

## ISSUES BRIEF

# Wetlands of the Yellow River Delta: a heritage to conserve and treasure

## KEY MESSAGES

- Dongying municipality's vision to combine rapid economic growth with sound environmental management requires recognizing the value of its wetlands.
- Wetlands are not wastelands, as they are often maligned, because they offer many practical and intangible benefits.
- Estuarine wetlands are fragile ecosystems whose health depends on conditions in surrounding areas and far upstream.
- A more complete valuation of wetland ecosystem services can strengthen the argument for the continued conservation of the Yellow River Delta Nature Reserve.
- Adopting low-impact and biodiversity-enhancing agriculture, low-carbon aquaculture, and cleaner industries can help preserve the health of delta wetlands.

## A NEW CITY ON NEW LAND

Dongying is a young municipality in Shandong Province of China with a population of 1.84 million and a gross domestic product growing by 13.7% per annum in 2008. It is blessed with a wealth of natural resources, two of which are most important in shaping its destiny: wetlands and petroleum.

Since a course change some 150 years ago, the Yellow River has deposited large quantities of sediment on its new delta at Dongying before flowing into the Bohai Sea, forming new wetlands at an average rate of 18 square kilometers per year. Older sediments have matured to form the land upon which Dongying is built. Dongying City was officially established in 1983 with the opening of the Shengli oilfield, the second largest in China. Dongying now takes its place globally among 16

cities forming the World Energy Cities Partnership and counts among its abundant resources "over 333,000 hectares of wasteland to be reclaimed" ([www.energycities.org/dongying.asp](http://www.energycities.org/dongying.asp)).

The wetlands of the Yellow River delta thus face a situation common in many developing countries where the quest for rapid economic growth brings development to the doorstep of natural ecosystems and threatens their health and survival. Can the wetlands in Dongying coexist with the modern development that is creeping towards them? Is there sufficient appreciation that these wetlands are worth caring for? How can Dongying achieve its aspiration to combine rapid economic growth with sound environmental management?

These are questions posed by a two-year research project supported by the Challenge Program for Water and Food and conducted by the WorldFish Center and the Chinese Academy of Fishery Sciences, with the cooperation of the Dongying Ocean and Fisheries Research Institute. The project aimed to raise awareness and understanding of the value of wetlands beyond their immediate and direct economic contributions. Piloted in four townships in eastern Dongying, the project demonstrated how this understanding might inform decision makers and guide their achievement of Dongying's vision of sustained and balanced development. The key messages from the research are summarized in this brief.

