

3.11 Risk and opportunity in Odisha, India

In this case study you will:

- ◆ learn how a contrasting coastal landscape can present risks and opportunities for human occupation
- ◆ evaluate human responses of resilience, mitigation and adaptation

Case study

Odisha: a distinctive and contrasting coastal landscape

Odisha is a state on the eastern coast of India bordering the Bay of Bengal (Figure 1). It is India's 9th largest state by area and 11th by population. Odisha has a relatively straight coastline (about 480 km long) with few natural inlets or harbours. The narrow, level coastal strip known as the Odisha Coastal Plains supports the bulk of the state's population.

The coastal plain mostly comprises depositional landforms of recent origin, geologically belonging to the post-Tertiary Period. There are six major deltas on the Odisha coast, which explains why the coastal plain is known locally as the 'Hexadeltaic region' or the 'Gift of Six Rivers' (the Subarnarekha, Budhabalanga, Baitarani, Brahmani, Mahanadi, and the Rushikulya).

The Odisha coast has a wide range of coastal and marine flora and fauna (including 1435 km² of mangrove forest). Figure 2 identifies the three major coastal ecological environments – it also gives a good impression of its relief. One of these environments is Chilika Lake, a brackish salty lagoon, well-renowned for its birdlife. During the monsoon season the lake becomes less saline, being diluted by the freshwater rainfall, and occupies a larger area than during the rest of the year. Chilika Lake is a good example of a temporary store in the water cycle; the beach that has created the lake is an important store within the coastal system.

In summary, the Odisha coast is essentially one of deposition, comprising several major deltas. It therefore represents a significant sediment store, providing a source (and sink) of sediment for this part of the Bay of Bengal. Rivers provide important transfers of sediment into the region in forming deltaic deposits.

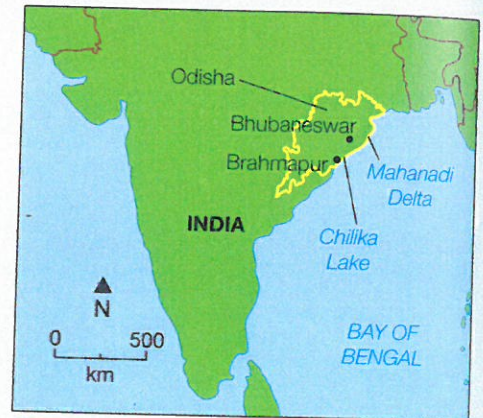
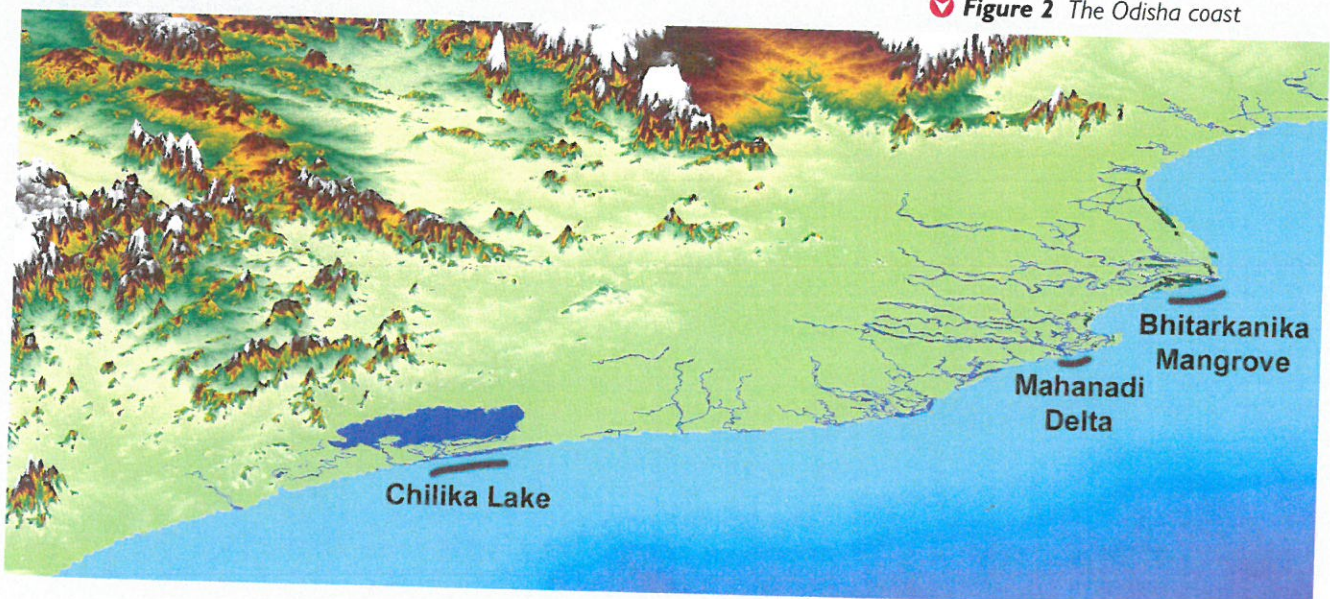


