

Causal chain analysis

This section aims to identify the root causes of the environmental and socio-economic impacts resulting from those issues and concerns that were prioritised during the assessment, so that appropriate policy interventions can be developed and focused where they will yield the greatest benefits for the region. In order to achieve this aim, the analysis involves a step-by-step process that identifies the most important causal links between the environmental and socio-economic impacts, their immediate causes, the human activities and economic sectors responsible and, finally, the root causes that determine the behaviour of those sectors. The GIWA Causal chain analysis also recognises that, within each region, there is often enormous variation in capacity and great social, cultural, political and environmental diversity. In order to ensure that the final outcomes of the GIWA are viable options for future remediation, the Causal chain analyses of the GIWA adopt relatively simple and practical analytical models and focus on specific sites within the region. For further details, please refer to the chapter describing the GIWA methodology.

The Causal chain analysis for Indonesian Seas is focused on Unsustainable exploitation of fish and other living resources, and the issue destructive fishing practices. This concern and issue was chosen as it has severe environmental and socio-economic impacts across much of Indonesian Seas, scoring highly in all three GIWA sub-systems (Sunda, Wallacea and Sahul). Within the context of destructive fishing, one method; poison fishing to supply the live food fish and aquarium trades, is of particular future concern. It has major transboundary implications, both in terms of target species populations and replenishment, and in terms of the driving forces, and is thus the main focus of the following causal chain analysis. The other major immediate causes of destructive fishing; blast fishing, muro-ami and inappropriate trawling, are not explicitly considered in this causal chain, although many of the immediate, intermediate and root causes are similar.

System description

The key aspects of the system are described in detail in the Regional definition and Assessment (Habitat and community modification and Unsustainable exploitation of fish and other living resource) sections. The coral reef fishery resources of Indonesian Seas, as with much of South East Asia in general, have been heavily targeted by the live fish food trade since the early 1990s, to supply primarily Chinese markets in Hong Kong, Shanghai, Taipei and other major cities. A secondary fishery to supply ornamental species for the global aquarium trade has also targeted these areas. The ornamental and aquarium trade is an international, multi-million dollar industry with 36% of the global trade coming from South East Asia (UNEP/WCMC 2004).

The live food fish and ornamental aquarium fisheries in the region and elsewhere are destructive because of the widespread use of sodium cyanide and/or potassium cyanide and/or various other soluble plant-derived poisons to narcotise the fish. In Indonesia, cyanide is widely used to capture both live reef food fish and aquarium fish. Weber (1998) assessed the status of some 200 fisheries around the world and concluded that the live reef fishery of South East Asia is one of the most threatened fisheries on the planet.

The poisons used to capture the fish have the detrimental side-effect of also poisoning and usually killing the non-target, sessile, sedentary and site-attached reef species in the vicinity, most notably the corals (Johannes & Riepen 1995). This has caused loss of considerable coral cover in many areas of Indonesian Seas and elsewhere in the greater South East Asian region, with secondary and tertiary effects on the structure and function of the associated coral reef communities.

There has been rapid expansion of the live fish trade in Indonesian Seas over the past two decades, since concerns were first raised in the early

1990s (see Johannes & Riepen 1995 for initial review and Pratt 1996). The official export information demonstrates that exports from South East Asia increased from some 400 tonnes in 1989 to more than 5 000 tonnes in 1995. However, by 1996 there was a 22% decline in recorded exports, suggesting overfishing (Bentley 1999). Of the total exports, Indonesia accounted for some 60% from 1990-1995.

History of the Indonesian fishery is traced back to the late 1970s and early 1980s, when reefs of western provinces (Sunda) were targeted. As these reefs were progressively overexploited, the rich resources of eastern Indonesian reefs (Wallacea and Sahul) were targeted and by 1993 accounted for more than 75% of all recorded exports (Bentley 1999). Reflecting the regional reduction in exports in 1996, exports from eastern Indonesia dropped by more than 450 tonnes that year. For example, Johannes and Riepen (1995) wrote: "...the information... paints an alarming picture of the extent and impact of the trade...the volumes of fish being traded are a poor indicator of the magnitude of the trade's environmental impact...because of the extensive collateral environmental destruction the trade is causing".

The full extent of poison fishing in Indonesian Seas is unknown (Johannes & Riepen 1995, Burke et al. 2002), because it targets some of the most isolated coral reefs where little if any scientific work has been conducted. However, in conducting a detailed threat analysis of destructive fishing in South East Asia, Burke et al. (2002) identified many of the reef areas of Sulawesi (Wallacea), offshore areas of the Jawa Sea and Sumatra (Sunda) and areas off Papua (Sahul) as all facing the highest level of threat. As noted by Bentley (1999): "The live food reef fish trade...

is complex. Involving several tiers of trade, the characteristics vary... and have changed over time. Although the fishery began with foreign vessels and crew, there was a rapid turnover to local operations... Exporters found it cheaper to employ locals."