## WETLANDS ARE NOT WASTELANDS

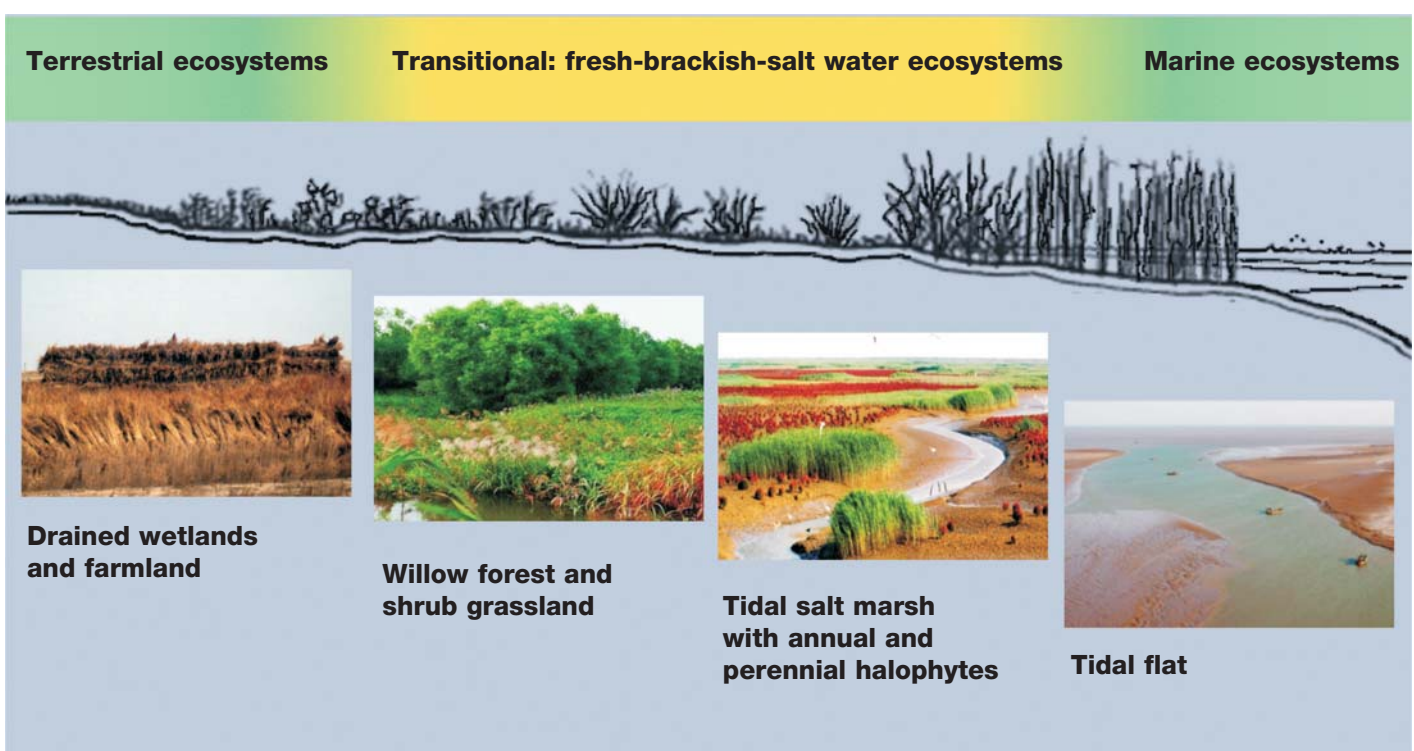
Wetlands are generally inaccessible, conjuring a biased mental image of boggy, impenetrable bush infested with mosquitoes and other threats to safety and health. This "wasteland" image makes wetlands natural targets to be drained, cleared and used for economic development. Yet the history of many civilizations and cultures suggests traditional recognition of the inherent value of wetlands that cannot be measured against our constructed value (see Box 1).

The natural wetlands of Dongying play all the ecological roles listed in Box 1, but maintaining bird diversity is the most visible and spectacular role. These wetlands are visited annually by 500,000 to 1 million migratory

birds representing almost 90 species. Many of these species are rare or endangered and of national or international conservation significance, which provided the main impetus for designating 153,000 hectares of wetlands as the Yellow River Delta Nature Reserve in 1992. This laudable move by the Chinese government also affords protection to the pristine, newly formed coastal wetland ecosystem, particularly within the 79,200 hectares of core zone designated for strict conservation. Even today, the delta is extending seaward at a rate of 2.2 kilometers per year, forming the fastest growing expanse of wetlands in the world. Continual growth means the wetlands along the present estuary are at different stages of maturity, providing a succession of habitats that are rich in plant and animal life across the saline-brackish-freshwater continuum (Figure 1).

In the 10,600-hectare buffer zone and 63,200-hectare experimental zone of the reserve, human modification of the natural habitat was set in motion before the reserve was established. Outside the nature reserve, the original wetlands have been subjected to various forms of use and change. The delta is a mosaic of wetlands in their natural state (protected within the nature reserve but not outside), manmade wetlands (including fresh- and brackish-water aquaculture ponds, salt evaporation pans, and reservoirs) and former wetlands that have been converted to agricultural, urban and industrial uses (Figure 2).

**Figure 1. Succession of wetland ecosystems in the Yellow River delta**



### Box 1. The inherent value of wetlands

Common expressions about wetlands reflect traditional wisdom about their roles that translates into modern, scientific language as ecosystem functions and services (indicated in parentheses below):

**Wetlands are larders** (*direct provisioning*), offering fish, crabs, shrimp and shellfish, as well as plants that can provide food, fiber, timber, medicine and other products.

**Wetlands act as sponges** (*water regulation*) that absorb and retain surplus water during the wet season and release water during the dry season, mitigating both floods and water shortages.

**Wetlands are the kidneys of the earth** (*water purification*) that act as natural filters to keep water clean. The profusion of stems and roots are effective sediment traps. Wetland plants remove pollutants and toxic substances from water. Beneficial bacteria capture other pollutants, like nitrates, contributing to the recycling of important nutrients.

