

PRESSURES ON THE COASTLINE

According to the United Nations Environment Programme (UNEP), the population density in coastal areas is now twice as high as the global average, with more than 50% of the global population living less than 60km from a coastline, in 180 coastal countries. Of the world's 33 mega-cities, 21 are in coastal areas, with 14 of the largest 15 on low-lying vulnerable areas, ranging from older world cities like London to newer mega-cities like Shanghai (Figure 1).

The coast and its river estuaries and deltas has always been a focus for trade, communications, industrial sites but also for natural goods and services. Fishing, aquaculture, tourism and recreation and even biomedicine depend on coastal biodiversity and landforms. Although 'nature's services' cannot easily be quantified, their economic value is critical, as shown even in the USA, where its largest commercial and recreational fishery, the Gulf of Mexico, is presently threatened by an oxygen-depleted 'dead zone' as large as the country of Belize. The 2005 Millennium Ecosystem Assessment highlighted that for millions of the world's poorest people, healthy coastal ecosystems are a matter of survival. The United Nations FAO states that one critical ecosystem for many tropical/subtropical coasts, the mangrove swamp, was reduced in

extent by 25% between 1980 and 2003. Increasing pressures may ironically also result from setting up conservation zones.

The 2004 Indian Ocean tsunami and 2005 Hurricane Katrina in New Orleans highlighted another issue to be faced by coastlines: that of flood risk. The UN Hyogo Framework for Action on Disaster 2005–2015 highlighted the problem of vulnerable populations being juxtaposed with increased flood risk, exacerbated by loss of coastal sediments and ecosystems and their 'buffering capacity' against natural hazards. Over 200 million people are at risk, with about a half of these living in areas no more than one metre above sea level. Vulnerability hot spots range from the Thames Gateway and the Netherlands, to the Bay of Bengal, much of East Asia, as well as large areas of the Caribbean and USA.

The coast is the interface between fluvial and marine systems which both creates highly productive ecosystems in its estuaries and near shore waters and also creates its main threat: some 80% of pollution in oceans originates from land-based activities. These activities destroy and contaminate habitats, and about half of all the world's coasts are threatened in some aspect from human activity, as shown in Figure 2.

The driving force is population pressure, from sheer numbers increasingly wanting to live along the coast, and their increased personal wealth and consumerist demands. Not only are new areas being developed in coastal zones, but major redevelopments are being undertaken in existing coastal settlements as they compete in an increasingly globalised world, for example Brooklyn and Queens in New York, London's Thames Gateway and Shanghai's Bund.

Only in the last few decades has any concerted effort been made to reconcile the many conflicting uses on coastlines, so now the pressures being tackled are at differing scales: locally, regionally, nationally and internationally. Traditionally, coastal pressures have been managed by a focus on single issues, for example over-fishing or erosion or pollution incidents. The more holistic and sustainable strategy of integrated coastal zone management (ICZM) has long had widespread support in the USA and UK, and even in Belize in Central America, but is a relatively new concept in many growth economies, such as China.

The one pressure which is uniting countries in a concerted international effort is that of the pressures associated with climate change (Figure 3). Paradoxically, many of

