

Executive summary

YELLOW SEA & BOHAI SEA

This report presents the results of environmental and socio-economic assessment studies of the Yellow Sea (GIWA region 34a) and the associated water body, the Bohai Sea (GIWA region 34b). The studies, which were facilitated through workshops with the participation of international experts, included impact assessments and causal chain analyses to determine the impacts and root causes of the priority GIWA concerns and issues, respectively. Policy options and associated strategic action programmes were also identified as to address the root causes of the priority environmental problem areas of the region based on the impact assessment and causal chain analysis results.

Yellow Sea region

The Yellow Sea region covers the following sea, river basins, watersheds and their associated coastal and marine habitats:

- Yellow Sea proper and its associated islands, coastal and offshore areas;
- Yalu River (Yalujiang) and its associated coastal and marine habitats at its river mouth located in the northern region of the Yellow Sea;
- Coastal river basins in the Liaodong Peninsula, which drain partially into the northern portion of the Yellow Sea (and partially to the Bohai Sea);
- Coastal river basins in the Shandong Peninsula, which partially drain into the middle and southern portions of the Yellow Sea (and partially into the Bohai Sea);
- Yongsan River (Yongsan-gang), Taedong River (Taedong-gang), Imjin River (Imjin-gang), Han River (Han-gang) and Kum River (Kum-gang) and their basins along the west coast of the Korean Peninsula, which drain into the Yellow Sea.

The region has diverse physical and socio-economic characteristics. The Yellow Sea is a semi-enclosed body of water bordering the Chinese mainland to the west, the Korean Peninsula to the east, and a line running

from the north bank of the mouth of the Yangtze River (Changjiang) to the south side of Cheju Island, covering an area of roughly 400 000 km². It is an important global resource for coastal and offshore fisheries. Fish species found in the near-shore bays and estuaries include Ocellate spot skate (*Raja kenoei*), Greenling (*Hexagrammos otakii*), Black snapper (*Lutjanus sp.*), Scaled sardine (*Harengula zunasi*), and Spotted sardine (*Clupanodon punctatus*). There are approximately 1 600 species that have been reported from marine and coastal habitats on the Korean side of the region. The region is interesting because of its substantial population and increasing anthropogenic pressure. Approximately 600 million people live in the areas around the Yellow Sea. The region contains the following large cities, with one million or more inhabitants: Qingdao, Tianjin, Dalian, Seoul/Inchon, and Pyongyang/Nampo. People of these large, urban areas depend on the Yellow Sea as a source of marine resources for human nutrition, economic development, recreation, and tourism. The main economic sectors include: fisheries, aquaculture, oil exploitation and tourism.

The detailed assessment indicated that the environmental and socio-economic impacts of the following GIWA concerns and issues in the region were severe:

- Freshwater shortage
 - Modification of stream flow
 - Pollution of existing supplies
- Habitat and community modification
 - Loss of ecosystems
 - Modification of ecosystems
- Unsustainable exploitation of fish and other living resources
 - Overexploitation
 - Destructive fishing practices

Modification of stream flow in the major rivers on both the Chinese and Korean sides of the region has reduced the discharge of river water into

the Yellow Sea. This has changed the environment and water quality of the Yellow Sea, affecting the well-being of the marine living resources and coastal habitats in both the Chinese and Korean waters of the region. Pollution of existing supplies in rivers on both the Korean and Chinese sides of the region has brought pollutants across national boundaries with significant transboundary impacts.

Loss and modification of ecosystems has depleted the living resources not only on the Chinese but also the Korean side of the region, particularly for the ecosystems that are the spawning or breeding grounds of fish species.

The major commercial species caught in the Yellow Sea are largely migratory species that are subject to seasonal migrations from one area of the sea to another. The catches in both the Chinese and Korean waters of the Yellow Sea would be seriously affected if overexploitation of these migratory species occurs. Overexploitation of fisheries resources has been found to be the most serious issue in the region. Cooperative efforts on a regional or transnational basis are required to attain sustainable management of the fisheries and other living resources of the region.

Destructive fishing practices are common in the region and can greatly impact on the viability of migratory species. Most of the fish species in the region are migratory species and there is evidence of changes in biological and genetic diversity in some of these species, resulting from overexploitation occurred.