The mode of export has also changed and diversified in recent years, from various forms of ship-based transport to the more widespread use of airfreight, with exports by air from Indonesia rising from 5% to 40% from 1991 to 1995 (Bentley 1999, Cesar et al. 2000).

The causal chain for the issue of destructive fishing/poison fishing shares many similarities across the three Indonesian Seas sub-systems, as indeed with neighbouring regions of Sulu-Celebes (Sulawesi) Sea and South China Sea.

Causal chain analysis

The Causal chain analysis was founded in the extensive background knowledge and publications of the GIWA Task team and additional information provided by various government agencies, academic institutions, NGOs and other agencies, as cited herein (also see Annexes VII and VIII). Nonetheless, some large gaps in information remain. In particular, there is a serious lack of long-term socio-economic data on human use patterns. Figure 15 illustrates the causal links for destructive fishing practices in the Indonesian Seas region.

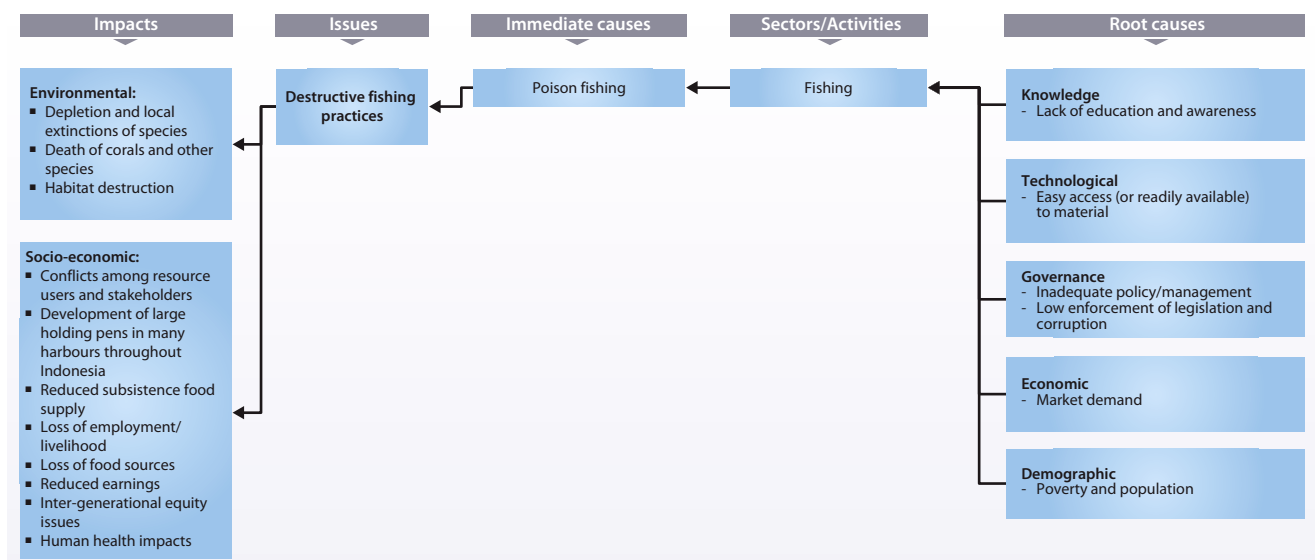


Figure 15 Causal chain diagram illustrating the causal links for destructive fishing practices.

Environmental impacts

- Depletion and local extinctions of targeted and non-targeted species;
- Death of corals and other sessile, sedentary and site-attached species, with concomitant changes in community structure;
- Loss of coral cover, with effects on the structure and function of the associated coral reef communities.

Socio-economic impacts

- Conflicts among resource users and other stakeholders and foreign vessels involved in the live reef fish export trade;
- Development of large holding pens in many harbours throughout Indonesia (Figure 16);
- Reduced subsistence food supply through reduced Catch Per Unit Effort (CPUE) to small-scale local village fishermen;
- Loss of employment/livelihood among local village fishermen;
- Loss of food sources (e.g. sources of protein) in parts of Indonesia;
- Reduced earnings in one area by destruction of juveniles and brood stock in other areas;
- Inter-generational equity issues (access to resources) among poor local fisher families;
- Human health impacts, particularly to divers.



Figure 16 Live fishholding pens, Anambas & Natuna Archipelago, Indonesia.

(Photo: J.L.N. Sivasothi, Reefbase)

There is strong and unequivocal evidence for all of the above indicators in the ecological data and in socio-economic assessments conducted as part of various MPA and coral reef management projects (e.g. Komodo National Park, Bunaken National Park, COREMAP project (see also Annexes VII, VIII).

