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Environmental Impact of Deforestation

The retreat of mangrove versus mangle dynamics[1]

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MANGROVE SWAMPS, VULNERABLE AND HIGHLY COVETED AREAS

Mangrove swamps, forests of mangrove trees that colonize tropical coastal swamps, were long seen as putrid, mosquito-infested, impenetrable and sterile. Since the 1960s, however, scientific progress, particularly in ecological terms, and increasing concern about conservation on the part of the different social players, have led to widespread condemnation of the excessive use and abuse of mangrove swamps, and to the implementation of policies aimed at protecting these ecosystems, which are now seen as rich but vulnerable.

This chapter shows the extent of mangrove swamp depletion, and goes on to look at the reasons behind it and the range of consequences. It sets out to cast new light on mangrove swamp dynamics and underline the ensuing conflicts.

INTENSIVE DEFORESTATION OF MANGROVES

Many compilations on mangrove swamps have been published in the last twenty years, from Rollet's bibliography (1981) to the atlas by Spalding et al. (1997), through the various management handbooks issued by governmental and non-governmental organizations including UNESCO and FAO, along with IUCN, WWF and IWRB (for a more comprehensive bibliography, see Cormier-Salem, 1999, Vol. 2). All the contributors, most of them naturalists specializing in the composition and structure of mangrove forests, comment on the extent of mangrove degradation and condemn the irreversible environmental damage caused by human intervention.

Human impact has increased significantly in recent decades as a result of population pressure, which is particularly strong in coastal areas, and of over-exploitation of resources (wood, fish, shrimps and so on). There are many examples to support these claims. For instance, annual mangrove losses are estimated at 24,000 ha in the Philippines, 5,000 ha in Malaysia and 35,000 ha in Ecuador. The area originally colonized by mangroves is considered to have shrunk by 50 per cent in Thailand and 75 per cent in Puerto Rico. There are no end of figures to confirm this rapid degradation of mangrove swamps

(Cormier-Salem, 1999), but we feel it would be more relevant to look at the causes and consequences of the trend.

FROM A MULTIPLE USAGE SYSTEM TO INTENSIVE MONOPRODUCTION

As shown by piles of shells or *kjökkenmödding*, mangrove swamps have been exploited for their resources – plants (wood, pulp, tannin), animals (crabs, shrimps, oysters, waterfowl, crocodiles, manatees) and minerals (salt, lime) – since the very beginnings of human occupation. In addition to their food uses, which are often essential in times of shortage, these resources can also be used for therapeutic purposes (medicines, dressings) and crafts (fuel, construction timber, other timber, dyes and so on). In most countries, mangrove swamps are exploited by small groups of shifting users and hunter-gatherers, as an occasional extractivist activity. The products of mangrove swamps are intended for domestic consumption or exchange with inland rural populations (Cormier-Salem, 1994).

There are two notable exceptions to this: according to the first written evidence – the chronicles of Portuguese navigators from the fifteenth century onwards – two particularly important economic activities had a significant impact on the coastal environment. The first was tannin extraction from mangrove tree bark. Tannin is primarily used to treat leather and hides, and was traded over long distances, between the coasts of East Africa, Arabia and India (Rollet, 1981). It was a major activity until the early twentieth century, when it was gradually replaced by synthetic substitutes. For instance, up to 200,000 tonnes of mangrove tree bark were exported from Madagascar between 1902 and 1918. However, this activity is now in decline (Pierre, 1994).

Agricultural development of the coastal mangrove swamps of Rivières du Sud (also known as Northern Rivers) in West Africa (from Senegal to Sierra Leone) led to the development of a veritable rice-based civilization (Cormier-Salem, 1992, 1998). By dint of several generations of hard work – from building dykes, clearing mudflats and desalinating the soils to ploughing plots and selecting seeds – and total control of the specificities of the environment, the local populations in Rivières du Sud have managed to set up amphibious plantations in the mangrove swamp (Plate 9.1). The high population density is both a cause and consequence of the success of these high-yielding dyked rice plantings. Mangrove swamp communal territories (or *terroirs*) are managed collectively by indigenous communities on an egalitarian basis. The multiplicity of uses of mangrove swamps – in addition to rice, fishing, oyster gathering, and salt and wood production – and the regulation of access to resources have contributed to the co-viability of the ecological and human systems that have developed in the region's mangrove swamps.

