Kyrgyzstan changed its water reservoir operating policy. It released 61-67 % higher flows in winter and 68 –77 % less in the summer from the Tokhtogul Reservoir than it did during the Soviet era (IWMI 2006). While the increase in winter flows mean the water can no longer be used in irrigation, the formation of an ice jam in the middle reaches of the Syr Darya means that the flows do not reach the Aral Sea, rather a large portion of the winter water release is now transferred to what is ostensibly a sink – Lake Arnasia.

Attempts to have the countries cooperate around this issue essentially failed, demonstrating that in this case, water transfers did not support broader regional cooperation. But later, according to UNDP, World Bank and Bank Netherlands Water Partnership Program (2003), an Interstate Agreement was signed in 1992 to guide the negotiated cooperation that is needed to re-establish trust and confidence, and facilitate effective management, utilization, and protection of water resources in the Aral Sea basin, and implement joint measures to address the Aral Sea problem. Numerous problems have been encountered during the implementation of these agreements.

This section of the case study highlights (a) the downside of water transfers if the enabling conditions unravel, especially for such a large scale; and (b) the growing recognition of the critical role that cooperation among riparian states can play as an innovative institutional instrument for facilitating faster regional development through co-development, cost and benefit sharing and a shift of focus from water sharing to benefit sharing as a way to redress past inequity in water sharing.

Inter-basin Water Transfer in Spain—Tagus-Segura-Ebro Basins Case Study

The general perception is that it is the government's responsibility to correct the natural hydrologic imbalance, particularly where such imbalance is the main constraint to socioeconomic development of water-scarce areas. In this case study we examine the critical role played by the Government of Spain.

Agriculture is the main economic sector in the Segura Basin, but its performance is constrained by scarcity and variability of both ground and surface water resources. In the 1930s, irrigation expansion plans called for the development of local surface and groundwater and transferring water from the Tagus and Ebro basins. In the 1940s, two dozen reservoirs were constructed with a combined capacity of 1,000 Mm^3 in the Segura Basin and in the 1950s and 1960s; the Government of Spain implemented a program that supported groundwater irrigation.

In 1979, the Tagus-Segura water transfer project with a design capacity of 100 Mm^3 $year^{-1}$ became operational, but only delivered on average 30 Mm^3 $year^{-1}$ due to there being less water available in the Tagus Basin than estimated. However, irrigation continued to expand with the private and unregulated development of groundwater, which in turn led to overexploitation of groundwater aquifers. The government responded to the groundwater overexploitation challenge by the passage of the 1985 Water Law, which set a cap on the number of wells and their discharge. The law was not adequately enforced and groundwater overdraft continued. The irrigated area, which increased from 90,000 to 115,000 ha between 1933 and 1963, jumped to 197,000 by 1983 mainly because of Tagus water transfer in 1979. And by the year 2000, the irrigated area had increased to 252,000 hectares.

In 2001, the Spanish Parliament enacted the Law of the National Water Plan[8] in which 1,050 Mm^3 $year^{-1}$ was to be transferred from the Ebro River, of which 50 % was to be used to reduce water stress in parts of the Segura Basin that were experiencing groundwater overdraft. The Ebro water transfer was strongly opposed by (a) the Government of the Aragon autonomous region located in the Ebro Basin; (b) the people of Ebro delta region; and (c) many environmental groups, scholars and members of civil society. Massive demonstrations

[8] The Law of the National Water Plan has several articles that guard against the misuse of the water to be transferred. They include: (a) Article 18 which states that not a single drop of the Ebro River can go to an overexploited aquifer if detailed studies of the situation are not previously performed and approved by the Central Government; (b) Article 29 established the need to carry out comprehensive groundwater studies and to foster the formation of groundwater user groups to spur small-scale hydrosolidarity; and (c) Article 34 seeks to promote good water management and ethics through educational campaigns (Llamas and Perez-Picazo 2001).

against the project took place[9], as those opposed to the water transfer perceived it as a project that threatened livelihoods and ecosystems, ignored environmental directives and mocked the idea of spending public money responsibly. According to Llamas and Perez-Picazo (2001), a poll on the social perception of the Ebro water transfer showed that 50 % of the respondents were in favor of the project and 30 % against. Those in favour were mainly influenced by the common belief in every culture or religion that water should be given to the thirsty. Those against were more influenced by their perception that Segura had more water than it needed if only it could use it more efficiently and productively. Several studies have shown that water demand management would for the time being be a better option to addressing the problems of the Segura Basin than transferring water from Ebro Basin.[10]

The case of the Tagus-Segura-Ebro basins presents facets that appear particularly relevant to the Indian context. The original water transfer, while it seems to have been relatively successful, was seriously compromised by a significant overestimation of the available water, which, among other things, affects the credibility of future efforts to develop transfers. The prevailing financial and market conditions made it attractive for farmers to expand irrigated areas using groundwater. Efforts to regulate groundwater use failed, and a project aimed at providing an alternative water source for the irrigated area and other users within the receiving basin was effectively blocked by the stakeholders in the proposed donor basin, despite a general perception that the project was appropriate.

