CHAPTER 28

IS HARBOUR DEVELOPMENT ECOLOGICALLY SUSTAINABLE?

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1. INTRODUCTION

Not one of the twelve harbours studied in this book was developed in an ecologically sustainable way. The data presented in this book quantify environmental impacts ranging from degradation to ecosystem collapse.

A simple measure of the impact of harbours and urbanisation is the fisheries. In Tokyo Bay the total annual fish catch of fish decreased by a factor of ten, from 1×10^5 tons yr^{-1} in the 1950's to less than 5×10^4 tons yr^{-1} in the 1970's; this has not improved since even though environmental protection measures are being implemented. In the Changjiang Estuary, the biomass of *Stolephorus*, a traditional commercial fish species in the region, has been considerably reduced after 1990 and shows almost no landing records in last 5-10 years; the catch of *Stolephorus* decreased from 560 tons yr^{-1} in the 1960s to 5-10 tons yr^{-1} in 1990; and the commercial fishing for crabs in this region has shut-down after 1980s and all catches of crabs were banned in 1990 owing to a population crash. Fish kills are now occurring nearly routinely in the Pearl River Estuary and in Hong Kong waters from hypoxia and harmful algae blooms (HAB). Pearl Harbor is degraded but much less seriously; 99% of the oysters died in 1972; however fish and invertebrates survived into the 1990s when water quality improved. Bangkok estuarine waters can, in the dry season, become anoxic and inhospitable to fish; the situation is severe but not hopeless in the upper Gulf of Thailand; the catch per effort decreased by a factor of ten from about 290 kg hr^{-1} in 1963 to 20-30 kg hr^{-1} in the 1990s; fishery production declined greatly from 1986 to 1995. Fish stocks in Ho Chi Minh City estuarine waters have virtually collapsed and only aquaculture remains. In Manila Bay the trawl catch per unit effort decreased from 46 kg hr^{-1} in 1947 to 10 kg hr^{-1} in 1993; the demersal biomass decreased from 4.61 mt km^{-2} in 1947 to 0.47 mt km^{-2} in 1993. Hypoxia events are now reported in Klang Harbour, clearly inhospitable to fish. In Singapore waters, marine fish species composition between 1934 and 1973 showed no loss of species but definitely less abundance; wild fisheries are now negligible; occasional fish kills have occurred from spills and anoxia especially in Johor Strait. Jakarta Bay has very little intact fisheries; the remaining fisheries are

E. Wolanski (ed.), The Environment in Asia Pacific Harbours, 489–493.

comprised of more opportunistic fish species that can exist in the now heavily polluted waters. By comparison Darwin Harbour fisheries are still rich but they are completely non-managed in a free-for-all philosophy as if there was no tomorrow; in 2000, 37% of Darwin residents spent some of their time fishing and one in every five resident households owned a pleasure boat used at least partly for recreational fishing; the total number of hours fished annually in 2000 was estimated to be 540,481 hours; some fish spawning aggregations have disappeared; the resulting ecosystem impact is unknown and basically not studied, and this lack of data precludes sustainable management.

There are other parameters of environmental degradation. These include in all harbours studied in this book some, but not all, of the following symptoms: harmful algae blooms, anoxia and hypoxia (oxygen depletion), and poisoning by fecal pollution, 4,4'- DDE and 4,4'-DDT, pesticides, PAHs and phenol, the production of toxins that accumulate through marine food chains to poison marine mammals, seabirds and humans. In extreme cases of grossly polluted, poorly flushed waters a parameter of pollution is simply gross stench.

Another measure of environmental degradation is a decrease in biodiversity. In the Pearl and Changjiang estuaries for instance, the number of species of plankton and benthos has decreased dramatically, the community composition of plankton and benthos is now much simpler, and the biodiversity is degraded.

In some cases such as the Changjiang Estuary the ecosystem has essentially collapsed; its historical role of providing multiple ecological services to society is changing to a simplified service system, e.g. the estuary essentially provides only land for settlement and waterways for transportation and trade.

Protecting endemic species from invasive species is low on the priority list of port operators. Invasive species are increasingly common, mainly introduced through ballast water in large bulk cargo carriers and vessel fouling, especially of slow moving barges and dry docks. These can overwhelm some endemic species.

2. THE BAGGAGE OF HISTORY

The historical practice in these harbours has been to combat human poverty and to develop economically at the accepted, explicit cost of environmental degradation. This policy appears still to prevail in several harbours such as the Pearl and Changjiang estuaries, Jakarta Bay, and Ho Chi Minh City.

In all harbours the environmental damage has been done. In some cases it is being vigorously addressed. In the case of Tokyo Bay, Singapore and Pearl Harbor, after these countries became wealthy and strictly controlled pollution, the waters became clear, giving the appearance of health; a high diversity of marine life is still present; this indicates that port waters can support marine species; however the ecosystem is severely depleted, it does not provide ecosystem services to maintain the quality of life that the population could enjoy if the marine environment was rich and healthy.

The key mechanisms preventing ecosystem recovery in wealthy countries' harbours appear to be habitat loss, habitat degradation and habitat modification. These key habitats are mangroves and salt marshes, mud flats, seagrass meadows, and coral reefs. The pace of converting marine habitats to meet development needs appears unsustainable. The key culprits appear to be seabed dredging, infilling, and the dumping of dredged spoils, and land reclamation for settlement, industry, harbours and aquaculture. Two other major culprits are over-fishing and the intentional or accidental introduction of species - and diseases – mainly from ships.

In less wealthy but emerging countries, there appears to be a will to restore environmental quality, such as is the case of Manila Bay; the practical means to do so are limited.