The prioritised issues were analysed in two Causal chain analyses; the first one targeting habitat and community modification as well as freshwater shortage problems in the region, and the second targeting overexploitation and destructive fishing practices in the Yellow Sea. Modification of stream flow and pollution of existing supplies are important issues under the concern freshwater shortage. Habitat and community modification in the region is primarily due to reclamation of coastal land, irrigation, embankments, discharges of nutrients, trace metals and organic material and the introduction of invasive species and diseases.

The sectors involved in these issues are intensified and expanded agriculture; increased discharge of pollutants from a growing industry as well as urbanisation, and infrastructure provisions like the construction of dams and dikes for flood control. Moreover, both increased shipping traffic and modern aquaculture have raised the risk of introducing alien species.

The identified root causes are;

- Demographic: Increased population growth and mass migration to urban area.
- Technology: Poor crop irrigation systems.
- Economic: Changes in economic structure and increased economic growth; Insufficient investments in "green technology".
- Knowledge: Little access to technical and scientific information and low education level of the rural population. Profit-oriented attitudes disregarding environmental impacts.
- Legal: Insufficient enforcement of regulations and laws.
- Natural: Typhoons, causing storms and floods.

The increased fishing effort, higher efficiency and use of destructive fishing practices in the region have led to unsustainable exploitation of fish and other living resources. The environmental and socio-economic impacts are overexploited fisheries resources, destruction of aquatic habitats, decreased employment rates in the fisheries sector and decreased opportunities in the seafood processing industry.

The identified root causes of unsustainable exploitation of fish and other living resources are:

- Demographic: Increased demand for food as a result of increased population.
- Economic: Profit-oriented attitudes disregarding environmental impacts and increased market demand.
- Technology: Easy access to improved fishing technologies.
- Knowledge: Lack of public awareness.

The following policy options were formulated with regards to freshwater shortage:

- Integration of the development and management of agricultural irrigation systems with integrated river basin management programmes.
- Adoption and promotion of water-saving technologies for crop irrigation.
- Adoption of the Natural Forest Protection Program (NFPP) to cope with the uncontrolled deforestation.
- Adoption of integrated forest management practices.
- Adoption of efficient law enforcement mechanisms to prevent illegal logging and other forest destructive practices.
- Adoption of programs for raising public awareness and participation in forest management and restoration.
- Promotion of market incentive systems to encourage the use of green production technology in the industry sector.
- Enhancement of laws and enforcement mechanisms related to pollution prevention and wastewater treatment practices.

- Adoption of laws, regulations and enforcement mechanisms to control the use and disposal of fertilisers and pesticides.
- Adoption of educational and public awareness campaign programs on good practices in agriculture.
- Adoption of sustainable soil management system(s) to improve soil fertility and productivity.
- Adoption of efficient soil fertility improvement technology and crop irrigation systems to improve the soil productivity

The following policy options were formulated with regards to habitat and community modification;

- Adoption of laws, regulations and enforcement mechanisms to restrict population migration.
- Adoption of an approach that encourages the development of small, rural-oriented urban centres in rural areas to cope with population migration.
- Adoption of laws, regulations and enforcement mechanisms to promote good practices in agriculture including minimisation of the discharge of agricultural runoff high in harmful pollutants.
- Adoption of laws, regulations and enforcement mechanisms to restrict the introduction of exotic and invasive species for aquaculture.
- Adoption of programs related to raising public awareness on and participation in good practices in agriculture and recognising the environmental impact of introducing exotic and invasive species for aquaculture.
- Adoption of programs to raise public aware on and participation in good practices in using fertilisers and pesticides.
- Adoption of sustainable agriculture production technologies that would minimise the use of fertilisers and pesticides.

The following policy options were formulated with regards to unsustainable exploitation of fish and other living resources;

- Enhancement of laws, regulations and enforcement mechanisms to restrict the entry of excessive fishing fleets and fishermen into the fishing industry.
- Adoption of alternative livelihood programs for fishermen and other fisheries operators.
- Adoption of public awareness and education programs on the environmental and social consequences of over-harvesting of fisheries resources.
- Adoption of the sustainable production practices to enhance fisheries and aquaculture production.
- Enhancement of law enforcement mechanisms to restrict the destructive fishing practices.
- Adoption of public awareness campaign and education programs

on the environmental and social consequences of the destructive fishing practices.

For each of the policy options, a Strategic Action Programme is defined, in order to give suggestions about how the policy options could be implemented.