Figure 1 Location of Odisha, India

Figure 2 The Odisha coast



Opportunities for human occupation and development

In addition to providing relatively flat land for settlement, the coastal plain provides several economic and environmental opportunities.

- ◆ Odisha's coastal zone has a wide variety of marine and coastal flora and fauna including mangroves, sea grasses, salt marshes, sand dunes, estuaries and lagoons.
- ◆ There are large stocks of fish, marine mammals, reptiles and Olive Ridley turtles, seagrass meadows, and abundant seaweeds.
- ◆ There area has huge potential for offshore wind, tidal and wave power.
- ◆ Thirty-five per cent of the coastal stretch is laden with substantial placer (sediment) minerals and heavy metal deposits. There are important clay and limestone resources in the north of the state.
- ◆ There are opportunities for offshore oil and natural gas, as well as seabed mining.
- ◆ Many local people are employed in coastal fishing and increasingly in aquaculture such as shrimps.
- ◆ Cultural and archaeological sites also dot the coast, drawing visitors from around the world.
- ◆ Tourism is important, with the coastal beaches and wildlife sanctuaries being major attractions.
- ◆ The Chilika Lake Bird Sanctuary boasts over 150 migratory and resident species of birds (Figure 3).

✓ **Figure 3** Chilika Lake Bird Sanctuary



Risks for human occupation and development

Coastal erosion

In 2011 the Ministry of Environment and Forests released its latest Assessment of Shoreline Change for the state of Odisha, focusing on mapping the areas of greatest erosion along the coast. Rates of erosion have increased in recent decades, partly through natural processes but also as a consequence of human intervention methods, which have been used to protect infrastructures (Figure 4). With the majority of the state's population living on the coastal plain, the Indian government has become concerned about the increased vulnerability of coastal communities to storm surges and tsunami as well as the longer-term threats posed by climate change and rising sea levels.

The Odisha coastline is a naturally changing environment. Erosion provides important inputs of sediment that, once transferred along the coast by waves, tides and currents, is deposited to form beaches, dunes and barrier beaches, which characterise this stretch of India's coast. Natural seasonal variations occur along the coast, with accretion occurring in the summer during relatively low-energy wave conditions and erosion in the winter when high-energy destructive waves remove and deposit sediment offshore.

'Attempting to halt natural coastal process with seawalls and other hard structures, only shifts the problem, subjecting downdrift coastal areas to similar losses. Also, without the sediment transport, some of the beaches, dunes, barrier beaches, salt marshes, and estuaries are threatened and would disappear as the sand sources that feed and sustain them are eliminated.'

