

Policy options

Arias, E., Boone, A., Chia, D., Vargas, A., Gao, J., Becerra, M., Muñoz, C. and J. Sáinz

This section aims to identify feasible policy options that target key components identified in the Causal chain analysis in order to minimise future impacts on the transboundary aquatic environment. Recommended policy options were identified through a pragmatic process that evaluated a wide range of potential policy options proposed by regional experts and key political actors according to a number of criteria that were appropriate for the institutional context, such as political and social acceptability, costs and benefits and capacity for implementation. The policy options presented in the report require additional detailed analysis that is beyond the scope of the GIWA and, as a consequence, they are not formal recommendations to governments but rather contributions to broader policy processes in the region.

This report recommends four options to secure at least a portion of the annual flow requirements for the delta ecosystem. The options have been categorised into short-term (less than 5 years), medium-term (5-10 years), and long-term (greater than 10 years) periods. The short-term option is to lease water rights from farmers in the Mexicali or San Luis Rio Colorado Valleys (District 14). Since existing Mexican laws and regulations allow for the lease and transfer of water rights for conservation purposes, this is the most expedient method to secure a guaranteed water supply for the delta.

The medium-term proposal is to buy or lease water rights in the United States and transfer the water to the delta. Since significant legal barriers (e.g. the 1944 U.S.-Mexico Treaty) exist to prevent the transfer of this water to Mexico, it may not be feasible to implement this option in the near-term. However, there are serious equity concerns regarding the exclusive purchase and leasing of water in Mexico, therefore the amendment of a Minute to the 1944 Water Treaty is recommended.

Finally, for the long-term, the implementation of water markets to increase the efficiencies of water use in Mexico is proposed, and the elimination of electricity subsidies to farmers in order to motivate them to use less water, thereby “freeing up” water potentially available for the delta. At the same time, farmers would benefit from these changes by being able to market their water savings. Deep-seated institutional and political obstacles may very likely challenge any attempt to push these options forward. Thus, a long-term horizon is an appropriate way to frame their potential implementation.

Any solution to secure a guaranteed flow of water for the delta must come from existing users in the United States and Mexico. This is due to the fact that the River is already over-allocated; there is simply no more water to allocate. However, getting this water will undoubtedly be challenging considering the fact that agricultural interests, the largest users of water, are powerful and politically well connected, as are municipal users. Moreover, since existing users are not likely to voluntarily give up water for the good of the delta, any non-voluntary effort must involve a reallocation of water under the auspices of the Law of the River, an effort that is almost certainly doomed to fail.

Moreover, it is strongly emphasised that any strategy to obtain a guaranteed source of water must be bi-national; that is, both countries should bear the ultimate responsibility of restoring the delta ecosystem. As eloquently stated by Glennon and Culp (2002):

“The historical context must inform any solution to the Delta problem. Mexico has seen one of its largest rivers, wealthiest agricultural districts, and most important fisheries dried up, or salted up, by U.S. development upstream. From a Mexican perspective, the Mexico-U.S. Water Treaty--negotiated during a period of U.S. dominance and relative Mexican weakness--was substantively unfair. In the intervening years, the U.S. has consistently denied responsibility for the harsh environmental,



Figure 21 Colorado River Delta and the Upper Gulf of California.
Irrigation and urban sprawl now prevent the River from reaching the Gulf, which can be seen in solid blue at the lower right hand corner of the image.
 (Photo: NASA)

social, and economic impacts to Mexico of its development policies on the Colorado...Of the 17.5 maf of Colorado River water that is allocated...the U.S. claims 16 maf--around 92 percent...To use only Mexico's apportionment to save what little is left of the Delta heaps insult upon injury. Equity requires that the burden of water needed for restoration be shared between the two countries."

Consistent with this perspective, options that can be implemented in both Mexico and the U.S. are proposed. Below each option is described and general steps to implement each option are further discussed.

Short-term policy options

Lease water rights in the Mexicali and San Luis Rio Colorado Valleys and transfer associated water to delta ecosystem

This option involves the leasing of water rights in District 14 as the primary mechanism in Mexico to secure a guaranteed annual water source for the delta. This option can be implemented immediately as existing Mexican laws currently allow water transfers for conservation

purposes. Other mechanisms to secure water include permanently purchasing water rights or land with associated water rights. However, as explained below, at this point, the most expedient and economical option is to lease water rights since farmers are reportedly opposed to selling their land and by extension, their water rights. This section briefly describes the legal basis for leasing and transferring water rights and the steps that generally should be taken to implement this option.

Legal basis for leasing water rights

Essentially all the water available in District 14 is defined as national waters, falling under the jurisdiction of the Mexican Water Commission (Comisión Nacional de Aguas, CNA). The Mexican government first allocated water rights in this district in 1938 (Clark et al. 2001). These rights are tied to the land and allocated commensurate with the size of the parcel. In most cases, a water rights holder receives enough water to irrigate a 20 ha parcel. However, depending on the availability of water, this amount can vary from year to year (IBWC 1944).