Immediate causes

Poison fishing

The topical application of the poison; various forms of cyanide and other poisons, usually by surface-supplied 'hookah divers' using easily prepared 'squirt bottles' (usually old detergent bottles or similar) directly in the vicinity of the target species allows for ease of collection. The poisons are cheap to purchase and widely available; so this is not limiting the spreading of the fishery.

The divers often work at night, when most species of target fish are more easily collected, systematically removing fish (either food fish or ornamental aquarium species) along entire reef slopes. Concurrently, the input of hundreds of tonnes of cyanide and other poisons per year to Indonesia's coral reef communities, particularly targeting the larger brood-stock and spawning aggregations of reef-associated fishes, has had disastrous consequences both for the populations of the target species themselves, and for the incident reef communities. The removal of brood-stock and targeted collection of spawning aggregations has resulted in broad-scale depletion of reproductive stocks and likely major decline in reproductive output and recruitment back to the fisheries. This is now beginning to be evidenced in the reduction in large fishes and relatively high number of small-size fishes being sold at local markets.

On the one hand, the live food fish and aquarium trades have become highly organised over the decade since the early 1990s, with large operations of up to 20 'hookah divers' with air supplied from the surface working together in dories operating from larger vessels to supply the lucrative Chinese and developing global markets. On the other hand, small-scale village operators also deplete their local reefs, either to supply visiting buyers or to support their own or other villagers' aquaculture activities, particularly for reef groupers (Serranidae). Thus, there are both highly commercial and 'subsistence' aspects to the trade.

Root causes

The current harvesting practice of the trade is unsustainable (Johannes & Riepen 1995, Burke et al. 2002). Poison fishing remains the predominant technique for reef fish capture in Indonesian Seas. The economic benefits for the fishers themselves are minimal, with the greatest profit margins limited to the middle men and restaurant points of sale (e.g. in Hong Kong). The live reef food fish trade (particularly in China) and ornamental aquarium trade (global) are lucrative industries where reef food fish can fetch prices of up to 100 USD/kg and ornamental species (e.g. reef angel fish) more than 100 USD per pair. For the very rarest of ornamental species, prices in the thousands of USD have been

charged (DeVantier pers. comm.). Between 1996 and 1999, the share of the United States ornamental fish market coming from South East Asia increased from 67-78% (US Fish & Wildlife Custom declarations unpubl. data).

Knowledge

Lack of education and awareness

Destructive poison fishers often have little education and lack awareness and appreciation of the environment. Many fishermen in Indonesia have only rudimentary education and little to no basic understanding of the ecology of the fishes or indeed coral reefs generally. Because of their poverty, the fishermen have little option than to participate in the fishery when offered comparatively lucrative returns for their effort. Moreover, there is a widely held misconception amongst fishers that the use of destructive fishing is better because it yields a bigger catch for the least effort. The coincident widespread lack of awareness about the destructive aspects of the fishery, combined with the typical viewpoint

of 'if not me then someone else will do it' has led to the 'Tragedy of the Commons' situation common and almost axiomatic in many fisheries worldwide.

Technological

Easy access to (or readily available) material

The ready availability of the poisons (e.g. from electro-plating industry) has contributed to their widespread use. Training has also been provided to locals by the exporters in some areas.

Economic

Market demand

The almost insatiable market demand for live seafood, particularly from China and from Chinese people in other areas, has created a class of willing fishers who will use any fishing methods to achieve goals of maximum yield at the minimal effort. Both the commercial (export) and local (grow-out for mariculture) ends of the live fish market offer comparatively lucrative rewards for effort, relative to hook-and-line and trap fishing (the other main modes of supplying live fish) (Bentley 1999). This demand is largely focused on a few groups of reef fishes. Notable are the food fish groupers Serranidae (Figure 17), especially various species of Coral cods (*Epinephelis* spp. and *Cephalopholis* spp.), Coral trout (*Plectropomus* spp.) and the Barramundi cod (*Cromileptes altivelis*) (Figure 18), snappers (Lutjanidae) and emperor bream (Lethrinidae) and the labrid Maori wrasse (*Chelinus undulatus*) (Figure 19). The ornamental aquarium trade tends to target the gaudy site-attached or home-ranging fish species, particularly the angelfishes, tangs, anemone (clown) fishes and butterfly fishes. The lack of accountability and responsibility, both among fishers themselves and in some cases



Figure 17 Live reef fish, including large groupers *Epinephelis* and *Plectropomus* spp. for sale in restaurants, Hong Kong. (Photo: C. Cheung)



Figure 18 Live reef fish, including Barramundi cod *Cromileptes altivelis* for sale in restaurants, Hong Kong. (Photo: C. Cheung)



Figure 19 Live reef fish, including Maori wrasse *Chelinus undulatus* for sale in restaurants, Hong Kong. (Photo: C. Cheung)

at the point of sale and the absence of any effective education and awareness campaigns or surveillance and enforcement, exacerbates the situation.