Long Distance Inter-basin Water Transfer—China's South-to-North Transfer

China's unprecedented economic growth combined with its high population and water scarcity has resulted in increased calls for water transfers from the water surplus southern to the water-scarce northern basins. Feasibility studies on the South-to-North water transfers started

[9] For 3 years, thousands of people participated in massive demonstrations. They raised awareness of the negative impacts of water transfers and mobilized support to stop the transfer. They used a wide range of approaches that included: candlelit procession, people chaining themselves outside government offices, holding public meetings, using attention grabbing leaflets, graffiti, concerts, fiestas, puppets and organizing competitions. They mobilized activists from all social strata (category). Fifteen thousand protestors went to Brussels to demonstrate in favor of EU legislation and against their country receiving EU funds (Starbridge 2005).

[10] Albiac (2002) examined water demand management in the Segura Basin as an alternative to water transfer from the Ebro Basin. He considers two water demand management instruments–1) restriction on groundwater use; and 2) increase in water price. He reported that (a) the transferred water would have higher costs, 0.19-0.75 Euro/m^3 higher than current costs and, hence would only be economic for high-value crops; (b) the Segura Basin would only be able to absorb 2.2 Mm3 of the water destined for agricultural use at the water transfer price and not the 3.62 Mm^3 designated in the National Hydrologic Plan to achieve sustainable groundwater management; and (c) subsidy of transferred water would be feasible, but very expensive to the non-agricultural users in Segura. He, therefore, argued that demand management strategy would be preferable, because it guarantees the relief of pressure on aquifers coming from agricultural use without needing to establish strict controls on wells.

in the 1950s and identified three major water transfers (the western,[11] central[12] and eastern[13] route) projects. Environmental impact assessments of the Eastern and Central Route water transfer projects were completed and the projects approved for construction (Shao et al. 2003).

Overcoming Technical Challenges:

Many studies were carried out to identify and address the technical challenges associated with the long-distance of the eastern and central route water transfers. We highlight a few studies to illustrate the technical complexities and technical solutions.

Shao et al. (2003) presented a review of structural problems associated with slope stability, seepage loss and groundwater rise, the settlement of ground surface in the coal mining area, freezing and thawing of the soil and liquefaction of sand in the central route. Mitigation measures were identified and implemented.[14]

Environmental and health hazards were also carefully assessed and addressed. Yin et al. 2001 (quoted by Shao et al. 2003) reported that the diversion from the Hanjiang River into the middle route worsened the eutrophication problem downstream of the diversion point. Sufficient solar radiation during the spring season combined with higher nitrogen/phosphorous loading, low discharge (<500 $m^3 s^{-1}$), slow velocity (<0.8 $m^3 s^{-1}$) and high water temperature (10.5-12.8^{0}C) led to high algae bloom that was recorded in the lower reaches of the Hanjiang River in 1992, 1998 and 2000. Li et al. (2000 quoted in Shao et al. 2003) raised concerns over the possible proliferation of parasitic diseases. They reported that during the period 1989-1998, a total of 7,772 cases of acute schistosomiasis infection were reported in the Hubei Province. Huang et al, .2000 (quoted in Shao et al. 2003) reported that the total area of snail habitat in the Jiangsu Province was 162 km^2, and that inter-basin water transfers can lead to the development of

[11] The Western Route diverts water from three major tributaries of the Yangtze River to the Yellow River.

[12] The middle or central route diverts water from the Danjiangkou Reservoir on the Hanjiang River to the Yellow River.

[13] The Eastern Route diverts water from the Yangtze River, stores it in four natural lakes and several planned reservoirs and uses a siphon to cross the Yellow River.

[14] Slope stability problem was expected along 160 km (12%) of the transfer channel. Slope stabilization was achieved using a combination of countermeasures that included: smaller slope angle, vegetated canal banks, drainage ditches, grouting, anchoring and masonry protection. As the transfer canal passes through seven coalmine areas (51 km), surface subsidence, collapse and ground fissures on these areas were anticipated where the effects of coal mining and canal seepage combined. This problem was solved by either re-routing the canal to avoid such a combination or by providing artificial cushion foundation that reduced seepage and soil deformation. Liquefaction and collapse could also occur under seismic shocks if the canal is built on such silty sand base. Preventive measures for this problem included drainage, canal leak proofing, masonry protection, chemical grouting and in some cases deep foundation and anti-earthquake provisions. The presence of water is the main cause of frost heaving and its destructive effect, and consequently drainage and seepage prevention were complementary measures to reinforce the concrete lining of the canal.

snail habitats in the recipient basin. However, as snails cannot survive in the extreme cold climate, the spread of snail habitat north of Biama Lake in Jiangsu Province (above latitude 33^0 15') would be limited.

Analysis of the combined effect of the South-North water transfer and the Three Gorges Project showed that the operation of the two projects together will lead to a slightly longer time and distance of saltwater encroachment up the Yangtze River mouth, during the months of October, November and December (Wu and Wang 2002 quoted in Shao et al. 2003). The operation of the Three-Gorges Dam, the South to North water transfer and the deepwater navigation channel at Shanghai is expected to result in a 10-20 % decrease in sediment discharge into the Yangtze River delta. This may degrade the delta ecosystem with implications on the required level of coastal protection for Shanghai.