In 1992, the Mexican government passed a National Water Law (NWL) to legalise the purchase or lease of water between private parties. Water rights may be converted from an agricultural use to other uses (e.g. ecological purposes) as long as CNA approves the change and law permits the new use. When approved, a water (or irrigation) right is converted into a concession title and is valid for a period of 5 to 50 years. The concession title must then be registered in the Public Registry of Water Rights, created by the NWL as a way of legally proving the existence and status of a title. As of May 2001, CNA has never been requested to approve the transfer of water for ecological purposes. However, Clark et al. (2001), and Carrillo (2002) report that CNA officials in Mexicali generally would approve such transfers assuming the requirements of all laws and regulations are fulfilled.

The Mexican National Water Commission

Mexico's National Water Law (NWL) serves as the basis for the management of national waters. The National Water Commission (CNA) is the federal agency designated to implement the policies of the NWL and develop associated regulations. To manage water allocations, CNA has divided water management districts into geographic modules. Each module is governed by a local government entity that is responsible for the management, operation, and maintenance of the module's water distribution canals. Each module submits its water order to CNA who then delivers the order to the external boundary of each module. The module employs *zanjeros* (ditch riders) who make the final delivery of water to individual parcels. In District 14, CNA allocates water rights based on the assignment of regional and national cropping patterns.

Thus, if a farmer grows a more water-intensive crop, he receives a greater amount of water.

This system reportedly operates effectively while minimising illegal water diversions (Carrillo 2002). However, Clark et al. (2001) recommends: "If the CNA canal system and delivery ditches within the modules are to be used to deliver water to the Delta ecosystem, it is imperative that an advocate for delivery of the Delta water be an active participant in the governance of the participating module or modules".

Step 1: Inventory available water

Initially, it is recommended that an inventory of available water supplies for lease in District 14 should be conducted. The Sonoran Institute of Arizona is currently carrying out this task by focusing on those parcels that have not been under production for three to five years (Zamora-Arroyo pers. comm.). According to the Institute, if farmers do not use their land or water rights for agricultural purposes for four consecutive years, they may lose their water rights. Therefore, the above timeframe should provide a rough estimate of the total amount of water potentially available for lease.

Step 2: Lease water rights from willing farmers

After this inventory is available, individual farmers can then be approached to gauge their interest in leasing all or some of their water allotment. Alternatively, where appropriate, advertisements could be placed in newspapers or in the offices of CNA or modules. The price of water may be determined through three methods: (i) a standing offer; (ii) individually negotiated contracts; or (iii) through an auction (Pitt et al. 2002).

Carrillo (2002) surveyed farmers within and outside District 14 to assess their attitudes and willingness to lease their water rights or retire their land for delta conservation purposes. For this reason, the survey was limited to farmers owning land adjacent to the River or its levees; that is, land which is the most suitable for riparian or wetland restoration. The results of the survey indicated that 87% of the farmers surveyed with water rights are willing to lease them for purposes of maintaining and enhancing native riparian vegetation. Of 663 ha of irrigated land owned by these farmers, the water rights associated with about 214 ha could be available for leasing. This amount of water is approximately 2.14 km³ and the cost to lease this water is between 54 and 271 USD/ha/year or approximately between 8 210 and 41 400 USD/m³/year. Thus, using these figures, the cost to secure an annual flow of 39 million m³ of water would range between 213 100 and 1 073 600 USD.

Purchasing water rights or land with water rights attached is another option to secure water for the delta. Based on preliminary estimates,

the cost to permanently purchase water rights in District 14 is approximately 1 000 USD/ha or 152 000 USD/m³ (Zamora-Arroyo pers. comm.). Thus, the total cost to purchase 39 million m³ of water would be 3 950 700 USD. While a significantly greater upfront payment is necessary, purchasing water rights would be the most cost-effective approach as benefits can be permanently guaranteed. Compared to leasing water rights, one would break-even by purchasing water rights after approximately the fourth year of leasing (using the upper end of leasing costs). However, according to the survey by Carrillo (2002), almost all farmers contacted (96%) would be unwilling to sell their land "...because it is the only legacy they could leave to their children" (Carrillo 2002). With this in mind, high resistance to purchasing water rights may also be encountered assuming farmers wish to leave a legacy that involves the use of water. Nonetheless, because of it is more cost-effective than leasing water rights; this option should not be dismissed, as some farmers may be willing to sell their water rights.

Further steps

With adequate funding from the Global Environmental Facility (GEF), a NGO could implement a water rights leasing programme in Mexico. As discussed above, the Sonoran Institute is initiating such a programme by inventorying available agricultural water supplies in District 14. After leasing water rights, the NGO is expected to monitor the delivery of leased water to the delta through the local CNA office, the responsible entity for delivering water to the delta. As recommended by Clark et al. (2001), representatives of the NGO should also establish relationships with the leaders of the module(s) in which the water rights were leased (Clark et al. 2001). Considering the precedent-setting nature of such a programme, it is important that the NGO gain the trust of the leaders of the module and the community at large.