Figure 1: Coastal populations

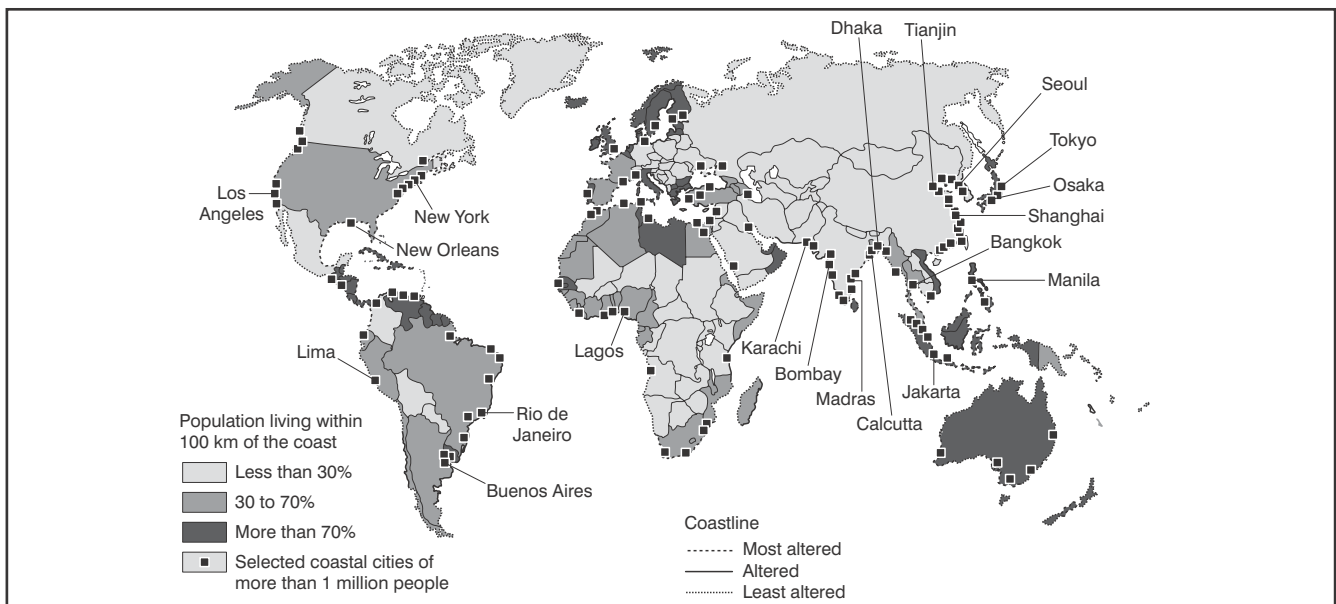


Figure 2: Sources of pressures on coastlines

Pressures	Major impacts
Climate change	Sea level rise, increased risk of storm surges, flooding and erosion, increased sea temperature, biodiversity change and often loss.
Urbanisation	Coastal squeeze, habitat disruption and destruction, eutrophication and pollution, artificial management of coastal processes e.g. sea walls, nourishment, water demand from rivers and aquifers resulting in salt water intrusion.
Tourism and recreation	As in urbanisation, plus seasonal demands and spatial hotspots. Increasing influence as the growth industry of the 21 st century and as the pleasure periphery for holiday makers expands to encompass 'new' locations.
Manufacturing industry	Coastal squeeze, pollution, biodiversity and habitat loss, landscape change, bio-product exploitation.
Primary industry – agriculture and forestry	Eutrophication, pollution, biodiversity and habitat loss and fragmentation, salinisation, altered sediment inputs, increased water demand resulting in less fresh water input to coasts.
Primary industry – fisheries	Over-exploitation of fish stocks, by catch of non-targeted species, destruction of bottom species' habitats, large scale disruption to food webs.
Primary industry – aquaculture	Eutrophication from overuse of nutrients and pollution, genetic alterations and alien species invasions, diseases and parasitic spread to indigenous fish.
Infrastructure including shipping	Operational and accidental spillages, pollution.
Energy: exploration, exploitation and distribution of raw materials	Alteration to habitats and landscapes, subsidence, contamination, pollution (noise, light, substances, altered sediment flows), sea bed and shore disturbance.

NB these pressures may not be local to the coast but may be felt quite some way inland, as rivers act as corridors for pollution and changed freshwater and sediment input to coastal zones

Adapted from the EU Marine Strategy Directive, 2005

these coastal cities vulnerable to increased sea levels, storms and surges are themselves partly responsible for increasing the greenhouse gas levels globally, because of their large and growing 'climate footprint'! They face growing economic disruption and increased regulation of production systems, energy resources, and standards for health and environment to combat their impact on the environment.

Case studies of pressures

Case study 1: Country-scale pressures and management options: China

With 18,000 km of continental coastline, China can be viewed as a 'marine nation' with its future development increasingly tied to coastal areas and resources. Its coastline is facing several growing

major issues, including rising sea levels threatening low-lying areas, pollution of inshore waters and loss of biodiversity, together with growing, increasing pressures to increase conservation. A recent report by China's State Oceanic Administration estimates the percentage of 'unsalvageable' eco-systems is 73% for mangroves, 80% for coral reefs and 57% for wetlands.