This section of the case study illustrates the technical complexities associated with long-distance water transfers and the need to take a holistic view. By combining the effects of water transfers with those of the Three-Gorges Dam, they were able to assess the cumulative effect. It also illustrates that generally there are technical solutions; the problem may be getting the resources to implement them.

Innovative Co-financing Arrangements:

In 1999 there was a shift in China's water policy from structural measures to integrated and holistic approaches (Boxer 2001). This was followed in 2002 by the institutionalization of water rights and water markets. The law provides a framework for promoting sustainable water management through appropriate water rights and licensing systems, river basin management approaches, progressive water pricing and a penalty price for water use that exceeds the allocated quota.

Securing funding for such a massive water transfer project was a major challenge that was further complicated by (a) the fact that water would be transferred from one province to another and in some cases through other provinces; (b) disagreements attributed to the fact that all provinces have their own administrative powers and economic interest; and (c) the fact that water infrastructure is considered to be part of the national infrastructure, and provinces were not keen to finance national infrastructure. An innovative co-financing arrangement was formulated in which (a) the construction of the back-bone infrastructure of the South-to-North transfer is financed through the establishment of a construction fund to cover construction, interest and maintenance costs, which is shared by each province in the form of purchasing water rights (Wang 2001 quoted in Shao et al.. 2003); and (b) each province could raise funds by charging individual users for their water use.

In this section of the case study we note that, just as in the United States of America case study, the water policy reform towards water pricing, water markets and co-financing are creating the appropriate enabling environment. Innovative co-financing arrangements can avail additional resources needed for massive projects; can increase the level of participation, transparency and good governance; and can lower implementation cost, thereby making water transfers more cost-effective. Also, when water users know that they will end up paying for the water transferred they are more likely to fully exploit opportunities for the better management of existing water resources before demanding additional water resources through water transfer schemes.

Transboundary Water Transfer—Lesotho Highland Water Project Case Study

India has less powerful but water-rich upstream neighbors – Bhutan and Nepal. They present opportunities for the co-development of water resources for the benefit of all parties. We examined the Lesotho Highland Water Project for lessons on how upstream and downstream countries can enhance basin-wide benefits through water, cost and benefit sharing mechanisms.

Politics Can Be a Major Stumbling Block:

Lesotho is a land-locked poor country surrounded by South Africa, but it is strategically located in the Drakensberg Mountains, a major water tower for South Africa. South Africa recognized this potential and carried out a reconnaissance study in 1956. This opportunity was revisited by the Government of South Africa following the catastrophic droughts of the mid-1960s. In 1968, South Africa and Lesotho reached an agreement in principle and started consultations, but the negotiation broke off in the 1970s over royalty payment issues. Lesotho Government's support to the black South African struggle for independence strained the relationship between the two countries, and the talks were suspended in 1976. Low-level consultations resumed in 1980 and paved the way for feasibility studies. It was not until the 1986 regime change in Lesotho by a military coup d'etat that the negotiations were concluded. The two conditions that facilitated successful water transfer from Lesotho to South Africa were: (a) the treaty (signed in 1986) that clearly defined the roles and responsibilities of the two states, the strategies for preventing and settling disputes, and facilitated the setting up of governance structures that symbolized cooperation and overcome mistrust; and (b) adequate direct and in-direct benefits that motivated the states' commitment (Mirumachi 2004).

Corruption Can Mar Good Intentions:

The construction of Phase 1A of the project was undertaken between 1989 and 1998 and facilitated the transfer of 0.5 km^3 of water per year from the Orange River to the Vaal River for use in South Africa's industrial province of Gauteng. Phase1B was started and upon completion increased the transfer rate from 18 to 30 $m^3\ s^{-1}$. The project infrastructure affected over 30,000 people, displaced 325 households and led to an ex-closure of 2,300 and 3,400 hectares of crop and grazing land, respectively. The annual royalties that Lesotho receives are estimated to be over US$80 million and accounts for approximately 28 % of the total government revenue (WWF 2007).

The project was expected to cost US$4 billion but ended up costing US$8 billion. Corruption was largely blamed for the escalating costs. In an analysis of what went wrong, Hildyard (2000), highlighted the need to consider the possibility that what went most 'wrong' from the perspective of project-affected people, human rights groups, environmentalists and a range of other civil society groups concerned with accountability, transparency, equity and sustainable development is precisely what went most 'right' from the perspective of those who have benefited institutionally and financially from the project. He argued that taking this approach challenges us to focus less on the perceived 'lack of political will' to tackle corruption and instead focus more on those vested interests that generate immense political will to block investigations when they are initiated and to undermine anti-corruption drives. This will facilitate the analysis of how regulations could be improved and how institutional practices can be changed and empowered to effectively implement anti-corruption regulations. He concluded that (a) the problem of corruption is unlikely to be addressed by new regulations unless and until the well-documented structural and institutional barriers to their rigorous implementation are addressed; (b) addressing institutional and structural barriers requires a major overhaul of the mission, management and culture of institutions, which act so consistently to the detriment of openness, accountability and democratic decision-making processes; and (c) such radical change is unlikely to come about through the goodwill of the institutions under scrutiny and, hence public pressure is a prerequisite for change. These findings are significant not just for India but for all situations where corruption is expected to adversely affect perception over the effectiveness of government investment in such projects.