(Shoreline Change Assessment for Odisha Coast, 2011)

✓ **Figure 4** Coastal erosion, Odisha



Risk and opportunity in Odisha, India

The key findings of the Assessment of Shoreline Change included the following:

- ◆ The coast of Odisha is largely accreting (46.8 per cent), with 36.8 per cent eroding and 14.4 per cent stable.
- ◆ Most accretion is in the north, focused on the major deltas.
- ◆ Most of the erosion is in the south. Here, there are major structures (sea walls, breakwaters and rock armour) protecting infrastructures (mainly ports), which have interfered with natural processes exacerbating rates of erosion.
- ◆ Due to the presence of dense mangrove vegetation, the coastal districts of Kendrapara, Bhadrak and Baleswar show levels of accretion that are more than 50 per cent higher than anywhere else on the coast (Figure 5).
- ◆ Shoreline change is extremely dynamic along the mouths of rivers, suggesting that the inflow pattern determines the nature of the shoreline – rates of accretion and erosion were found to vary considerable either side of the major river mouths.

In summary, the research has found the coastline to be a very dynamic coastal system (only 14.4 per cent of the coast is 'stable') and subject to considerable change. It is affected by significant seasonal variation in wave energy and sediment input via the region's major rivers. Human intervention has had a major impact on the system, interfering with sediment transfer and destabilising patterns of wave energy, resulting in severe erosion in certain localities. These changes are of concern to the state authorities given the enormous economic value of the coastal strip and possible increased threats from storm surges, tsunami and sea level rise.



▲ **Figure 5** Mangrove in Odisha



▲ **Figure 6** The impact of Cyclone Phailin on the Odisha coast

Tropical cyclones – resilience, mitigation and adaptation

The Odisha coast is at risk from tropical cyclones and the associated storm surges. There is some evidence to suggest that the frequency and intensity of these storms may increase in the future as a result of climate change. With sea levels rising, this represents a significant threat to the coast.

In October 2013 Cyclone Phailin struck the Odisha coast near Gopalpur (Figure 6). Windspeeds touched 200 km/h, tearing down power lines and uprooting trees. Over one million people were evacuated from those areas deemed to be at greatest risk. Forty-four people died in Odisha and many thousands were affected, with buildings damaged and economic activity disrupted. The coastal district of Ganjam was most severely affected by the storm. In total, some 500 000 ha of agricultural crops were destroyed and economic losses were close to US\$700 000. Chilika Lake suffered from a storm surge

that may take the ecosystem years to recover and, along the coast, thousands of mangrove trees were destroyed, temporarily rendering this stretch of coastline more vulnerable to storm surges.

Odisha is very vulnerable to tropical cyclones and its people have developed considerable resilience in adapting to the threat. In 1999, the infamous Odisha Cyclone, the strongest cyclone ever recorded in the northern Indian Ocean, brought massive destruction to the region, killing over 10 000 people. The authorities now employ a number of mitigation strategies – providing relief supplies ahead of an approaching storm, broadcasting warnings and conducting staged evacuations away from the most vulnerable areas. The relatively small death toll pays testament to the mitigation strategies as well as the resilience of the people and their ability to adapt to changing circumstances.

Managing the Odisha coast

In the light of the 2011 Assessment of Shoreline Change report, it is clear that piecemeal and highly localised management strategies are likely to cause more long-term harm than good – they are certainly likely to upset any existing coastal system balance (less than 15 per cent of the coastline was found to be stable).

A recent ICZM project has coordinated the activities of the various stakeholders and promoted the sustainable use of the natural resources of the Odisha coast while maintaining the natural environment (Figure 7). The ICZM aims to:

- ◆ establish sustainable levels of economic and social activity
- ◆ resolve environmental, social and economic challenges and conflicts
- ◆ protect the coastal environment.

The project is a joint venture involving the Ministry of Forest and Environment, the Indian government, the World Bank and the government of Odisha. The major issues that have been identified include:

- ◆ coastal erosion and associated oceanographic processes
- ◆ assessing vulnerability to disaster (particularly tropical cyclones)
- ◆ biodiversity conservation
- ◆ livelihood security (e.g. fishing)
- ◆ pollution and environmental quality management
- ◆ conservation of cultural/archaeological assets.