Governance

Inadequate policy/management

The administrative structure has traditionally been cumbersome, divisive and top heavy. Until very recently (e.g. Butarbutar et al. 1999), power has rested almost exclusively with a multitude of central government agencies with provincial, regional and village levels poorly equipped to take on any significant responsibility, being little recognised in the legislative process. Legislation and regulation has traditionally favoured exploitation of coastal and marine resources rather than conservation (Annexes III-IV). Additionally, there are inadequate resources and capacity to develop policy and legislation more suited to addressing the identified impacts or to effectively execute relevant existing legislation.

These difficulties are exacerbated by the civil strife that has developed in some parts of Indonesia, particularly since the 1990s, and also by the three-tiered government system. National, provincial and local government levels are not well integrated in many areas in terms of making best use of the existing legislation. As a general rule, even where legislation is in place at provincial and local levels, surveillance and enforcement agencies have little or no capacity to implement it, except in a few small MPAs receiving both government and NGO support (e.g. Komodo National Park, Bunaken National Park) (Annexes VII and VIII).

Low enforcement of legislation and corruption

The lack of capacity in enforcing legislation has contributed to the establishment and continued increase in destructive fishing (e.g. Susiloweti 1998). This is exacerbated by widespread corruption and the fact that many destructive fishing activities are carried out in remote places, whereas enforcement capability is largely restricted to the few well-managed MPAs (e.g. Komodo, Bunaken National Parks).

Demographic

Poverty and population growth

The coastal fishing communities of Indonesia, as indeed throughout much of South East Asia, are often characterised by large families, high populations and extreme poverty. Coastal communities in general are the poorest in Indonesia. With low incomes, lack of access to credit, a lack of opportunity for alternative incomes and a general lack of social infrastructures, these communities contribute to the environmental decline, and through their subsistence activities are pushing many coastal resources beyond their sustainable limits (Hopley & Suharsono 2000).

These are strong driving forces behind most negative environmental and socio-economic impacts of fisheries in the region. The dependence of most of the coastal people on their fisheries resources, for their subsistence on the one hand and for hard currency on the other, is so strong that most resources will be extracted unless alternative livelihoods and other concerted long-term interventions, at the scale of the region, are implemented, far beyond those that are already occurring.

Providing alternative livelihoods for poor coastal people can be difficult, as they need to be convinced that they would get a better deal with a new initiative. An example of this is poison fishing, whereby the fishers need to be convinced that: (i) a new (less destructive) method will yield the same if not better catch; and/or (ii) removal of unsustainable numbers of fish, including brood-stock, will cause collapse of the fishery, threatening both their own and their childrens' future livelihoods.

Recent attempts at developing alternative livelihoods, including some forms of ecologically-sustainable mariculture of species where all life-cycle stages have been 'closed' to exclude the need for wild-capture, and where food is sourced non-destructively (e.g. not trash fish from benthic trawling), are proving successful on small-scale trials (e.g. Hon Mun MPA, Nha Trang, Vietnam, in GIWA region 54 South China Sea).

Conclusions

In summary, constraints which have retarded Indonesia's coastal and marine management include (Hopley & Suharsono 2000):

- Lack of integration both vertically between different tiers of government and horizontally between a wide array of agencies;
- Lack of a conservation ethic and political will;
- Social and cultural constraints resulting from low levels of awareness, education, community participation in the management process, and high levels of poverty which limit the alternatives to activities such as destructive fishing;
- The weaknesses of the marine protected area system;
- Insufficient scientific, social and cultural data for effective management and lack of access to the data which is available;
- Insufficient human resources leading to lack of implementation of laws, regulations and management plans.

Destructive fishing, and particularly poison fishing to supply the highly lucrative international live fish food trade and ornamental aquarium trade, is an increasing problem (Pratt 1996, Barber & Pratt 1997) that

impacts all three sub-systems, both in terms of fisheries and habitat loss. The most significant root causes are the interactions among population growth, poverty and market trends, notably the insatiable international demand for live seafood. Population growth is exacerbating unemployment and poverty, which are placing greater pressure on stocks of fish and other living resources. Lack of enforcement of laws governing destructive fishing, abetted through corruption within enforcement agencies and some government officials, allows the illegal fishing practices to flourish. Economics and market trends drive the unsustainable use of resources and also influence corruption and the illegal practices.

Key government departments, including the enforcement agencies, are hampered by a lack of qualified and experienced staff, and also by funding shortfalls and cutbacks in part related to currency depreciation and shifts in government spending. Despite a recent trend towards decentralisation in governance, there remains insufficient capacity for effective stewardship and control of the renewable resources. What is currently lacking is coordination and capacity to apply the existing legislation, particularly at local government levels, and to review and amend the legislation to improve its functionality, particularly cross-sectorally and at provincial and local levels.