**Wetlands buffer the forces of nature** (*erosion, storm and flood protection*), slowing the flow of water with complex root systems that bind the soil, and absorbing wind and wave energy to reduce flooding, riverbank and shoreline erosion, and threats to lives and property.

As more scientific studies are conducted on wetlands, the common wisdom about their roles has grown:

**Wetlands are nurseries, feeding grounds and sanctuaries** (*biological and food web support*) that provide food and shelter for fish and shellfish. They are important spawning and nursery areas for a variety of saltwater and freshwater fish, many of which support commercial fisheries and provide food and income for fisher communities.

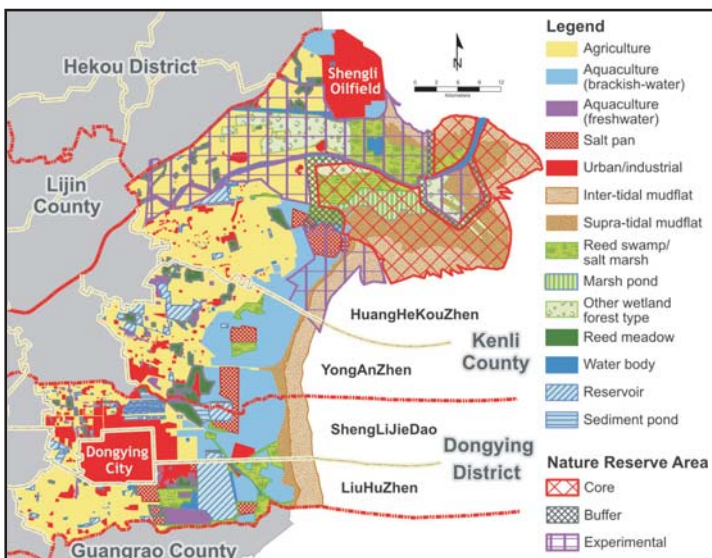
**Wetlands are gene banks** (*biodiversity support*) of immense biological diversity that reflect the meeting and mixing of land and water environments. Many wetland plants have medicinal, food and economic value. Some are wild relatives of crop species, providing a treasure trove of genetic resources for breeding hardier crop varieties and safeguarding the food security of future generations.

**Wetlands are international airports and winter resorts for birds** (*biological and biodiversity support*) that provide diverse temperate and tropical habitats for aquatic birds, both local species and migrants that either stop over to feed or winter over to breed. Many migratory bird species are rare or endangered, and their survival is increasingly threatened as wetlands along their migratory paths are degraded or cleared.

**Wetlands are carbon and nutrient sinks** (*climate change mitigation*) that store carbon and nitrogen in waterlogged soil. Storing carbon is important as rising levels of carbon dioxide in the atmosphere sharpen concerns about global warming and sea-level rise. The saline conditions of coastal and estuarine wetlands inhibit the production of other greenhouse gases like methane, while encouraging the complete reduction of trapped nitrates to harmless nitrogen gas.

**Wetlands have natural beauty and heritage value** (*cultural support*), contrary to misconceptions of wetlands as unpleasant and dangerous areas to be avoided. Wetlands offer natural beauty and recreational opportunities for people who enjoy the great outdoors and watching wildlife.

**Figure 2. Land use of eastern Dongying Municipality (2009)**



## WETLANDS ARE FRAGILE ECOSYSTEMS

Impenetrable and robust as they may appear to be, wetlands are fragile ecosystems whose health depends on continual nourishment in the form of sediment to build its soil base and water to supply the semi-aquatic and aquatic habitats of plant and animal communities. The health of delta wetlands depends on and is influenced by surrounding and upstream land and water use. The recent history of reduced water flow in the lower Yellow River and its impact on the wetlands ecosystem proves this point. Increasing withdrawal of water from upstream stretches of the Yellow River reduced its discharge into the sea starting in the mid-1980s, causing freshwater marshes in the estuarine wetlands to degrade and disappear. Careful monitoring of a subsequent 10-year ecological restoration project in the Yellow River estuary proved that a sustained supply of freshwater is key to maintaining the health of wetlands in the Yellow River delta.

## A DUAL FOCUS ON WETLANDS AND THE ECONOMY CAN BALANCE DEVELOPMENT

Opportunities to improve the management of the wetlands of the Yellow River delta hinge on recognizing the broader ecosystem services of wetlands, both natural and manmade, and how their value can be enhanced. The following recommended strategies can increase the chances of sustaining the wetlands and improve the general environment of Dongying in line with its vision of balanced development.