Challenges in Assessing and Mitigating Environmental Impacts:

The treaty between South Africa and Lesotho included specific environmental conservation and compensation requirements. However, the project started without an Environmental Impact Assessment (EIA). Nevertheless, a full EIA with a proper environmental flow analysis (including examination of the physical, chemical and biological characteristics, and modeling of water quality) was carried out for phase 1B. The EIA raised concerns over critically endangered Maloti minnow, threatened habitats, reduced volume of water for effective dilution of pollutants in the lower reaches of the Orange River and risk of increased de-oxygenation and eutrophication. The utility of the environmental flow assessment was criticised for: (a) lack of legal framework for implementing recommendations; (b) inadequate involvement of the key stakeholders and profession disciplines; and (c) lack of criteria for judging what level of environmental degradation might be considered acceptable by both parties (Watson 2006). Environmental impacts assessment should, therefore, be integrated into various stages of project planning and any concerns addressed by a multidisciplinary and multi-level group of stakeholders, so as to fully incorporate any environmental, social, cultural, economic, legal and political consideration.

Inter-basin Water Transfer—Sao Francisco Interlinking Project, Brazil

Brazil is generally considered to be a water-rich country, but its northern-east region is water-scarce and experiences frequent droughts. The rationale for planning Sao Francisco water transfers is the belief that transferring water from water abundant to water-scarce areas is in the national interest of enhancing socioeconomic development and reducing regional inequity. However, as this case study illustrates, getting a consensus on how to achieve the noble goals of equitable socioeconomic development remains elusive.

The semi-arid areas of north-eastern Brazil are drought prone. According to the International Research Institute for Climate and Society (2005) the area has experienced 28 severe drought years between 1900 and 1999. The effects of many of these droughts are felt for 3-4 years. Drought-proofing the region by transferring water to this region has, therefore, been under consideration for a long time. In 1981, the National Department of Reclamation Works (DNOS) carried out feasibility studies. These formed the basis for the request by the Government of Brazil for the World Bank to finance the preparation of an action plan for the Sao Francisco

Transbasin Project. According to Simpson (1999), the proposed action plan recommended: (a) the full development of local and state water-related institutional capacity before the construction of the Sao Francisco diversion works; (b) establishment of irrigation pilot areas in the plateau of Jaguaribe in Ceará and Apodi in Rio Grande do Norte; (c) establishment of a multi-sectoral entity to develop detailed plans and implement the project; and (d) the requirement that institutional constraints to efficient water use at both the state and federal levels be resolved prior to the project implementation study. In 1989, CODEVASF (Companhia do Desenvolvimento dos Vales do São Francisco) prepared a comprehensive basin plan after a detailed assessment of the needs and potential for development and commercialization of agriculture, hydropower, water supply and wastewater treatment. In 1995, the states of the north-east in cooperation with the National Secretariat of Water Resources formed a group representing water resources sectors of all states to foster water resources legal and institutional cooperation.

In 2000, the government revived planning of the Sao Francisco Interlinking Project. The project aims at enhancing water supply to the over 12 million people and irrigate over 300,000 hectares in the semi-arid region of Pernambuco Agreste and the Metropolitan area of Fortaleza in north-east Brazil. Approximately 99 m^3/s of water was to be transferred from the Sao Francisco River to Ceara, Rio Grande do Norte and Paraiba states that are outside the basin, and a further 28 m^3/s of inter-basin transfer to the Pernambuco states. The project is estimated to cost at least US$2.38 billion and generate jobs for up to 1 million people.

According to Tortajada (2006), the proposed water transfer has the following innovative ideas: (a) the water transferred will be paid for by the receiving state or irrigators; (b) full cost recovery principle will be applied to promote the efficient use of irrigation water; (c) charges for drinking water will be lower corresponding to the so called social rate for the rural population; (d) the volume of irrigation water delivered will depend on the implementation of demand management practices and water-saving technology adopted by the farmers; and (e) negative impacts of water transfers will be reduced. The government has also addressed emerging concerns. Existing water uses are secured and so are the water requirements for energy up to 2025.

Despite all the above assurances and the fact that the project was approved by National Water Resources Council acting on behalf of the Federal Government in February 2006, the construction has been delayed due to (a) the delay in approval by the river basin committee that publicly expressed concerns over the proposed approach and the process followed thus far; (b) the government's decision to shelve the project until after the elections; and (c) concerns raised by various lobby groups such as the use of unrealistic costs and benefits.

Analysis of Case Studies

In this section we analyze the experience of the six case studies and discern lessons that can guide planning, implementation, operation and maintenance of future water transfer projects. We capture issues associated with long distance transfers (China and Aral sea case studies), transboundary inter-basin transfers (Lesotho-South Africa and Aral Sea case studies); inter-basin transfers in a federal government set up (China and Brazil case studies) and within water project and intra-basin transfers (USA case study).

What Are Some of the Impacts?

Hydrologic, Environmental and Socioeconomic Impacts

The literature espousing the hydrologic, environmental and socioeconomic impacts of water transfers is vast (ICID 2006; Das 2006; Gibbins et al. 2000; Snaddon and Davis 1998; and Howe and Goemans 2003), and the case studies highlight the nature and extent of these impacts. In this section we analyze the extent to which the impacts and mitigation measures are identified and adequately assessed.