Many different organisations have an interest in managing the coast and these have been consulted, along with others who have a stake in its future. In addition to the inter-organisational consultations, a wide range of public consultations have also been held, including with individual villages about issues such as:

- ◆ the assessment and control of coastal erosion
- ◆ the development of ecotourism (Figure 8)
- ◆ planting or replanting mangroves
- ◆ building cyclone shelters.

Greenpeace India (an environmental pressure group) has also been involved in meetings about income generation and the management of marine resources, acting with some of the villages included in the ICZM project.

Central (federal) government	State and local government	Stakeholders in the local economy
Archaeology Department of Culture	Odisha State Disaster Management Authority	Odisha Tourism Development Corporation
Water Resource Department	Odisha State Pollution Control Board	Handicraft and cottage Industries
Fisheries Department	Wildlife Wing of Forest and Environment Department (State)	

▲ **Figure 7** ICZM Project Odisha, players and stakeholders

▼ **Figure 8** Godwit Eco Cottage is a collection of holiday cottages close to Chilika Lake. They are made of bamboo and mud, with thatched roofs.



Management of the Mahanadi Delta

The Mahanadi Delta (Figures 2 and 9) is an important ecological zone, providing important natural habitats for a wide variety of wildlife. However, in recent decades there has been a considerable loss of mangroves, largely due to the development of fisheries and other economic demands. Fifty years ago, coastal villages in Odisha had an average width of 5.1 km of mangroves protecting them. Today, that figure is an average of 1.2 km. In 1999, during 'super-cyclone' Kalina, villages that still had four or more kilometres of mangroves, recorded no deaths. However, in areas where the protective belt was less than 3 km wide, death rates rose sharply. With sea levels rising and tropical cyclones expected to become more frequent and intense, integrated management of this stretch of the Odisha coast is essential.

The NGO, Wetlands International, along with the Indian government and Odisha's ICZM project, is now trying to reverse decades of mangrove destruction. They are helping villagers to cultivate and plant mangroves along the coastline, and also on the banks of all tidal rivers along Odisha's coast. This is a good illustration of a sustainable and highly appropriate coastal management (mitigation) scheme that is followed, not just in India, but in many parts of the world that have similar flooding issues (Figure 10).



Figure 9 Satellite image of the Mahanadi Delta, India



Figure 10 Planting mangrove seedlings, Andaman Coast, Thailand. According to Daniel Alongi of the Australian Institute of Marine Science, the faster sea levels rise, the faster mangroves accumulate sediment (sediment store) in their roots. They can keep up with a rise of 25 mm a year – eight times the current global rate. No sea wall can do that.

STRETCH YOURSELF

Access the Odisha ICZM website at www.iczmpodisha.org/aim_and_objective.htm to find out more about the project. Evaluate the work done so far in terms of its sustainability. What are the challenges for the future?



▲ Figure 11 A 1:250 000 topographic map around Chilika Lake, Odisha

ACTIVITIES

- Study Figure 2. What are the distinctive aspects of Odisha's coast. How does it compare with named stretches of coastline in the UK?
- Use Figure 2 to draw a large sketch of the Odisha coast. Use text boxes to identify some of the issues associated with this stretch of coastline. Consider both opportunities and risks. Use the internet to provide additional information and illustrate your work with photos.
- What are the aims of the ICZM project?
 - Suggest the criteria that will be used to judge whether it has been successful in achieving its aims.
- Examine the role of mangroves in reducing the threat from flooding.
 - To what extent is the replanting of mangroves a sustainable solution to the problem of flooding in India and Bangladesh?
- Consider the ways in which resilience, mitigation and adaptation have been evident in the approaches to coastal management adopted by organisations and local communities.
- 'An understanding of coastal systems is essential if coastal management is to be successful.' Do you agree?
- Look at Figure 11. Describe in detail the coastal landscape and the human uses of this area of coastline.