### Strategy 1: Enhance the benefits of the nature reserve

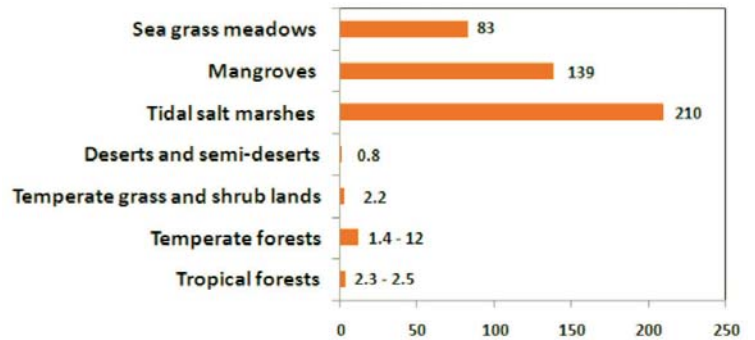
A more complete valuation of ecosystem services can strengthen the argument for continued conservation of the wetlands nature reserve and dispel the notion that wetlands are wastelands. The richly diverse coastal wetland habitats that are kept in pristine condition in the core reserve offer a veritable outdoor laboratory for conducting research locally that can help scientifically quantify the various indirect benefits of coastal and estuarine wetlands in the temperate zone:

- Biologically, wetlands are natural gene banks for plants and animals and recruiting grounds for commercially important fish species.
- In their regulatory role, wetlands retain and recycle nutrients and purify water.
- Toward mitigating global warming, wetlands absorb carbon and thereby reduce emissions of the greenhouse gases carbon dioxide and methane.

Local awareness of these ecosystem services of the Yellow River delta wetlands is low, mainly because they are hard to see or systematically quantify. Studies conducted on similar wetlands elsewhere have firmly

established, for example, the important roles of wetlands in recruiting fish and other aquatic species that support fisheries and in regulating water flow and quality. Studies of nutrient cycling conducted in the Chesapeake Bay in the United States of America and other estuaries suggest that tidal freshwater marshes trap 35% of the nitrogen and 80% of the phosphorus that would otherwise leach into the surroundings.

**Figure 3. Long-term rate of carbon accumulation in sediment (g C per sq m per year)**



Source: Kennedy and Bjork (2009)\*

The role of wetlands as carbon sinks is gaining prominence in the light of global warming, with important economic implications. Studies carried out along the US coastlines suggest that the sediments of saline tidal marshes, similar to those of Yellow River delta wetlands, trap and hold over the long term large amounts of carbon that would otherwise be released as the greenhouse gas (GHG) carbon dioxide into the atmosphere. This carbon sequestration rate per hectare is even higher than that of tropical mangroves and estimated to be 100 times that of tropical forests (Figure 3). Saline conditions also inhibit bacteria that produce methane, another GHG that is associated with freshwater marshes.



\* Kennedy, H., and M. Bjork. 2009. Seagrass meadows. In: Laffoley, D.d'A. & Grimsditch, G. (eds). *The management of natural coastal carbon sinks*. IUCN, Gland, Switzerland. 53 pp.

Scientific evidence generated locally will strengthen the case for ensuring that the freshwater flow from the Yellow River is adequate to continue nourishing these wetlands, despite competing demands on the river's water resources from users in nine provinces upstream. It will also back the claim that temperate coastal and estuarine wetlands should be eligible for carbon offset and credit schemes, thereby financially rewarding the conservation of carbon-sequestering wetlands (Box 2).

### Box 2. Carbon offset: an important ecosystem service of the Yellow River delta wetlands

Being one of the largest and fastest growing economies in the world, China faces the challenge of reconciling its massive energy use with the need to respond to international pressure to curb emissions of greenhouse gases. Rapid industrial growth and its population of 1.25 billion put China at the top of carbon dioxide emitting countries, even though its per capita emission is just above the world average ([wikipedia.org/wiki/List\\_of\\_countries\\_by\\_carbon\\_dioxide\\_emissions](http://wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions)). There are opportunities for China to demonstrate its role in mitigating greenhouse gas emissions through conserving and proper management of its vast areas of natural and manmade vegetation. Conserving the coastal wetlands of the Yellow River Delta is a good example. Although not as extensive as the terrestrial forests, these wetlands can sequester (i.e. store) up to 100 times more carbon in the soil and vegetation than tropical forests, if left undisturbed. There is now economic value placed on sequestered carbon in natural ecosystems. This is known as carbon offset. A carbon offset can be an act of preventing one tonne of greenhouse gases from being emitted for each tonne than an individual, company or country has caused. Carbon offsets that are monetized are commercially accepted as carbon credits. **Carbon credits earned from keeping natural ecosystems such as the Yellow River delta wetlands intact can be used as compensation for China's greenhouse gas emissions.**