The impacts can be positive or negative, and their nature and extent varies widely depending on the type and characteristics of water transfer and on other biophysical and socioeconomic conditions (see Table 1). The impacts affect different stakeholders in different locations and in different ways, and have a high temporal variability. And yet, in most cases impacts are presented in a summarized and condensed manner, giving the impression that the impacts are the same everywhere and all the time. Generally, the direct and indirect effect of water transfers on livelihoods;[15] food security;[16] poverty alleviation;[17] health mortality, morbidity

Table 1. Impact categories and effects of water transfers.

Impact category	Effects of water transfer
Hydrologic	Volume, rate and timing of surface flow Seepage transmission losses Evapotranspiration from water bodies Groundwater recharge and discharge Areas of freshwater ecosystems Channel erosion and siltation
Environmental	Reservoir induced seismicity Water quality (physical, biological and chemical pollutants) Soil salinization Waterlogging Desiccation and loss of connectivity of freshwater ecosystems Habitat status Transfers of alien and invasive flora and fauna Invertebrates diversity and quantity Fish diversity and population Disease vectors
Socioeconomic	Changes in value/reliability of benefits derived from in- and off-stream water uses Changes in costs/vulnerability associated with in- and off-stream water uses Displacement and resettlement costs and benefits Costs associated with conflict management Benefits associated with cooperation Multiplier effect of direct benefits arising from water transfer Opportunity cost of investment in water transfer

[15] Such as changes in production, employment, processing and trade related incomes.

[16] Such as changes in regional or household food production and market prices.

[17] In terms of number of people who are better or worse off and change in income of the poor.

and health risks; and access and quality of regulating, supporting and cultural services derived from freshwater ecosystems prior to the implementation of the transfer are poorly documented. Third party[18] impacts resulting mainly from loss of farm-related jobs and market opportunities for the goods and services are also inadequately documented. This is partly attributed to the fact that indirect impacts are more difficult to quantify, that they are believed to be minimal and that they are assumed to be naturally mitigated as if the economy is able to self-adjust to create opportunities for those who lose. In other cases the problem may be the ineffectual implementation of mitigation measures.

Impacts on Agricultural Production, Food Security and Poverty

Available literature highlights the complex inter-relationships that determine the nature and extent of both positive and negative impacts and the difficulty in fully identifying the conditions that determine the direction, nature and extent of these impacts. The cause-effect is sometimes difficult to establish, and in some cases, the impacts have been mainly attributed to the broader effects of dynamic changes in the rural and urban economies, such as the declining competitiveness of agriculture in the area (Rosegrant and Ringler 1999).

Transferring water from agriculture can impact a wide range of stakeholders, depending on how dependent they are on the agricultural economy. Transfers can result in changes in the cropping pattern, irrigated area, intensity and productivity. Whereas the recipient and donor of the water may gain through their transactions, other parties may be negatively affected through the reduced water availability and quality. For example, (a) water transfer from rural to urban areas could lower farm employment and demand for rural services and increase them in urban areas; (b) reducing water use in agriculture might positively benefit by improving water quantity and quality downstream to the benefit of fish and other downstream water users; while reducing irrigation drainage outflow might harm flora and fauna dependent on habitats sustained by irrigation return flows. These changes can affect employment opportunities, agricultural incomes, local food self-sufficiency, associated business activities and local and central government revenue. The severity of economic impacts will differ depending on: (a) whether there is adequate economic integration between the source and recipient regions; (b) whether the water donors are compensated or the proceeds from the transfers are invested in the area of origin; (c) economic vitality of the water sources areas; and (d) other spin-off benefits that arise from the transfers.

[18] Potential third parties to water transfers include: general taxpayers; urban – (downstream urban uses; the poor urban crop, fish and livestock producers; those employed by companies that would be affected by the transfers); rural (irrigators, fishers and their employees; rural water supply organizations and their employees); and environmental (fish and wildlife habitat and those affected by potential land subsidence, overdraft, water quality deterioration and well interference).

Zhang and Zhang (1995) estimated that in the Yellow River basin, 3 billion cubic meters of urban and industrial wastewater per year has polluted 60 % of its drinking water. Rosegrant and Ringler (1999) reported that in the suburbs of Beijing, both grain output and overall agriculture output value continued to increase at the same time that water had been diverted to urban uses, which resulted a decline in the overall irrigated area.

Where water is being transferred to high-value uses and the water donors are compensated fairly, water transfer has resulted in increases in water productivity and agricultural incomes. In California, Dixon et al. (1993) reported that farmers who transferred some of their water to other uses reduced their operating cost by 11 % and crop sales by 20 %. These reductions adversely affected the suppliers of farm inputs, agricultural workers. Villarejo (1997) in a study on the impact of drought-related water transfers from agriculture to urban areas in Mendota, California reported a 30 %, 14 %, 26 % and 14 % decline in agricultural land value, irrigated area, the number of farms and labor income, respectively. Increased use of low-quality groundwater to compensate for the water transfer to urban areas resulted in a 37 % and 5 % decline in the yield of water melons and staple crops, respectively. Similarly, in the Jordan Valley, the transfer of freshwater to the urban areas and subsequent relatively unplanned transfers that replaced freshwater with reclaimed water has constrained the crops that can be grown in the Middle Valley. For example, stone fruits and vines are susceptible to the relatively high levels of chloride (McCornick, Grattan, and Abu-Eisheh 2003). Those farmers receiving reclaimed water pay half the service fees of those with access to freshwater. A study on the effect of the transfer of 10 % of agricultural water to urban use in San Diego, California reported that the worst case would reduce water for some by as much as 25 %. Such a reduction in water availability would result in a personal income reduction of 5 %, and an increase in average unemployment of the counties of 1.3 %, and in farm employment of 3.9 %.