Bohai Sea

The Bohai Sea is a national sea under the jurisdiction of China. It is located in the northwest corner of the Yellow Sea. From an ecological perspective, the Bohai Sea is a large, shallow embayment of the Yellow Sea. The Yellow Sea, in turn, is a shallow continental sea of the northwest Pacific Ocean. These relationships are important because of the physical and biological links between these systems; in particular, the fish and shellfish stocks in the Yellow Sea are dependent on the Bohai Sea as a reproduction and nursery area.

Given that the Bohai Sea is not a transboundary water body, the assessment report of the Bohai Sea is included in this report as an appendix to be used as a reference for further understanding of the Yellow Sea's environmental problems.

The Bohai Sea region covers the following sea, river basins, watersheds and their associated coastal and marine habitats:

- Bohai Sea, which consists of three bays: the Liaodong Bay to the north, the Bohai Bay to the west and the Laizhou Bay to the south;
- Liao River (Liaohe) Basin, coastal river basins in the Liaodong Peninsula, the Shuangtaizihe River Basin and their associated coastal and marine habitats in Liaodong Bay, north of the Bohai Sea;
- Hai River (Haihe) and Luan River (Luanhe) and their associated marine habitats in Bohai Bay west of the Bohai Sea;
- Yellow River (Huanghe) Basin, coastal river basins in the Shandong Peninsula and their associated coastal and marine habitats in Laizhou Bay, to the south of Bohai Sea.

The region has diverse physical and socio-economic characteristics. It is the historical heartland of China, and one of the most important agricultural and industrial regions in the country. The Bohai Sea has always been known as a "natural fishing ground" and harbours more than 1 540 species. Apart from such sea treasures as Prawn, Sea cucumber and Abalone, the Bohai Sea has over 100 species of major fish species among which the Small yellow croaker and the Hairtail

are the fish species with the largest production in the Bohai Sea and also among the four major fish products from China's seas. The Bohai Sea region covers an area of 1.6 million km², 19.4% of the nation's total area and with a population of 343.5 million, over 22% of the nation's population. The main economic sectors of the region include: fisheries and marine aquaculture, salt making, port development and marine transport, oil exploitation and tourism.

Based on the results of the assessment for the Bohai Sea region the GIWA issues that have been assessed as having severe environmental impacts were selected for further analysis. They include:

- Freshwater shortage:
 - Modification of stream flow
 - Pollution of existing supplies
 - Changes in water table
- Habitat and community modification
 - Loss of ecosystems
 - Modification of ecosystems
- Unsustainable exploitation of fish and other living resources
 - Overexploitation
 - Impact on biological and genetic diversity

These issues are analysed in two causal chain analyses; the first one targeting habitat and community modification as well as freshwater shortage problems in the region, and the second targeting overexploitation and destructive fishing practices in the Bohai Sea.

The root causes for each of the problem areas have been assessed and prioritised. Key root causes for each of the problem areas were selected and are as follows.

Freshwater shortage and habitat and community modification

- Demographic: Increased population growth and mass migration to urban areas.

- Technology: Inadequate access to technology leading to inefficient use of freshwater. The easy access to modern technology has propelled industrial growth that requires more use of water.
- Legal: Inadequate enforcement of laws and regulations to control the use of freshwater.
- Economic: Increase in economic growth. Increased energy demand by industries and domestic uses. Low investment in waste treatment facilities.
- Knowledge: Lack of public awareness on environmental impacts. Profit-oriented attitudes that disregard environmental impacts resulting in uncontrolled conversion of coastal wetlands for petrochemical plants.
- Natural causes. Decrease in rainfall has causing excessive extraction of groundwater to meet the needs for crop and industrial production.

Identified root causes regarding unsustainable exploitation of fish and other living resources are:

- Demographic: Increase in population growth leading to increased demand for food, including seafood. Shift in livelihood of fishermen from capture fisheries to aquaculture.
- Knowledge: Profit-driven attitudes of fisheries operators resulting in overexploitation of living resources. Insufficient awareness of the consequences of uncontrolled releases of hatchery-produced juveniles and overexploitation of spawning fish.
- Technology: Easy access to improved or new aquaculture technologies has propelled the increased development of aquaculture, leading to unsustainable use of living resources.

Suggested priority policy options and their associated strategic action programs to address the priority root causes for each of the problem areas have been formulated. Details of the policy options and their associated strategic action programmes are presented in this report.