Some 73% of China's GDP originates from the coastal zone, the location for all the country's 14 'economic free zones' and five 'special economic zones'. Over 56% of the country's population, 677 million, live in the 13 south-eastern and coastal provinces and two mega-cities, Shanghai and Tianjin. Guangdong Province, including the Pearl River Delta, has had one of the fastest economic

growth rates in East Asia over the past decade; similar to Hong Kong and Singapore. Now a new coastal growth centre is being developed at the China-Vietnam border, called the Beibu Gulf Economic Rim.

Environmentally, China's coastal zone has a rich variety of marine life, with many unique species such as the Dugong sea lions, Yangtze river dolphin, and Chinese white dolphin. Over-fishing, rapid urbanisation, and lack of pollution controls on agriculture and industry have degraded river and coastal water quality, which in turn has destroyed much of the marine habitat and reduced marine ecosystem stability and biodiversity. Indeed, over-fishing and growing trans-boundary water pollution from China are two issues that underlie political tensions in NE Asia. China dominates fish farming (70% globally). Decreased sediment flow to the coast, because of large-scale dam projects, is leading to accelerated coastal erosion, compounded by sand mining for the construction boom. Rising sea levels, and salt water intrusion, especially in the Yangtze and Pearl River delta zones, are being felt especially by Shanghai and Tianjin, port city for Beijing, both key to the country's economic wellbeing. They have had relative sea level rises of up to 19cm over the past 30 years, due to natural and human exacerbated subsidence from over-building, ground water abstraction and huge reclamation projects such as Shanghai's new Pudong business and residential zone, and Dongtan ecocity. Also threatened is the key industrial zone of the Pearl River Delta, a huge cluster of cities and provinces about the size of the Netherlands, with 30 million official residents and some 12 million migrant workers. 2004 and 2006 were critical years showing the effects of rising sea levels, coupled with storm surges, coastal erosion, and saline water intrusion. By 2050 an estimated 1,153 of its 41,698 km² will be flooded.

There are many blocks to effective management and conservation in China:

- conflicts of long-term conservation with shorter-term goals of industrialisation and demand for rising living standards;
- arguments between central and provincial governments;
- few laws and enforcement in place;
- Communist rulers quash any voices of dissent, major organised protests are rare, and there is no

Figure 3: Bio-physical effects of climate change on coastal areas

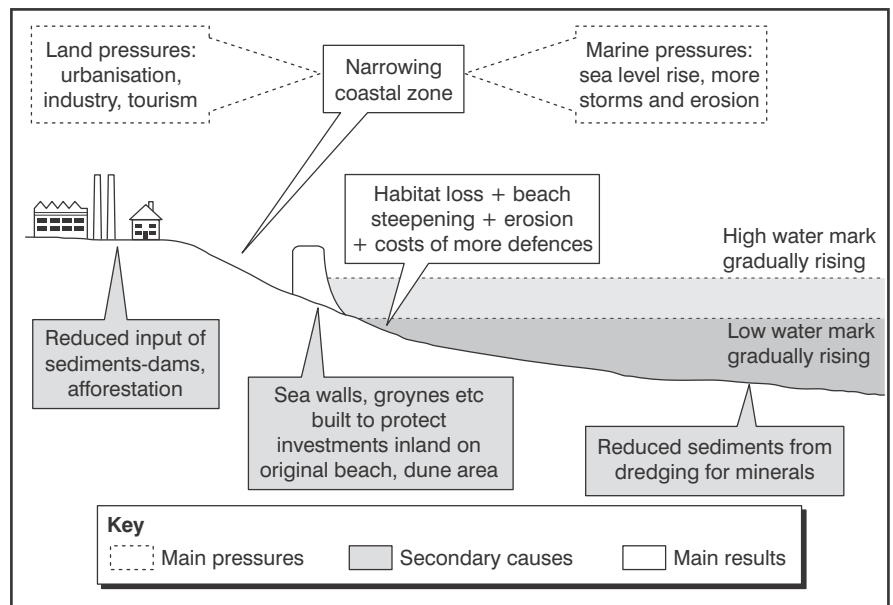
Type of change	Direction of change	Effects and pressures created
Global sea level	Increase – by 9–88 cm by 2100, 2–4 times the rate of that measured in the 20 th century. Regional variations – some areas little rise, others huge!	Storm surges-coastal inundation, displacement of wetlands, coastal erosion, increased storm flooding and damage, loss of ecosystems: from estuary to sand dune, mangrove to salt marsh, salt water intrusion, rising water tables, impeded drainage.
Sea water temperature	Increase	Effects on ecosystems, rates of productivity and growth. Coral bleaching is a negative effect.
Precipitation intensity	Increase	Effects on ecosystems, runoff, sediment movement into coastal areas, erosion.
Waves	Uncertain	Changed longshore drift and onshore drift patterns.
Storm frequency	Regional variations	Changed frequency and intensity of storm flooding and damage.
River runoff	Regional variations	Changed sediment supply from rivers to coast – if more floods then more sediment.
Atmospheric CO ₂	Increase	Increased productivity in coastal ecosystems.