The sustainable management by local communities of the many resources of mangrove swamps runs contrary to the large-scale monoproduction-based development schemes initiated by colonial administrators and continued until the present day by public and private bodies in independent countries (Cormier-Salem, 1998). Mangrove mudflats are primarily seen as huge reserves of arable land. In the first half of the twentieth century, they were dried, drained and developed for agriculture. Sugarcane and coconut plantations expanded at the expense of the Latin American mangrove swamps, while the swamps of West Africa were supposed to become the rice granary of French West Africa. Most of these large-scale schemes failed (Ruë, 1998): yields on developed plains were barely any higher than those of traditional farms, and drainage structures – dykes, drains, canals and dams – were not adopted by farmers as they were unsuitable for the agricultural and soil conditions of mangrove swamps. Moreover, modifying natural water flow disrupts ecosystem functioning. Large stretches of mangrove swamps, which were cleared and converted to rice, have now been abandoned and have become bare, sterile wastelands as a result of soil acidification and salinization.

Since the 1950s, mangrove swamps have been prime urban and port development sites. Huge industrial and port developments have had a direct impact on the extension of mangrove swamps, as shown by the land pressure in major coastal cities such as Sydney and Singapore. They have also had an indirect impact, through pollution of coastal waters. Moreover, runaway urbanization in developing countries has contributed to increased demand for mangrove swamp products. Mangrove wood is one of the main sources of fuelwood and charcoal in certain coastal towns such as Conakry in the Republic of Guinea (Cormier-Salem, 1999) or Tulear in Madagascar (Lebigre, 1997). While the importance of mangrove wood as a fuel and the consequences of felling for coastal wetlands dynamics are debatable (compare the discussion below), the conversion of mangrove swamps into aquaculture ponds now seems to be the main factor in mangrove degradation.

THE MAJOR CURRENT AND FUTURE IMPACTS OF SHRIMP FARMS

Shrimp farming has developed spectacularly since the 1980s throughout South-East Asia (Thailand, Vietnam, Malaysia, Philippines), India and also Latin America (Ecuador, Puerto Rico and so on). In Thailand, the total area of mangrove swamps is estimated to have shrunk from 367,900 ha in 1961 to 180,559 ha in 1991, due to deforestation for timber and charcoal, mudflat conversion into agricultural land, and above all the multiplication of shrimp farms. According to Christensen (1983), the income generated by the various mangrove swamp products (wood, oysters, fish, rice and so on) is generally below $200 per ha per year, whereas for shrimps, it looked set to top US$2,000 per ha per year by the year 2000.

Shrimp farming, be it extensive as in Vietnam (Nguyen Hong, 1992) or intensive as in Ecuador (Revelli, 1991), disrupts the ecological functioning of mangrove swamps for long periods and also upsets traditional multiple-usage systems.

In Minh Hai province, Vietnam, Camau mangrove swamp covered some 140,000 ha before the Vietnam War (estimate published in August 1945). It was the main source of timber, fuelwood and charcoal for the plains of southern Vietnam. From 1961 to 1972, the mangrove forests were bombed and largely destroyed by defoliants: some 45,000 ha were damaged. By 1975, there were just 92,000 ha of mangrove swamps. From 1975 to 1980, significant efforts were made to replant with Rhizophora, but at the same time, despite a ban, mangrove trees were being used to supply urban markets with fuelwood and charcoal, and also as construction timber to build dams around aquaculture ponds. In fact, since the late 1980s, the development of extensive shrimp farming has precipitated the deforestation of the Camau swamp. Mudflats with mangrove swamps attract immigrants in search of land and are converted for production, agricultural, and increasingly, aquacultural purposes. These shifting users, who are often in dire financial straits, adopt an extractivist, short-term management approach with respect to the mangrove swamps. Yields are low and life is hard, away from urban centres and without infrastructures. Extensive shrimp farming exacerbates not only environmental degradation, but also the social and economic vulnerability of swamp users.