What Facilitates or Constraints Water Transfers?

The determinants of a water transfer can be grouped into three categories: (a) the natural and human factors that influence the quantity demanded and available supply; (b) the willingness and ability of the water donors and recipients to negotiate and implement the transfer; and (c) external factors that influence the water transfer institutions.

Water Demand and Supply

Water transfer is a response to the growing mismatch between water demand and supply. The water may be transferred to reduce flood damage to a downstream location, but it is generally transferred because there is a water deficit area that can benefit from the excess water available elsewhere. Human needs, how the needs are met and how the available water is managed combine with natural factors to determine water demand and supply. In general, increasing water demand associated with export and local consumption of agricultural produce in a water deficit area increases the demand for water transfer. For example, in the Spain case study, the flourishing agriculture produce export and local trade in the Segura Basin was the main driver of irrigation water requirements and groundwater overdraft.

Willingness and Ability of Water Donors and Recipients to Implement the Transfers

The willingness and ability of water donors to engage in a water transfer scheme depend on the availability of surplus water and the rationale for sharing and exporting water to the water recipients. The easiest water to transfer is the surplus water (renewable water resource less the sum of what is currently and likely to be used in the future and what is required to flow to the river outlet and satisfy other environmental requirements). However, regions/basins with large quantities of excess water are few. Canada, Brazil, Democratic Republic of Congo and Nepal are among the few countries with huge quantities of surplus water. In most other cases, for example, the Mekong Basin, where excess water is available only during the rainy season and huge storage capacities may be required to even the flow. In other cases, the surplus water is not so huge, but opportunities for augmenting it exist through some form of water saving practices, although this is becoming less viable as basin level efficiencies are already relatively high in many basins in the arid and semi-arid parts of the world. The water donors participate in water transfer because of: (a) the direct economic gain as in the case of Lesotho; and (b) indirect gains as part of a grand plan for regional cooperation as in the case of Egypt and Turkey's willingness to transfer water to the Middle East (Dinar and Wolf 1997; Tesfaye 2001), driven by interests beyond the immediate region.

The recipient basin/region will be willing to participate in the water supply if the perceived future benefits are high and the costs of importing water is much less than the cost of water demand management. This is particularly so in the case of transboundary water transfers (see Lesotho case study), but in the case of national water transfers the government may be willing to subsidize the project as in the case of China, Spain, Brazil and the United States, and is effectively a major driver for developing the transfer. We note that while it may be easier to implement a transfer with a strong federal government presence, the long-term sustainability may be more assured with a strong state involvement.

High transaction costs and risks are the two main factors that can dissuade potential partners in water transfer. Transaction costs may include: legal fees; costs of public agency review; costs of required technical studies; and costs involved in settling claims from third parties. Risks may be related to climatic changes, to unilateral actions of water donors that might reduce the amount of water available for transfer, and to structural failure, particularly for long distance water transfers.

External Factors that Influence the Water Transfer Institutions

The main external drivers that we consider are associated with government and lobby groups. In the case of within national water transfer, the level of government commitment and financial support is a major driver as evidenced in the Brazil, China and Spain case studies. In all case studies, federal, state and local governments play a critical role in creating enabling conditions that improve the prospects for water transfers by: (a) improving information and facilitating consultations and negotiations regarding transfers and transfer impacts; (b) ensuring that there is a credible process for managing third party impacts; (c) reducing the transaction costs associated with water transfers; (d) increasing the probability that acceptable water transfer will be successful; and (e) securing funds for the transfers. In most cases these conditions may not be met, leading to sub-optimal performances.

Environmental and civil society lobby groups have also played a key role, particularly in highlighting the negative social and environmental impacts and the need to consider other alternatives to water transfers. Their role is particularly conspicuous in the Brazil and Spain case studies where they challenged the credibility of the costs and benefits of the proposed water transferred, and argued that there were cheaper alternatives in which the government resources could be invested to achieve the same goal but had not been considered.

What Institutional Arrangements Facilitate Transfers Best?

There is growing evidence that water transfer will continue to take place (Tumbare 2001; Davis et al. 1993, ICID 2006). The key question is what institutional arrangement will be required to facilitate the development of environmentally, socially, economically and politically acceptable water transfers. The case studies illustrate that changes in policy, legal and organizational frameworks are needed to: (a) defer water transfers where water demand management options are more economical; (b) secure water rights and facilitate their effective transfers so as to reduce risks and protect the rights of the poor and the environment; (c) protect third parties from the negative impacts of water transfers; (d) facilitate effective consultations and negotiations; and (e) provide incentives for lending agencies and the private sector to participate in water transfers. The precise nature of reform and instruments to be deployed will vary from area to area depending on the relative water scarcity, level of agricultural intensification, nature and extent of negative impacts, level of economic development and organizational capabilities.