Unresolved concerns

Assuming the actual amount of water available for lease in District 14 is consistent with that which Carrillo (2002) identified (2 million m³); this amount represents only 5% of the estimated 39 million m³ in annual flow needs. In order to meet this need, the balance would have to be made up from U.S. or other sources. Nonetheless, even limited guaranteed flows to the delta could benefit existing riparian or wetland habitat during periods of drought (Carrillo 2002).

Although this report does not address the potential economic effects of this option, they should not be ignored. It is expected that farmers would participate in a water-leasing programme if they expect to receive greater economic benefits than those received from farming. Farmers with water rights that are currently not farming would likely be most interested in participating. However, to the extent that the

programme offers a leasing price high enough to encourage farmers to stop farming, there could be adverse economic consequences.

Moreover, this option does not address the documented need for periodic flood flows in order to inundate the floodplain and produce responses in native riparian vegetation. Zamora et al. (2001) recommend that when surpluses arrive in the River, they be delivered as flood flows to the delta. The U.S. Department of Interior (Bureau of Reclamation) and the International Boundary and Water Commission (IBWC) would likely be the most appropriate entities capable of addressing this need. More specifically, new surplus criteria should be developed to allow environmental considerations to be taken into account when deciding how annual surplus flows are allocated.

The results of Carrillo's (2002) survey indicate that Mexican farmers realise the importance of in-stream flows and are willing to participate in water leasing or land retirement programmes that would provide these flows to the delta ecosystem. In addition to financial gain, farmers also understand that healthy riparian forests minimise the loss of farmland to erosion during flood events by providing stabilising riverbanks. Other farmers acknowledge that by converting their land to wetland or marsh habitat, they could, with expert advice, also explore other uses of their land such as small-scale aquaculture operations or ecotourism activities such as bird watching and camping (Carrillo 2002). This willingness holds much potential for a water leasing or land retirement programmes that could ultimately be expanded to a greater level with community, NGO, and government support and funding. At the same time, efforts to assist farmers in developing economically viable alternatives to farming should also be encouraged.

Sub-category: Grant subsidies to farmers in the U.S. and Mexico for implementing water conservation measures

In exchange for subsidies farmers could dedicate rights to water saved. This water could be diverted into the delta.

Mexico is experiencing a serious problem of water waste, especially in the agricultural sector. According to CNA (2001) 83% of the water in Mexico is dedicated to the agricultural sector. Of this, water loss fluctuates between 30% and 50%. One of the explanations for this water waste is the lack of resources to implement conservation measures. This is one of the reasons farmers get less water for their production activities, especially in areas where scarcity prevails. Implementing water conservation measures could help increase the quantity of water received in the agricultural sector, and thus farmers could divert water into the delta for conservation purposes.



Figure 22 Irrigation system, California, U.S.
(Photo: Corbis)

Potential for water conservation in the agricultural sector

According to Pontius (1997), water conservation is the most effective tool in demand management and often the cheapest source of new water supplies. Water conservation measures are one of the least expensive methods to provide water for growth and to assure an adequate supply for the future. Evidence suggests that there is much potential in the Lower Colorado River Basin (U.S. and Mexico) for effective water conservation in the agricultural sector. Farmers would also save money from reduced water pumping costs.

Payment of environmental services

PROCAMPO operates through direct payments to communities that participate in the conservation of the environment. That is not to say that every subsidy produce negative effects. Subsidies could be a good government option if they cover three criteria: (i) increase income levels of poor people (equity); (ii) do not distort the market (efficiency); and (iii) incentive environment protection. These three aspects could be covered under a scheme of Payment for Environmental Services (PES), where farmers get a payment if they follow the conservation

practices stipulated in a contract. This programme has been used mainly to provide incentives for forest conservation, oriented to the production of environmental services such as improvement of water quality, and biodiversity conservation or carbon capture (SAGARPA 1998). Other subsidies of this kind would be payment in exchange of PES, where individuals voluntarily refrain from certain uses that impact the environment in his property.

The importance of technological measures

It is very important to balance available water resources between users, especially if the demand for water is increasing. The technological methods that can be used to improve the conservation of water in the agricultural sector are as follow: better maintenance of existing irrigation systems, information management techniques, altered tillage and soil management, or changes in cropping patterns (e.g. reduce acreage, switch to less water intensive crops).

The structural methods for the same purpose are: replacing open ditches with underground pipe, lining ditches, use of gated pipe, fitting

gated pipe systems with surge-flow devices, conversion from furrow to sprinkler irrigation or drip irrigation, upgrading existing sprinkler systems, and installation of tail water recovery systems.

Morrison et al. (1996) suggested that approximately 1.73 km³ of water savings could be achieved by the agricultural sector by investment in irrigation efficiency and retiring marginal land. The California State Water Resources Control Board found that the Imperial Irrigation District could save up to 0.49 km³/year with irrigation efficiency improvements.