culture of pressure groups. There are, however, signs of a growing environmental movement, as shown in 2007 by the use of 1million mobile texts to the local government to halt a billion-dollar petrochemical plant (to make paraxylene, linked to cancer), in the major port of Xiamen.

The main management solution to rising sea levels will be by adaptation, for example by higher sea walls, and ‘water gates’ like the Thames barrier, e.g. Wu Song Kou Wai, on the Yangtze estuary. China is now fully involved in the post-Kyoto-Bali Roadmap, which attempts to address global warming at the source by reducing emissions. Attempts in the 1960s to reduce the level of groundwater exploitation and recharge the aquifers reduced subsidence in the Shanghai zone to a few millimetres annually, but this has not been maintained in the current economic expansion with growing land reclamation. A combination of building and water abstraction conservation plus recharge wells and basins, will be needed to protect fresh water supplies at the coast, where salt water intrusion is a growing pressure.

Whilst ‘Coastal Environmental Stewardship’ is apparently now a national priority, China faces even greater political, social, and economic issues. China is facing many development problems at a level unknown to most of the world, and it may be argued that the nature of the challenges to their coastal waters is no different than many others – but perhaps the rate and scale of change are larger!

Figure 4: The term ‘coastal squeeze’ is applied to the situation where the coastal margin is squeezed between the fixed landward boundary (artificial or otherwise) and the rising sea level



Case study 2: Meso scale pressures: the Mediterranean coastal squeeze
 ‘Coastal squeeze’ has serious implications for wildlife, particularly birds which need beaches and mudflats to feed, and for farmers and property owners who are losing land. This is a global pressure – and it is well illustrated around the Mediterranean. Development along the Mediterranean has created the so called ‘Med Wall’ where over 50% of the coast is dominated by concrete. Two-thirds of Europe’s wetlands, most of which are coastal, have been destroyed over the past 100 years. Population densities along Europe’s coast are higher and continue to grow faster than those inland, especially in Portugal, Ireland, Spain, France, Italy and Greece. This pressure is from

spontaneous tourism and from EU subsidies designed to help economic restructuring in the form of new roads, which subsequently has attracted residential sprawl. Some 9% of all European coastal zones lie below 5 metres, especially in the Netherlands and Belgium, and are vulnerable to rises in sea level and related storm surges. Localised hotspots exist, especially the highly developed Venice area.

A recent feature of many Mediterranean coastlines is the huge growth of ‘urbanisations’, a Spanish term for self-contained clusters of apartments and villas catering for affluent retired foreigners and holiday makers, facilitated by cheap flights. One of the largest is La Marina near

Figure 5: Students studying the microcosm of pressures on coastal Belize: Caye Caulker



Source: Stephen Carville

Alicante on the Spanish Costa Blanca. Development began in 1985 and has pressurised the low-lying coastline and sand dunes, with issues ranging from water supply to lack of social integration with the local population.