According to Revelli (1991), the destruction of the mangrove swamps (35,000 ha) in Ecuador and the marginalization of indigenous fisher-farmers can be put down to the expansion of intensive shrimp farming since the 1980s. From January to May 1990, 350,000 tonnes of shrimps were exported, primarily to the United States and the EEC. The shrimp market in Ecuador is controlled by a powerful lobby of businesspeople under the umbrella Federation of Shrimp Exporters. Shrimp farming adversely affects ecosystem functioning: the introduction of foreign shrimp species modifies the food chain, and the emergence of parasites, which affect both imported shrimps and the local fauna, is significant proof of this. In addition to the ecological hazards, there are also health, social and economic risks. Extending aquaculture ponds increases the risk of malaria. Shrimp monoculture upsets the traditional multiple-usage systems practised in mangrove swamps, which combine small-scale fishing, clam and crab gathering, timber cutting and tannin extraction. Fisher-farmers either become hired labour on shrimp farms or move to large towns.

DEFORESTATION AND LOSS OF BIODIVERSITY

Recent ecological studies have demonstrated the impact of polderizing mangrove swamps on the coastal environment, on a local and also worldwide

scale. Since the 1960s, mangrove swamps have been seen as rich but vulnerable ecosystems that must be protected if terrestrial and marine biodiversity is to be preserved. They have multiple ecological functions (Table 9.1).

The main aim of the Ramsar International Convention on the protection of wetlands was to protect the habitat of migratory birds, which fly south in the winter. UNESCO's mangrove replanting programmes have set out, amongst other things, to preserve mangrove swamps as reproduction habitats for numerous fish species. As they put it, 'no forest on land, no fish in the sea'.

DISCUSSION OF THE INEVITABLE RETREAT OF MANGROVE SWAMPS

The results of recent multidisciplinary work on West African coastal areas and a bibliographical compilation on mangrove swamps worldwide have gone some way towards moderating the dominant view of the vulnerability of mangrove swamps and their irreversible retreat, and cast new light on degradation processes (Cormier-Salem, 1999).

The first point of interest is mangrove ecosystem dynamics (Field, 1995, 1996). The available data on the current extension of mangrove swamps worldwide are somewhat unreliable and difficult to compare: different authors used different measuring instruments; the floristic composition of mangroves is hotly debated and estimated to include anything between fifty-three and seventy-five species; and mangrove swamp delimitation varies depending on the source and may either be limited to the mudflats colonized by mangrove trees or cover the whole of the intertidal zone, including wastelands and areas developed at the expense of the mangrove swamps. This lack of a common

Table 9.1 Main physical and biological roles of mangrove swamps

Physical roles	coastal stabilization
	acceleration of polderization or land extension processes
	barrier against wind, storms, cyclones and waves
	beach and riverbank protection, riverbank retention
	waste absorption
	tidal channel drainage maintenance
Biological roles	econiche for microflora and microfauna
	organic matter supplies, enriching coastal waters and soils
	spawning beds for fish, shrimps and shellfish
	refuge for migratory birds
	natural habitat for various forms of animal life

Sources: Saenger et al., 1983; UNESCO, 1986.

frame of reference, combined with the mobility of mangrove mudflats and the fluidity of sediments, makes estimates difficult. It is important to stress the remarkable natural dynamism of mangrove swamps. They may shrink, as a result of a rise in sea level, erosion or excessive sediment deposits along the coast, as shown by mangrove graveyards (Plate 9.2), or spread, following extension of the coast and its rapid colonization by pneumatophores, as shown by Avicennia pioneer fronts (Plate 9.3).

These observations suggest that further studies are needed of the extent of mangrove swamp retreat, compensation phenomena, both natural and artificial (reforestation), colonization of sediment banks and the regeneration capacity of mangrove swamps. Mangroves in fact appear to be more robust than other forest ecosystems. Mangrove specialists all recognize the remarkable stability of this type of plant structure, at least over long periods, and the relatively minor changes that have affected its spread over the past millennium.

Moreover, the real impact and long-term consequences of human intervention are questionable. This article has stressed the spectacular expansion of shrimp farms at the expense of mangrove swamps in Asia, Latin America and, to a lesser extent, Africa, and described the conflicts of interest on various levels (between indigenous and outside users, public and private interests, ecological pressure groups and industrial lobbies, and so on). More specific attention should perhaps be paid to mangrove tree felling, which is often seen as one of the major causes of environmental degradation. It transpires that mangroves play a very limited, if not negligible, role as sources of fuelwood, charcoal, wood and construction timber, compared with inland forest ecosystems.