Water transfers

Water transfers of this kind are becoming more common in California including a proposed agreement by the San Diego County Water Authority and Imperial Irrigation District to “free up” 620 million m³ of water. However, in order to transfer water to Mexico, a Minute to the 1944 Mexico- US Treaty would have to be executed.

Political feasibility

In order for the farmers to dedicate water to the delta and not keep the water for their own use, they have to have the right incentives. As previously discussed, the leasing of water rights is an incentive to save water. For example, the IBWC (2003) through Minute 309, has given approval for the technification project of Delicias Irrigation District in Mexico, which is presently under way to transfer volumes of water saved (396 million m³/year) that will eventually be incorporated waters down of the Rio Conchos to Delicias Irrigation District and afterwards sent to the Rio Bravo in the U.S. (COCEF 2002).

Medium-term policy options

Purchase or lease water rights in the United States in order to use the water for ecological purposes in the Colorado River Delta

Water transfers, or the purchase or lease of water, are an important and successful tool to redistribute water between geographic areas or between user groups. Water transfers such as those between the Central Arizona Project and other southwestern states have allowed for the redistribution of water that would have otherwise not been feasible because of the rigidity of the Law of the River. The purchase or lease of water rights in the U.S. may provide a significant portion of the annual flow needs of the delta, although there exists legal challenges to transfer the water between the Lower and Upper River basins and between the U.S. and Mexico. Because agricultural production in this region is of low value and uses water inefficiently, the purchase or

lease of water represents an economically feasible way to ensure water for the delta.

Legal basis and needed changes for the purchase or lease of water in the U.S.

Existing law establishes a strong foundation for this policy option. Under current U.S. law, water rights may be purchased or leased without buying the property to which the rights are assigned. However, property owners who have weak or junior water rights (those which have legal standing after water allocation to senior rights holders have been fulfilled) may be at a disadvantage to those with more secure rights and may receive a lower price for their water.

Despite this foundation, there are legal challenges to the transfer of water between the Upper and Lower Basin states and between the U.S. and Mexico. The Colorado River Compact of 1922 allocates 9.25 km³ of water to both the Upper (Colorado, Wyoming, Utah, and New Mexico) and Lower Basin states (Nevada, Arizona and California). If water is to be transferred from the Upper Basin for restoration of the delta, the Compact may need to be amended in order to overcome political opposition from Lower Basin states.

Lease or purchase rights from willing farmers

Agricultural production in the Colorado River Basin is often of low value and consists of water intensive crops such as wheat and upland cotton which return approximately 35 USD and 40 USD per million m³ of water, respectively (Pitt et al. 2002). A recent report has estimated the cost of leasing water in the Wellton-Mohawk Irrigation and Drainage District in Arizona as 53 USD per million m³ plus an incentive payment. It would cost approximately 2 million USD per year to provide the delta with an estimated annual flow of 39 million m³ (Lueck et al. 1999). The cost for purchasing water in the Wellton-Mohawk is estimated to be about 10 times the cost of leasing it or about 530 USD per million m³, excluding incentive payments (Pitt pers. comm.). Therefore, the estimated cost to purchase water rights equivalent to 39 million m³ would be 17 million USD. It is believed that securing permanent water rights will be significantly more difficult than leasing because it limits the options for agricultural production on the property.

Institutional capabilities

With adequate funding a non-profit or governmental entity could be charged with identifying available water to purchase or lease in the U.S. This entity would purchase/lease, hold, and monitor the delivery of the water to the delta. The proper price of water may be determined through three methods: (i) a standing offer; (ii) individually negotiated contracts; or (iii) auctioning (Pitt et al. 2002)

In the Upper Basin, it is impossible to quantify how much water each farmer uses because of a lack of gauging stations at individual parcels. The use of water is determined by comparing historic outflows (as a proxy of current inflows) to present-day outflows. Overall, Upper Basin usage is determined by what is used downstream, severely limiting the extent to which water rights purchased in the Upper Basin may be enforced.

At the Mexican border, the IBWC would be responsible for ensuring that the purchased amount of water reaches the delta. A stream gauge station should be located near or at the delta to aid in monitoring. The IBWC has recently asserted its interests in ecological issues through Minute 306, passed in 2000 (IBWC 2000), that provides a framework for bi-national cooperation in carrying out scientific research on the delta ecosystems. The Minute establishes a “framework for cooperation” to address ecological concerns of the delta and suggest possible alternatives for restoring the delta. The process would include the “formulation of recommendations for cooperative projects” (IBWC 2000). The Minute represents a substantial leap forward towards the restoration of the delta.

The entity holding the water rights must have the institutional capability to ensure, by checking stream gauge readings and water records, that IBWC is delivering the appropriate amount of water to the delta. In addition, experts believe that independent observers may be necessary to ensure unbiased monitoring (El caso del agua dulce en Mexico 2003).

