

# Executive summary

In regions where water demand approaches or exceeds the limit of available supplies, competition intensifies amongst various users, turning water scarcity into a potential source of conflict. This report applies an analytical methodology developed by the GIWA programme, that consists of: (i) the regional definition, based on its main physical, socio-economic and legal framework; (ii) an assessment which identifies and prioritises five predefined GIWA concerns based on the magnitude of their impacts on the environment and societies in the region; (iii) a causal chain analysis to identify the root causes of these problems; and (iv) the analysis of policy options that address these root causes in order to reverse negative trends in the aquatic environment.

The Gulf of California, GIWA region 27 has its limits to the north of the Pacific and extends to the southeast of the Pacific, and comprises a portion of the American Southwest and Mexico's Northwest. The region includes land surrounding the river systems that feed the Gulf of California, also known as Sea of Cortez. The largest of them is the Colorado River Basin, which is almost entirely located in the United States, while the oceanic component of the region (Upper Gulf of California) and small tributaries (e.g. San Pedro and partly Santa Cruz rivers) are in Mexico. Within the GIWA Gulf of California region, the Colorado River Basin is the system with the most prominent transboundary character. The Colorado River Basin is of great significance considering that the River supplies more water for consumptive use than any other river in the U.S and supports not only a booming economy but also a vast number of terrestrial and marine species. Therefore, the analysis in this report has been focused on the Colorado River Basin.

From an environmental point of view the Colorado River Delta and Upper Gulf of California is of great importance to the region, and correspondingly was declared an International Biosphere Reserve in 1993. Today the delta consists of 60 000 ha of wetlands and riparian forests (prior to the construction of dams the delta maintained

780 000 ha). The delta ecosystems are important for migratory shorebirds travelling along the Pacific Flyway; serve as a breeding ground for marine species of the Gulf of California; support a number of endangered species; improve the quality of water that flows in from various sources and out to the Gulf; deliver a steady flow of freshwater to near-shore marine (brackish) environments in the Gulf, improving breeding and nursery grounds for the endangered vaquita; and produce important vegetation utilised by indigenous peoples. In addition to these environmental services, the delta has historically been a source of income for riparian communities, supporting lucrative fisheries and ecotourism activities.

The Colorado River Basin is extremely dynamic with expanding economies and increasing industrialisation, especially in the California and Baja California border regions. The population of the Basin is growing rapidly and urban areas are sprawling, often in an uncoordinated manner. Unmanaged growth in the Basin has produced serious transborder environmental problems and concerns, for example, the impact of urban development on the fauna and flora of already sensitive ecosystems. The principle demand for water in the basin arises mainly from agriculture; 80 to 90% of all water resources are used to irrigate agricultural lands. Considering that the region is characterised mainly by arid and semiarid zones, the problem of freshwater shortage is accentuated in the Lower Basin.

The assessment focused on the Colorado River Basin and the Upper Gulf of California and was conducted based on the five GIWA concerns. The assessment conducted through a participatory process and based on concepts and criteria developed by the GIWA Task team, ranked the concerns in the following order:

1. Freshwater shortage
2. Pollution
3. Habitat and community modification

4. Unsustainable exploitation of fish and other living resources
5. Global change

Freshwater shortage was the most significant GIWA concern for the region. The modification of stream flow by dams, the canalisation of riverbeds, and the alteration of riparian zones by agricultural activities in the Colorado River Basin have resulted in major environmental changes causing loss of fish, wildlife, and native flora, particularly in the Colorado River Delta region. The main impacts on the hydrological cycle include changes in the seasonal hydrology, water temperature and sediment loads of the Lower Colorado River. In the absence of sufficient sediment discharges, the deltaic basin has transformed from an estuarine setting to a hypersaline, anti-estuarine and erosive one.

Since the construction of major dams along the Colorado River, the Delta is sustained only by flood flows and, during dry years, groundwater seepage, agricultural drainage water and tidewater are its only sources. Presently, the economic impacts of freshwater shortage are largely associated with silt accretion and salinisation of agricultural lands, which today account in the U.S. for approximately 700 million USD per year. Programmed reductions of water to California, the rising costs of water treatment, and the high cost of restoring degraded water sources are prominent socio-economic issues that could potentially initiate conflicts over freshwater resources in forthcoming years.

Pollution of water resources in the Colorado River was considered a major concern affecting the ecology and population, since heavy metals, arsenic, lead pesticides, uranium, and other toxins have all been found in excessive levels in the soils and waters resources of the Basin. Salinity is considered as a significant and continuous issue, historically affecting U.S.-Mexico relations since the early 1940s. Stream flow modification has resulted in increased cases of water pollution by salts and selenium, which occur naturally in the Colorado River. The reduction of freshwater flows has diminished the dilution capacity of the region's water bodies, consequently increasing water pollution in the Lower Colorado River. Economic impacts associated with pollution were assessed as moderate, particularly due to increases in water treatment costs. There is also considerable evidence of impacts on health from chemical pollution, especially from contamination of the regions aquifers.

The construction and operation of dams has modified riparian habitats and changed seasonal flow patterns. As a result, large extensions of riparian habitat, wetlands and marshes have declined drastically. The reduction in native forest vegetation has led to a decline in the value of riparian habitats for native species. In the U.S., as in Mexico, increases in

riverbank salinity and other alterations to riparian zones have favoured the establishment of invasive, salt tolerant species (e.g. *Tamarix ramosissima*), occupying great extensions of modified habitat.

Various forms of human activity (shrimp trawls, pollution and freshwater shortage) are modifying the ecosystems of the Upper Gulf of California, which ultimately affect local fisheries. The semi-enclosed nature of the Upper Gulf serves to magnify the impact of these activities. By-catches and discards, as well as habitat destruction by trawling nets, have been important factors in altering these ecosystems, although studies have demonstrated that overexploitation and the reduction of freshwater flows to the Upper Gulf have been the main reasons for the commercial collapse of some fisheries.

The causal chain analysis addressed the following problem: too little water is being allocated for ecosystem maintenance or restoration in the Colorado River Delta. The immediate causes of freshwater shortage in the Colorado River Delta were primarily associated with increased diversion, reduced peak flows and changes in return flows.

The most important sectors responsible for these immediate causes are:

- Agriculture;
- Urbanisation;
- Industry;
- Energy production.

The root causes focused primarily on the agricultural sector, since from a historic point of view many of the changes made throughout the 19<sup>th</sup> century were influenced by agriculture, both in the U.S. and Mexico .

Some of the root causes behind these immediate causes were identified as:

- Demographic: Migration policies and incentives carried out during the 1940s in the U.S. Western states and Mexico.
- Technological: Increased development in irrigation technology throughout the Colorado River Basin.
- Economic: The existence of historical subsidies and the lack of economic valuation of water resources.
- Legal: Inappropriate legal framework to adequately manage water use, due to a lack of effective legal instruments.

It is proposed that the following options could secure freshwater resources for the Colorado River Delta in the short, medium and long-term:

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

- Convert electricity subsidies for Mexican farmers to cash subsidies, and eliminate price subsidies to municipal water users in Mexico as preliminary measures to ensure at least minimal flows of freshwater reach the delta;
- Increase the efficiencies of water use in Mexico through market mechanisms, thereby “freeing up” water potentially available for the delta;
- Amendment of a Minute to the 1944 Water Treaty to specifically stipulate water deliveries for the delta.

Presently the Colorado River Delta and the Upper Gulf ecosystem 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 to the river ecosystem survival does not depend on treaties or political factors.

In order to implement effective conservation programme more water flowing directly into the delta is needed. Economic and technical support from the U.S. will however 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 ecosystem 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.