3. A PATHWAY TO ECOLOGICAL SUSTAINABILITY

The case studies in this book demonstrate that, using only strict pollution control measures, it is unrealistic to expect urbanised waters to provide the quality of life that a wealthy population expects. Because these waters are semi-enclosed and generally poorly flushed, there are no boundaries. Thus the ecosystem services provided by the waters will not be restored by relying only on zoning for industry, ports, urban areas, and some marine protected areas, and fishing quotas.

Remedial measures based on engineering and technological fix have not been successful in restoring the ecological processes of healthy, robust waters in harbours and the urbanised coast; they will not reinstate the full beneficial functions of this ecosystem; the impacts on the quality of life of the human population is severe.

As the case studies in this book demonstrate, engineering alone is not a solution, though engineers (and am I one) often justify their environmental impacts by the statement that it is 'the world's best practice' – this is a fallacy! There is no such established world's best practice for environmental management of harbours, as the case studies in this book demonstrate.

Instead, the successful management of the urbanised coast requires an ecosystem-based, basin-wide approach (eg Zalewski, 2000 and 2002; Wolanski et al., 2004; Norse and Crowder, 2005). This necessitates changing present practices by official institutions based on municipalities and counties as an administrative unit, and the narrowly-focused approaches of managers of specific activities (e.g. farming and fisheries, water resources, port operators, urban planners, wetlands management, nature conservationists). Without this change in thinking and management concept, these waters will continue to degrade, whatever 'integrated coastal management plans' are implemented. This necessitates the establishment of political authorities to coordinate all activities within the drainage basin, the urban, harbours, and industrial areas, and the waters. This necessitates political will and determination, and in most cases this is generally lacking as the issue of quality of life is often seen as non-urgent. A welcome exception in all these cases is Tokyo Bay where the recent legislation recognises that the whole drainage basin and the bay must be managed as an ecosystem. People living along its coastline are expected to use it wisely, and the wishes of the local people are respected. Some habitat restoration is under planning.

Habitat restoration to improve ecosystem abundance may not be possible in Singapore because it has literally run out-of-room.

In Hong Kong, the issues are largely still simply to use engineering solutions to prevent ecosystem collapse; at times the system is overwhelmed both by local pollution and pollution brought in from upstream, as well as habitat destruction. The system resembles that of the Changjiang Estuary, i.e. an area primarily seen as valuable for land reclamation and shipping – its ecosystem survival is still not a political priority although the situation is slowly improving.

In less developed countries, there is room for optimism in some cases, such as in Manila and further down the scale of practicality for Jakarta Bay, because political coordination and determination do show signs of emerging. In both cases, the authors of the chapters arrive at the same conclusions, namely that the key element that prevents ecologically sustainable development is the lack of recognition of the key role of ecohydrology. The river basin and the coastal waters where the harbour is located form an ecosystem. It can only be managed in an ecologically sustainable way by an independent port and bay management authority – as opposed to an advisory committee - that involves all stakeholders in industry, government and the community, and comprises an executive body.

Where the practice has been to scatter ports all over the area, such as in Ho Chi Minh City and the Peal Estuary, in a free-for-all development strategy, the political process that is necessary to restore the environment has been made harder and has barely started. The environmental costs are staggering.

Which brings us to the case of Darwin Harbour. Its ecosystem is pristine compared to all the other harbours described in this book. There are large-scale current and proposed developments including increasing human population and urbanisation, doubling the size of the LNG gas plant, another pipeline through the Harbour to the expanded gas plant, further clearing of mangroves, a 10-fold increase in the size of the port, sea cage aquaculture, a Helium plant, dredging for port expansion, waterfront developments, sand mining, and an increase in shipping. Untreated or primarily treated sewage is still dumped in the harbour. Major developments have proceeded with minimal environmental impact and remediation studies. Fishing is large-scale and practically unregulated. Some of these fisheries may survive longer simply because the habitats (e.g. the land and the mangroves) are protected by Aboriginal traditional owners on the west bank – this may raise a social inequity issue as the Aborigines may not benefit from the service they provide to the community by helping to provide fish because the fisheries laws make these fish free for all. Despite the potential of Darwin Harbour ecosystem to degrade, there does not appear to be a cohesive management plan backed by political will, to ensure long-term ecological sustainability. Each development is assessed in isolation. An ecosystem-ecohydrology based approach is needed to avoid repeating the experience in the Asia Pacific harbours described in this book – namely, once the environment is degraded, the ecological services to sustain the quality of life of the human population cannot be fully restored. As a parent I view natural resources as a bank account that we hold in trust for future generations. If the politicians fail in Darwin Harbour to learn from the mistakes of other Asia Pacific harbours, we leave our children with a serious debt to pay and we fail a critical test as a society.

4. THE ROLE OF SCIENCE

As demonstrated by the twelve harbours described in this book, engineering and technology by themselves do not provide a long-term solution to sustainable development. Statements in the engineering community of 'world's best practices' when discussing environmental sustainability of harbours are nonsense and not backed by facts as the case studies in this book illustrate.

Instead an ecohydrology-ecosystem approach to harbour development is needed. Science has key role to play to help develop this approach (e.g. Beach, 2002; Norse and Crowder, 2005). Besides providing knowledge in traditional disciplines, such as physical and biological oceanography, taxonomy, and toxicology, scientific research is also needed to explain the workings of the ecosystem and its response to human-induced stressors. It can thus quantify the effects of biota and biotic processes on mediating the urbanised waters' response to changing hydrology, sediment, pollutants and nutrient flux. When that knowledge is gathered, then science can, in collaboration with engineers and technologists, provide science-based remediation measures at the basin scale, with elements of ecohydrology, habitat manipulation, and phytotechnology at their core, to strengthen the ability of the biota to sustain and adapt to human-induced stresses.

5. REFERENCES

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