Political feasibility

Despite the fact that the water transfers are voluntary and economically feasible, there may be political opposition to this policy option because of the enormous pressure on the Colorado River's resources. The Upper Basin states may oppose water transfers because it would signal that they are not using their entire allocation of water for “beneficial consumption”, opening up the possibility of a reallocation between basins. In addition, the Lower Basin states may oppose the transfer because they currently benefit from water that the Upper Basin does not use and therefore flows into their states. Water transfers would effectively mean that the Lower Basin states would have to pay for the water they are now receiving for free (Culp 2001). However, it is conceivable that water transfers for ecological purposes, as public goods, would not cause the political opposition that other water transfers may provoke.

On the other hand Glennon and Culp (2002) note that, while individual farmers within the Wellton-Mohawk Irrigation District might be

interested in selling water, the District itself is on record as opposing the sale or lease of its water and, under Arizona law, it has a veto power over sales by individual farmers to parties outside the district.

Despite the political and legal barriers to voluntary water transfers from the U.S. to the delta, this policy option represents a way in which water can be transferred to the delta without the need to renegotiate the Law of the River. Due to inefficiencies in agricultural production in the Colorado River Basin and the opportunity for farmers to benefit financially, a water transfer programme could address the needs of the delta ecosystem and water interests in both countries.

Sub-category: Amendment of a Minute to the 1944 Water Treaty for ecological purposes

Minute 242 to the 1944 Water Treaty already addresses the problem of salinity, while Minutes such as 261, 264, 270, 273, 295 and 298 already deal with various border sanitation issues. What is needed, more specifically, is an ecological Minute to the 1944 Treaty that addresses the full water cycle of the Lower Colorado River Basin as it relates to the native flora and fauna of this massive riparian ecosystem.

Legal basis for amending a Minute for ecological purposes

The U.S. National Environmental Policy Act (NEPA) requires all federal agencies to prepare an environmental impact statement (EIS) for all actions that significantly affect the environment.

The U.S. Fish and Wildlife Service (FWS) and all other federal agencies must ensure that their actions do not jeopardise the continued existence of or adversely modify the critical habitat of all listed species under the U.S. Endangered Species Act (ESA).

Particularly relevant to Mexico is the ESA requirement that federal action agencies such as the U.S. Bureau of Reclamation must consult with the FWS on any action that might jeopardise a listed species; the Totoaba, Vaquita porpoise, Desert pupfish, Yuma clapper rail, and Southwestern willow flycatcher are among the Mexican resident or migratory species listed under the U.S. Endangered Species Act.

In addition, the Colorado River is governed by the Law of the River; Mexico is an integral component of the Law of the River itself, through the 1944 U.S.-Mexico Water Treaty. In this way Mexico, entitled user of the Colorado River under International Law, has the right to negotiate over water resources of the Colorado River if the upper riparian state (U.S.) affects in any way the natural resources of the lower basin state (Mexico), in which case the construction of dams in the U.S. has affected the natural conditions of the Colorado River Delta and its ecosystem.

The Treaty of 1944 would need to be amended through a Minute of the IBWC to allow water to flow from the U.S. into Mexico in excess of the 1.85 km³ currently provided through the Treaty. For example, the Treaty of 1944 could be amended through a “congressional-executive” agreement that would accomplish the same results as a full-fledged amendment to the Treaty of 1944. However, it would be more politically feasible as it only requires a majority of both the U.S. House and Senate rather than a two-thirds vote required of the Senate for a treaty amendment. The minute will be able to overcome legal challenges raised by individual states because it is an executive agreement and as such, supersedes any conflicting state laws.

Political feasibility

Although many states will oppose the amending of a Minute to the Water Treaty regarding additional supplies of water for ecological purposes, it is quite comprehensible that actions to restore the delta consist of cooperation between both countries. In this way the U.S. in part should proportion part of the solution that is needed for restoration and maintenance of the delta.

Salinity increases as possible alternatives to increase water flows to the delta

Glennon and Culp (2002) considered that salinity increases in the Lower Colorado Region could be a factor of new negotiations of water deliveries in the short-term, due to the adoption of the new Colorado River Surplus Criteria. The Environmental Impact Statement of the USBR regarding Colorado River Surplus Criteria, completely ignored the salinity effects on Mexican water users, and failed to provide an estimate of increased river salinity below Imperial Dam. Because Minute 242 requires an exact proportion between the levels at Imperial and Morelos dams (a difference of no more than 115 ppm ±30 ppm), the salinity levels at Morelos are far more significant than the levels at Imperial Dam. The Basin states alternative would increase the flows that reach Imperial Dam but reduce them below the dam. Therefore, the salinity levels at Imperial and Morelos will likely diverge, which could easily result in violations of Minute 242.

On this basis, if salinity exceeds the salinity levels stipulated in Minute 242, the USBR may be forced to re-open the Yuma Desalting plant facility. Due to elevated operational costs, Glennon and Culp (2002) suggest that Mexico offer the U.S. an alternative and cheaper means of reducing salinity to an acceptable level based on increasing the flow of the River, thereby generating water for the delta as an incidental by-product (Glennon & Culp 2002).