Several countries have explicitly incorporated water transfer clauses in their water act and policy. South Africa is a good example. Their water policy states that: "*Inter-basin transfers will have to meet special planning requirements and implementation procedures, which must involve agencies from both donor and recipient catchments. Catchments to which water will be transferred will have to show that the water currently available in that catchment is being optimally used and that reasonable measures to conserve water are in force.*" This policy change has influenced the development of water transfer schemes by ensuring that water demand management approaches forestall water transfers and allow available funds for infrastructure investment to be focused on priority areas for service expansion (UNDESA 2005).

At a transboundary level, water transfer should be seen as part of a broader cooperative agreement. In southern Africa, the regional cooperation has created the enabling conditions for consultation and negotiations on water transfers by: (a) having a broader technical, commercial, political cooperation which helps in building mutual trust; (b) having negotiators who can be trusted; and (c) by having a framework for information sharing and research. Given that each basin state is entitled to an equitable and beneficial share of the water and the need to manage it sustainably, river basin institutions should promote understanding and mutual trust between the parties. The parties must: (a) establish potentials and alternative strategies for achieving those potentials; (b) discuss mutual expectations and fears; and (c) negotiate on the most desirable strategies. Long- and short-term river basin plans are needed to adequately define feasible options and prepare the stakeholders to raise their concerns and ensure that they are incorporated in the next basin plans. This can contribute to developing a shared vision and also in opening other opportunities for cooperation such as trade. Such plans can form the basis for improving cooperation (Saddoff and Grey 2005).

What Principles, Approaches and Processes Should Guide Planning?

Successful water transfer schemes are generally considered to be environmentally, economically, socially and politically acceptable. By using accepted principles, correct approaches and effective processes you ensure that major economic, ecological, social, cultural and political issues are adequately addressed.

Water transfer planning should be guided by acceptable hydrologic, ecological, economic and social principles. Most of these are already an integral part of water resources planning and management. The case studies illustrate the need to take into consideration all the principles and, specifically, the solidarity[19] and precautionary[20] principles.

Many water transfer projects have been criticized for failing to take a holistic approach to problem, opportunities and solution analysis. For example, the Brazil case study illustrates a failure to explore other options to achieve the desired socioeconomic development and only focus on water transfer as the main driver of economic development. In the Spain case study, it was argued that water-demand management would be more cost-effective than augmenting water by water transfers. In the case of the Aral Sea water transfer, some of the contentions revolved around the reservoir operating policy and its effect on the benefits derived from hydropower and irrigation and as to who received the benefits. We, therefore, argue that using the correct approaches will improve the changes in planning acceptable water transfers.

Water transfers generally take a long time to accomplish. The processes followed in the pre-feasibility, feasibility, design, implementation and operation and maintenance should ensure continuity, and have an inbuilt flexibility to take into consideration new insights, data and analytical tools. The processes followed should take into consideration the fact that water transfers issues are shaped by the context, information, assessment, consultation and negotiation. Regular and well-structured debates should be part of the processes that help clarify and agree on the vision, goals, targets, problems and opportunities, possible interventions, criteria to be used in selecting the most appropriate interventions and the required monitoring, evaluation and adaptive management. We surmise that most water transfer controversies can be resolved by using the right process, at the right time and within the right context. Such idealistic conditions can only be achieved through a gradual process of adaptive management.

[19] Principle of solidarity – Solidarity of those who have the resource and give it up to those who lack it, thereby contributing to the creation of employment and wealth creation for the country/region that is beneficial for all.

[20] The Precautionary Principle is also reflected in Principle 15 of the United Nations Conference on Environment and Development (UNCED): it states that ‘Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

How Can Research Contribute?

Water transfer controversies are generally fuelled by lack of a good understanding of the complex system, and how water transfer will impact people and the ecosystems they depend on. The primary responsibility of research is to improve stakeholders' understanding of the economic, ecological, social, cultural and political issues associated with water transfers, and present feasible solutions to the problems that may emerge. Other important contributions are developing tools and methods for generating and applying information on contentious issues such as: (a) dispelling the myths; (b) risk and uncertainty associated with human behavior, politics and climate change; and (c) water and water-related benefit sharing. In practice, this is not happening, partly due to the disconnection between researchers and those involved in planning and implementing water transfer projects.

Conclusions and Lessons for the NRLP

Conclusions

The case studies illustrate the fact that the water transfer context changes. First, changing political, governance and trade contexts create opportunities and challenges for shifts from unilateral to cooperative actions. The shift from water sharing to hydro-solidarity, best joint utilization and benefit sharing is also providing additional impetus for cooperative actions. Under cooperative action, water transfer schemes are more acceptable in keeping with the solidarity and benefit sharing concepts. Second, land use intensification (in situ moisture conservation, runoff control, small dams) is increasing evapotranspiration and groundwater recharge resulting in unplanned/unintended water transfers. Third, there is a growing recognition of the high potential for areas experiencing water scarcity to use demand-management approaches instead of relying on inter- and/or intra-basin water transfers. Virtual water transfer can increase or decrease the demand for water transfers, depending on what the recipient basin imports and exports and its water demand implications. In all cases, there is a need for rigorous planning that considers the likely trajectory of water use, what can be realistically expected from demand-management and other non-physical interventions, and develop reasonable plans for the prudent development of transfers, where appropriate.