The influential 1995 Dobris report provided the first major assessment of the state of coastlines and seas in Europe, but a review in 2007 suggested pressures on the seas and coasts continues to be high, despite all efforts at management such as the 'blue corridor' network of reserves and attempts at 'integrated coastal zone management' linked to the wider context of ecosystems and human well-being set up by the Millennium Ecosystem Assessment. Amazingly, management is still hindered in such an affluent area by the lack of a systematic GIS database for the European coast! Pollution has improved from reductions of nutrient pollution from industry and waste water, but agricultural run-off remains a problem.

Case study 3: Belize a small, middle-income country attempting integrated coastline management
 Belize, in Central America, has a complex, dynamic physical coastal system made up of the world's second largest barrier reef, a UNESCO World Heritage Site, offshore atolls, hundreds of patch reefs, extensive seagrass beds, mangrove forests, and more than 1,000 offshore islands called cayes. The latter dominate the tourism industry because of their natural attractions, with the first hotel built on Ambergris Caye in 1965. The pressures originate from:

- Concentration of people: over 45% of Belize's 314,000 population (2007) lives at the coast.
- 33% of the population live below the poverty line, despite Belize being classed in 2006 as an upper-middle income country by the

World Bank (China is classed as lower-middle income). To meet its reduction in poverty goals as part of the 2000 Millennium Development Goals, its coastal natural resources are essential.

- The economy is dominated by tourism and fisheries. In 1970 there were under 30,000 tourists, but by 2007 over 400,000 a year.
- The rise of cruise ships, both visiting the country (over 500% increase since 2000, with about 200 visits per year now) and passing by on Caribbean routes, add another concentrated dimension to tourism pressures, discharging not just swimmers to 'reef walk', but their sewage, called 'black water'!
- Growth of aquaculture, especially shrimp farming, is increasing in economic importance and physical impact.
- Increasing intensification of sugar and citrus production inland results in chemicals being washed into the relatively pristine coastal waters with fragile ecosystems.
- Rise in pharmaceutical companies wishing to carry out bio-prospecting for new products from the reef, creating more disturbance and potential damage to a vulnerable ecosystem already adjusting to global warming and sea level and temperature changes.
- Low investment and fragmented management

As a result, certain species have become endangered: the West Indian manatee, American crocodile, marine turtles and several types of birds.

However, since the late 1980s an attempt at Coastal Zone Management has been making some progress, funded mainly by the Global

Environment Facility and United Nations Development Programme, helped as well by the EU, and operated by the Belizean government's Ministry of Fisheries, Research and Monitoring. 2000 is taken as a base line for data collection, although measuring changes in the marine environment is obviously difficult! Education is seen as a prime role for Coastal Zone Management. The coast is split into nine planning zones, with various 'roadmaps' for planning aquaculture and demand for new facilities like hotels. Ecotourism is encouraged by the government, with organisations like the Belizean Ecotourism Association and Programme for Belize which work with the government to try and control the worst effects of tourist pressures. By the 21st century, marine reserves covered 11% of the coastal mainland, but only 1% of the ocean/atolls and cayes.

Conclusion

The pressures on all coastlines are increasing rapidly, both from physical and human causes. There is an increased determination to plan the coastline in an integrated, long-term holistic manner, involving all stakeholders in an attempt to balance the needs of development with protection of the very resources that sustain coastal economies. However, lack of reliable data and often government effectiveness has meant the ideals of integrated coastal management are a long way from being met on a large scale.

FOCUS QUESTIONS

1. How do the types and scales of changes at coastlines create different pressures? (What are the categories causing change: human e.g. tourism, industrial, and physical e.g. rising sea level.)
2. Why is coastal squeeze a complex issue? (Consider the variety of direct and indirect causes and consequences.)
3. What factors make coastal pressures difficult to manage effectively? (Categorise the barriers e.g. under funding, institutional capacity political will, scale of pressure, need to coordinate so many organisations involved, lack of data e.g. on destruction rates, lack of cohesive lobbying.)
4. Why is integrated coastal zone management seen as the ideal strategy in all these case studies? (Think of the scale, the complexity and the range of the pressures experienced in the case studies.)