Comparative water transfer costs

The cost of permanently acquiring water rights in the U.S. is expensive, ranging from 10 to 20 times the price of leasing water rights. The cost of leasing water in Mexico will become more expensive than permanently purchasing water rights after 3-18 years, based upon the range of leasing prices. In the U.S. the cost of leasing will exceed the cost of permanently purchasing rights after 10 years. However, one must consider that leasing costs will decrease in the future due to discounting.

In addition, the cost of leasing water in the Wellton-Mohawk district is two to seven times the price of leasing water in Mexicali and San Luis Rio Colorado. The cost of purchasing water in Wellton-Mohawk is roughly 4.3 times the price to purchase water rights in Mexicali and San Luis Rio Colorado (Table 37).

Table 38 analyses the cost of providing one-half (19.5 million m³), three-fourths (29 million m³) and the full amount of annual flows (39 million m³) needed for the delta based on preliminary estimates. In addition, it analyses the difference between providing the amount of water exclusively within Mexico, exclusively within the U.S., and shared equally between the two countries.

The lowest cost option for leasing or purchasing water over all amounts is to obtain the water from the Mexicali/San Luis Rio Colorado district.

Table 37 Price of leasing compared to purchasing rights .

	Location			
	Mexicali and San Luis Río Colorado, Mexico		Wellton-Mohawk, Arizona, U.S.	
	Price (USD/ million m ³)	Total cost (USD) ¹	Price (USD/ million m ³)	Total cost (USD) ¹
Lease	6.66-33.55	213 120-1 073 600 ²	53	1 696 000 ²
Purchase	123.46	3 950 720	530	16 960 000

Note: ¹ Total cost to provide 39 million m³. ² Total cost per year.

(Source: With data from Pitt et al. 2002, Carrillo 2002, Zamora-Arroyo pers. comm.)

Table 38 Sensitivity analysis of purchase/lease allocation in the Wellton-Mohawk and Mexicali/San Luis Rio Colorado districts.

Location of purchase	Amount of water (km ³)	100% lease (USD)	50% lease/ 50% purchase (USD)	100% purchase (USD)
100% Mexico	19.5	342 000	1 220 000	2 099 000
	29	503 000	1 795 000	3 087 000
	39	643 000	2 297 000	3 951 000
50% Mexico/ 50% U.S.	19.5	621 000	3 088 000	5 554 000
	29	914 000	4 541 000	8 168 000
	39	1 170 000	5 813 000	10 455 000
100% U.S.	19.5	901 000	4 956 000	9 010 000
	29	1 325 000	7 288 000	13 250 000
	39	1 696 000	9 328 000	16 960 000

(Source: With data from Pitt et al. 2002, Carrillo 2002, Zamora-Arroyo pers. comm.)

However, the exclusive purchase and leasing of water in Mexico has serious equity concerns. It is frequently asserted that Mexico lacked bargaining power during the 1944 Treaty negotiations and thus, was under-allocated its fair share of water (Culp 2001). Therefore it is recommended that the U.S. and Mexico share purchase or lease of water rights to some degree.

Long-term policy options

Institutionalise the market for water in Mexico and convert electricity subsidies

This policy option aims at institutionalise the market for water in Mexico, convert the electricity subsidy in the agricultural sector through a cash subsidy or decoupled subsidy in order to approximate to the real price of water, as well as eliminating the price subsidies of domestic users of water.

Currently, farmers receive water at a highly subsidised rate - essentially it is free. Not only does this provide an incentive to overconsume water, but it also distorts the water market. The estimate of the real price of water could be useful to reduce information asymmetries in water transfers. The different prices of water that have been negotiated by farmers do not always reflect the "real" cost of water; in economic terms, the market price does not equal the marginal cost of providing it. Authorities estimate that most transactions are below the marginal cost. Currently water rights sold in the Mexicali Valley range between 700 and 1 200 USD per ha. The "real" costs of water are estimated between 3 000 and 4 000 USD (Oyarzabal pers. comm.).

Farmers currently receive subsidies in the price of electricity to pump out groundwater. These subsidies give farmers the incentive to overexploit this source of water. Though eliminating this subsidy may not be politically feasible, converting it into a cash subsidy could lead to greater efficiencies in use. Currently, most farmers receive cash subsidies to compensate price subsidies elimination in agricultural inputs (e.g. seeds, fertiliser) through the Program for Direct Assistance in Agriculture (PROCAMPO). With a cash subsidy, farmers could choose if they prefer to consume other goods and reduce or eliminate their consumption of underground water. In other words, farmers may be able to find cheaper sources of water thereby reducing or eliminating their consumption of groundwater while using the money they save for other purposes. Therefore, this policy can lead to the reduction of market distortions, overexploitation of groundwater, and save public resources without harming the interests of farmers.