In situations where there are suitable sources of surplus water and a growing demand in a water deficit area, it is not a question of whether the transfer will occur or not, but rather when, and how much water will transfer and how to implement the transfer in ways that reduce negative impacts. We, therefore, argue that good economics (benefits higher for all), good politics (reduce conflicts, assess whether plans will yield equitable and reasonable benefits) and good environmental management are pre-conditions for acceptable water transfers. Achieving this is generally not easy as illustrated by the case studies we reviewed.

Based on the analysis of the case studies, we surmise that water transfer schemes are more likely to succeed where: (a) the recipient basin/area is utilizing its water efficiently through appropriate demand-management, and that the proposed water transfer is the most cost-effective means of securing additional water; (b) the donor basin has enough water to meet its current and future needs (including environmental) and a surplus that can be transferred; (d) environmental and social costs in the areas donating and receiving the water and in the areas/facilities linking the exporting and receiving areas can be reduced to acceptable levels; (d) cooperation and benefits sharing arrangements that result in a 'win-win' or at least 'win-no lose' situations can be established; and (e) the processes and structures create an enabling environment for effective consultation and negotiations and for more effective strategic and pro-active approaches to address emerging challenges and opportunities.

Lessons for the NRLP

The key lessons for the NRLP are:

1. A wide range of water transfer options exist depending on the objectives, geographical scope, route, arrangement and operation criteria of the water transfer scheme. This increases the flexibility of integrating water transfers with other water management strategies and of implementing water transfers in the most prudent ways.

2. In most cases, cost-effective mitigation measures now exist but have not been highlighted in the planning stages nor implemented in part because the approaches proposed are viewed as unrealistic and burdensome by the decision makers, and also because the incentive structures for and political interest in large-scale developments dissipates once they are operational. The subsequent non-performance of the mitigation measures and inadequate information on the positive effects of the project after development, results in a general negative perception of the impact.

3. High transaction costs and risks are the two main factors that can dissuade potential partners in water transfer. Transaction costs may include legal fees, costs of public agency review, costs of required technical studies and oversight of the implementation, and costs involved in settling claims from third parties. Risks may be related to politics and associated conflicts, to climatic changes, to unilateral actions of water donors that might reduce the amount of water available for transfer, and to structural failure particularly for long distance water transfers.

4. Water transfer options can only be explored comprehensively and their acceptability negotiated if there is an enabling environment. The following institutional changes may be required: (a) legislation that stipulates that the minimum flow requirements of the donor basin are met, and that the recipient basin must prove that it has used every reasonable method to develop and conserve its own resources before looking outwards; (b) creation of the offices of environmental and water transfer ombudsman through which grievances may be aired and credible information sought and effectively used to inform consultations and negotiations; (c) use of innovative water transfer arrangements such as water banks and markets; and (d) appropriate water, cost and benefit sharing arrangements.

5. Effective planning, design and implementation are constrained by inadequate understanding of the system, and how it is likely to respond to hydrologic changes induced by the water transfer. The process is further constrained by: (a) lack of

comprehensive impact studies, follow up monitoring and adaptive management; (b) inadequate coordination of environmental, engineering and socioeconomic studies; (c) geographic or issue bias depending on data availability and political influence; and (d) the divergence of opinions, and in some cases reluctance to change, between those for and those against the transfer. Tools and methods are needed to improve the understanding of such complex systems and their responses and to facilitate the use of credible information in the complex consultation and negotiation processes. Guidelines on how to plan, design and implement acceptable water transfer schemes would ensure that consistent approaches and methods are applied and, thereby increase the chances of arriving at a consensus on water transfer impacts.

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Appendix 1.

Impacts by Zones

Zone	Hydrologic changes	Environmental	Social-economic
Water contributing area in the donor basin		Barrier to migration of fish species Loss of some species	
Zone downstream of the diversion point	Reduced flows	Sedimentation Down-cutting of tributaries due to decreased base flow Higher concentration of pollutants Increased geostatic loading (seismicity) Reduced availability of important fish food organisms	Reduced fish catches Reduced flood plain usage Loss of flood plain agriculture
Water transfer route zone	Increased seepage loss and groundwater recharge	Water quality deterioration in open canals Salinization due to seepage Transfer of disease vectors and pathogens Increase mosquito habitat Introduction of alien species	Increased health risks Loss of or damage to sites of archaeological, historical and cultural values Loss of homelands and culture of indigenous people
Zone below water transfer point in the recipient basin	Increased flow and changes in seasonality of flows Heightened flood peaks Increased groundwater level	Reduced bank stabilization as a result of increased flows Reduced deterioration of estuarine and inland sea system Increased sedimentation Dilution of effluents	Increased flood plain usage Loss of homelands and culture of indigenous people
Zone upstream of water transfer in the recipient basin			
Other outside these zones but dependent on goods and services derived from these zones.			