Precedents exist. The role of tropical forests in GHG mitigation is now widely accepted, qualifying many developing countries to participate in the United Nations Reducing Emissions from Deforestation and Forest Degradation (UN-REDD) schemes ([www.un-redd.org](http://www.un-redd.org)). The scheme provides funds (as one form of carbon credit) for participating countries to build their capacity for REDD, including establishing emissions reference levels, adopting strategies to reduce deforestation, and designing monitoring systems. Originally applied to tropical forests, this scheme was subsequently expanded to cover mangrove conservation on the strength of substantial evidence of mangroves' mitigation of climate change. As many of Asia's temperate coastal wetlands are in China, much of the case for their eligibility for carbon offset schemes, including the UN-REDD, must come from this country, making the Yellow River delta even more valuable as an outdoor laboratory.

## Strategy 2: Green the economy

Opportunities exist for further greening the economy of Dongying, augmenting the city's ecological and economic strengths, and reducing the impact of development on natural wetlands, both within and outside the reserve.

**Low-impact and biodiversity-enhancing agriculture** needs to be encouraged, particularly in and near the reserve. This entails selecting crops and cropping practices with lower demand for water, and creating an agroforestry landscape that offers habitats attractive to birds.

Bird diversity declined outside the core nature reserve when farmers shifted from grains and soybeans to cotton, which consumes a lot of water and is ecologically more sterile. Forestry Bureau plans to plant more trees in belts and along roads and canals can be coordinated with plans for encouraging agricultural diversity and organic farming to establish a landscape of diverse vegetation without compromising the economic benefits from agriculture and agroforestry. Remnants of wetland meadows that have been drained can be revived to restore some ecosystem services, such as water regulation and purification, while attracting birds and other aquatic life that can enhance the appeal of the rural landscape.



**Low-carbon aquaculture** can provide good economic returns with a small carbon footprint. There is already a move away from dominant shrimp aquaculture, which is fraught with disease problems, toward culturing more diverse aquatic organisms, including crabs and sea cucumber. This move opens up opportunities for introducing low-carbon aquaculture of species that feed low on the food chain, such as sea cucumber. That sea cucumber requires good water quality is an impetus for sound environmental protection and management of the land and sea around the culture area. Farming shellfish, such as oysters and mussels, is not only good business, but also helps clean coastal waters and sequester carbon. Culturing algae, which are at the bottom of the food chain, converts carbon dioxide into green matter with high market value as health food.

**Cleaner industries that create less water pollution** can reduce threats to the health of natural wetlands and pond aquaculture. While the mainstream of the Yellow River and its large and medium-sized reservoirs have fairly good water quality, meeting Grade 3 of China's Environmental Quality Standards for Surface Water (usable for swimming and purification into drinking water), agricultural runoff and industrial effluents render the water of small associated rivers too polluted to meet even the lowest Grade 5 (for agricultural and general landscape uses) standards, which means it is essentially useless. Establishing cleaner industries and strictly enforcing sound environmental protection guidelines, such as those established by Shengli oilfield, are necessary to reduce water pollution.

## IN SUMMARY

Protecting wetlands does not have to mean depriving people of opportunities for economic benefits. Carefully chosen economic activities can coexist with natural wetland conservation and, further, complement the ecosystem services that the wetlands provide. Strong political will and good institutional coordination will ensure that these activities complement rather than compete for and degrade the wetland resources that they depend on. Achieving this will help realize "the highly efficient eco-economy" that Dongying envisions and make it a model for emulation elsewhere in China and around the world.



This brief summarizes findings from PN69 'Valuing living aquatic resources of wetlands in China', a project of the CGIAR Challenge Program on Water and Food.

### Photo credits

Yellow River Delta National Nature Reserve

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Issues Brief 2107. The WorldFish Center, July 2010

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