In addition, according to the OECD (2002), "Decoupling refers to the effects of a measure, or a set of measures", a policy is decoupled if it has no or only very small effects on production and trade. A decoupled policy should not affect either production or consumption decisions (OECD 2002). Contrary to the decoupled subsidies, ordinary subsidies do not necessarily contribute to a more efficient way of production. They lack the incentives to use efficient ways of production, and the misuse of resources such as water or electricity is greater. It has been demonstrated that decoupled subsidies work better because there is compensation to the price increase, in which it is calculated how much payment is needed in order to raise the price of electricity for instance.

As discussed above, it is natural to believe that there will be opposition coming from the agricultural sector, especially because water price has not been an issue in their production decisions. However, with a decoupled subsidy this burden can be diminished. In the European Union one of the most important forms of support to the agricultural sector has been cash payment. Experts argue that these payments are more secure than a price support system, with a better guarantee behind them (Frawley & Keeney 2000). This option may be politically feasible if the cash payments can indeed improve production in the agricultural sector. Therefore, this option would be more feasible in the long-term, giving an opportunity to the farmers to adjust to the idea that water has a price.

As far as water price is concerned, it is proposed that the elimination of price subsidies to domestic users of water. Subsidies to export-oriented crops are difficult to modify given the possible reduction in competitiveness for agricultural products in the international markets. Similarly, modifying water subsidies for industry can affect the competitiveness of Mexico as a main recipient of foreign investment.

In order to minimise political opposition to this proposal the government can lower taxes to the general population and increase cash subsidies to the low-income population. Currently the low-income population is very well identified through a cash subsidy programme called OPORTUNIDADES. This programme targets the poorest families in the country offering cash grants if they met certain conditions (e.g. sending their children to school, go to clinics for regular check ups) (SEDESOL 2003). To meet these conditions without enhancing current disparities in water distribution, a parallel increase of water distribution to underserved areas would be necessary. The recently approved changes obligate CNA and local and state governments to expand the distribution of water to underserved areas and increase price subsidies for low-income groups. Approximately, 10% of urban population does not have access to water. Most of this population lives in poverty or extreme

poverty in Mexico. However, they are forced to pay the highest prices for water, which they purchase from mobile tanks (Roemer 1993).

However, this increase in price subsidies might be the wrong strategy to follow because it generates incentives for overconsumption and would probably represent an expensive burden to public finances. Like the farmers using groundwater, low-income groups might prefer increased cash subsidies to buy other goods while at the same time being able to cover their water needs by paying the “real” price of water.

Sub-category: Volumetric allocation

Volumetric allocation is the quantity of water per hectare that corresponds to each user registered in the user’s census (Padron de usuarios). Each association is responsible for determining the quantity; on basis of the irrigated surface rights of their associates and the volume of water that corresponds to its release point, deducing loss from canal seepage and dividing surplus volumes among the irrigated surface of all the users that conform the (Guillen et al. 1999).

Potential for water conservation in the agricultural sector

As have been described above, one of the main problems of highly subsidised water prices is that subsidies give farmers the incentive to waste large amounts of water due to a lack of control of federal agencies (CNA). A possible way to reduce water waste from agricultural use, without reducing the farmer’s share of water or changing crop patterns, is to allocate water portions volumetrically. This way every farmer or consumptive user gets a quantified measure of water and uses it efficiently, relying on the fact that they won’t be able to acquire any more water than that designated or at least at a low cost, unless they buy water rights from another stakeholder.

Political feasibility

Despite the fact that there may be political opposition to this policy option because of the enormous pressure of farmers who already have “stipulated” quantities of water, on the other hand there are new demands to give new concessions of water of an already over-apportioned river. The only way of obtaining more water for agricultural purposes is to reduce wastewater and make distribution more efficient. This could be a solution, although many farmers may oppose to volumetric allotments because it would signal that they are not using their entire allocation of water for “beneficial consumption”.

If a price is placed on water used in agriculture, farmers will begin to question the economic viability of growing water intensive crops, which may lead to a change in crop types.

Identification of the recommended policy options

This report addressed the following problem: too little water is being allocated towards ecosystem maintenance or restoration in the Colorado River Delta. In fact, neither the United States nor Mexico officially allocates any water to the delta. As a result, it has suffered considerable environmental degradation and affected the lives that depend on it for survival. Though it still supports diverse plant and animal life, including threatened and endangered species, its expanse has shrunk from approximately 7 770 km² to only 600 km²; and only 5% of its original wetlands still remain (Lueck et al. 1999).