In West Africa, for instance, the vast stretches of mangrove in the Niger delta and along the Cameroonian coast are barely used. Local populations prefer the equatorial and tropical forests, which are much richer and more varied, to the relatively inaccessible mangrove swamps. In the Rivières du Sud region, the forests are only intensively exploited around the main coastal towns, Conakry, Freetown and, to a lesser extent, Bissau and Ziguinchor. However, estimates are generally inadequate and the available data unreliable, since mangrove swamps are so mobile and deforestation is so difficult to measure. The multidisciplinary field work done in the region since 1980 seems to suggest that the retreat of the mangrove swamps is less due to their widely assumed over-exploitation than to the drought from which the area has been suffering since the 1960s (Cormier-Salem, 1999).

Furthermore, community–mangrove relations in Rivières du Sud cast considerable doubt on the Malthusian theories that would have it that environmental degradation is linked to population pressure, over-exploitation of resources and poverty. The degradation of farming systems in mangrove swamps is not caused by population pressure but, on the contrary, by rural exoduses. Young men and women traditionally made up the bulk of the workforce. The number of people remaining in the villages, which is

constantly falling, is no longer sufficient to maintain amphibious territories and particularly the protective dykes they require. The gradual abandoning of rice growing in mangrove swamps results in soil salinization and acidification, and, eventually, in the development of wastelands. In other words, conserving the ecological and cultural heritage constituted by mangrove swamps means maintaining both dyked rice paddies and traditional social structures.

On a world scale, the share of mangroves in fuel supplies only seems to be of any significance in countries in which inland wood supplies (savannahs and forests) are non-existent, over-exploited and/or subject to strict controls. Moreover, clear felling of mangrove trees generally seems to be restricted to an area within a 30 km radius of large towns (Pierre, 1994). While deforestatio of coastal mudflats is currently very limited and mangroves have a high regeneration capacity, appropriate legislative steps still need to be taken soon to forestall the growing demand from urban markets for mangrove swamp products.

CONCLUSION

Mangrove forests (or mangroves) are retreating markedly in favour of aquaculture ponds in certain developing countries for which shrimp farming is a crucial source of foreign currency. However, mangrove swamps (or mangles) are not limited to mangroves alone, and shrimp farming does not reflect the whole range of relations between local communities and mangrove swamps.

Mangrove swamps are complex ecological and cultural interfaces. While there are often abrupt short-term changes on a local level, on a world level and over a longer time span their expansion seems remarkably stable. The current trend reflects a combination of factors, of both natural (rise in sea level, change in sediment deposits, adverse climatic change and so on) and human origin (changing values and functions of wetlands, population growth, innovative strategies, changing management policy and so on).

The contrasting trends occurring in mangrove swamps mean that scientists need to define reference states, investigate the processes involved in environmental change, and identify social stakeholders and their strategies, on a local, regional and international level, and that policy-makers should be setting up discussion forums with a view to reconciling the interests of all those with a stake in mangrove swamps and adapting legislation to specific situations.

NOTE

1. In English, two distinct words are used that French does not have: ‘mangrove’, referring to forest, and ‘mangle’, referring to mangrove habitat or swamp.

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PLATE 9.1 A mangrove *terroir* in West Africa (Casamance). Source: © Cormier

PLATE 9.2 Retreat of mangrove swamps: a mangrove cemetery in French Guiana (Kaw estuary). Source: © Cormier

PLATE 9.3 Progression of mangrove swamps: mangrove pioneer front in French Guiana (Sinnamary estuary). Source: © Cormier

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Published jointly in 2004 by the United Nations Educational, Scientific and Cultural Organization (UNESCO)
7, Place de Fontenoy, F-75352 Paris 07 SP
and the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD),
42, rue Scheffer, 75116 Paris

Typeset by Curran Publishing Services, Norwich, UK
Printed by Jouve, Mayenne

ISBN UNESCO 92-3-103941-5
ISBN CIRAD 2-87614-577-4

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Printed in France