Therefore, the short-term policy option: Lease water rights in the Mexicali and San Luis Rio Colorado Valleys and transfer associated water to the delta ecosystem, and the long-term policy option: Institutionalise the market for water in Mexico and convert electricity subsidies, are proposed as preliminary measures to assure minimal flows of freshwater into the delta. Additionally, also proposed are the long-term policy option that attempts to increase the efficiencies of water use in Mexico through market mechanisms, thereby “freeing up” water potentially available for the delta, and the medium-term policy option: Amendment of a Minute to the 1944 Water Treaty in which it specifically stipulates water deliveries for the delta as a bi-national solution to compensate for freshwater loss to the delta ecosystem. The recommendations are in priority order:

- Lease water rights in the Mexicali and San Luis Rio Colorado Valleys and transfer associated water to the delta ecosystem. In addition, grant subsidies to farmers in Mexico for implementing water conservation measures.
- Convert electricity subsidies for Mexican farmers to cash subsidies, and eliminate price subsidies to municipal water users in Mexico.
- Increase the water use efficiency in Mexico through market mechanisms, thereby potentially “freeing up” water for the delta.
- Amend a Minute to the U.S.-Mexico Water Treaty, to stipulates minimum flow rates for the delta.

Analysing the future tendencies of water use in the Lower and Upper Basin of the Colorado River, the most viable way to obtain surplus water for ecological purposes is to change agricultural water use patterns without affecting present deliveries to water stakeholders and farmers in the Mexican part of the delta. This implies changes in the actual Mexican National Water Law, regarding the time and quantity of deliveries of water for agricultural purposes.

Although there are alternatives to water surplus deliveries like the Mexicali II Project, the implication of this alternative has negative

impacts for the U.S. portion of the Colorado River Delta. Each year Mexicali discharges about 49 million m³ of effluent into the International Boundary Drain, which empties in the New River. The New River originates 35 km, south of the international boundary and flows north through Mexicali, crossing the border into California's Imperial Valley. About 70 km to the north, it empties into California's Salton Sea, a closed basin, where evaporation tends to concentrate pollutants.

To reduce pollutants that are diverted to the New River and eventually the Salton Sea, the U.S. and Mexico, agreed to build a bi-national wastewater treatment plant to be called Mexicali II. The projects objective is to treat more than 1 645 litres per second and serve a population of more than 0.5 million people (IBWC 1996). The negative implication to the U.S. is a change in the plants design, since it could discharge in the New River (U.S.) or in the Hardy River (Mexico).

If the treated water is discharged to the New River, this could possibly improve water quality conditions in the Salton Sea. But if the treated water were to be emptied in the Hardy River Basin, a considerable amount of water would no longer reach the Salton Sea, creating more environmental problems than it already has. On the other hand disposal in the Hardy River wetlands would help maintain important ecosystems in the Colorado River Delta.

Conclusions

Under international law individual states are endowed with the right to control territorial resources. Consensus, however, is difficult to reach on what constitutes an equitable and reasonable utilisation and when another state is adversely affected by such utilisation.

Although the two countries cooperate as good neighbours in developing the vital water resources of the shared river in which each has an equitable interest, there is the obligation to notify projects related to transboundary water, considering that any change in the water balance affects both sides of the border. Presently the Colorado River Delta and the Upper Gulf ecosystems only receive flows of freshwater whenever a surplus of water exists in the River in excess of the amount of water necessary to supply the U.S. Base flows and periodic flows should be consistent to the delta despite the 1944 Treaty stipulations, due that the rivers ecosystem survival does not depend on treaties or political factors.

The long-term problem for the delta is the decline in stream flow of the River and its flooding regime. Changing the patterns of controlled

flooding will not always solve this problem. In order to implement effective conservation programmes more water flowing directly into the delta is needed. However, economic and technical support from the United States will be necessary, and realistically, the Lower Colorado River Basin states will probably not agree to allow more water to reach Mexico.

Therefore the preservation of the Colorado River Delta ecosystems will remain a complex task. To maintain sufficient stream flows in the River, the alignment of numerous institutions, agreements, and organisations will be required. As a transboundary representative, the International Boundary and Water Commission (IBWC) still remains as the most eligible institution to achieve this goal in the long-term, although it remains cautious in its jurisdiction over environmental problems relating to the Colorado River Delta; therefore the criticism of the way it operates and manages problems concerning to the environment.

Mexico has actively attempted to conserve the delta region through initiatives such as the Upper Gulf of California and Colorado River Delta Biosphere Reserve (Reserva de la Biosfera Alto Golfo de California y Delta del Rio Colorado). This has demonstrated the federal government's commitment to conserving this vital ecosystem..

Considering the transboundary implications of the Colorado River Delta as a shared watershed, the responsibility for its protection relies on both riparian states. To date, both Mexico and U.S. state and federal government agencies have resisted active bi-national cooperation to restore the health of the Colorado River Delta ecosystem. These agencies instead point to the absence of any formal agreement between the federal governments of the United States and Mexico regarding allocation of Colorado River water for delta conservation.

There is extensive legal precedent for protection of the delta region. There exists between Mexico and the United States a significant history of cooperation in the conservation of shared natural resources, including water, vegetation and wildlife. As evidenced by a substantial number of organisations, there exists broad international support for restoration and long-term protection of Mexico's Colorado River Delta region.

It is believed that the restoration of the Colorado River Delta comes down to all water consumptive users in the Colorado River Basin. There must be a continuity of public participation in policy and management decisions and recommends coordination among the various involved organisations to ensure that efforts are not duplicated.