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Assessment of sand extraction and use in coastal fishery communities of Cambodia

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Abstract

Coastal resources need to be maintained in order to support livelihoods and well-being of coastal resource-dependent communities, as well as to provide a balanced set of ecosystem goods and services. However, development projects, including infrastructure projects such as ports, modern settlements, resorts and tourist destinations, have been implemented at an alarming rate along the coastal areas of Cambodia in recent decades. In addition to these development projects, coastal areas have been exposed to sand extraction and related activities, all resulting in the coastal environment facing negative consequences. In order to identify, measure and analyze the above issues, a causal framework "DPSIR" model developed by European Environmental Agency (EEA) has been used. This model has five key elements namely, Driving Forces, Pressures, State (environmental change), Impacts and Responses . Based on household surveys and focus group discussions, the following observations have been made: environmental problems are a consequence of two key driving forces of sand extraction and use activities, and infrastructure developments taking place within Kampot port and the development projects in the Special Economic Zone (KSEZ). The coastal resources face varying levels of degradation; in addition to decreasing biodiversity, there have also been significant changes in other ecosystem elements and changes in environmental qualities. Social problems such as changes in traditional occupations, outward migration, conflicts and mental stress have also occurred. As a result of alteration of mangrove forests, the livelihoods of communities are also affected. In order to resolve these problems local authorities and fishing communities have responded with demonstrations, conflict mediation, mangrove replantation, and job alternatives but with limited success thus far.

Keywords: *Boeng Tuk Commune, Kampot Province, coastal ecosystem, DPSIR model.*

Introduction

Coastal areas, like other ecosystems such as tropical forests and wetlands, are vital to maintain a balance within the natural and social environments through the provision of ecosystem goods and services. Coastal resources, such as coral reefs, sea grass beds and mangroves are important for local environments, biodiversity and communities; providing them livelihood security and protecting communities from natural disasters such as storms, erosion and salinity intrusion (Sarker *et al.*, 2010). Among the coastal provinces of Cambodia, Kampot Province has been identified for its development potential. The Kampot Special Economic Zone (KSEZ) was created in order to develop an international sea

port with a total development cost of 80 million US Dollars (JICA, 2010). Together with shipways and a deep sea water port, several activities taking place in the area, such as sand dredging (Johnsen and Munford, 2012; Marschke, 2012), expansion of seashores and other infrastructure constructions cause many environmental problems to the local communities in Cambodia's coastal areas. Increased construction activity has led to greater demand for construction materials, especially sand for construction activities, building of dykes and seashore expansion activities. These infrastructure developments, plus dredging of the deepwater port and shipways would invariably cause coastal erosion, disrupt coastal ecosystem process, reduce sea water quality, and damage coastal habitats, such as mangroves, sea grasses and coral reefs. Lovell (2005) argued that extensive environmental impacts would occur with any sand extraction. This might be due to precipitating erosion or sand transport which would alter the environment and hence, the composition of organisms. It has been already documented that fish yields have declined, having a direct impact on Cambodia's coastal resource dependent dwellers (Sek Som, 2007; CES, 2008; Seak, 2011). So far, there have been no detailed studies to assess the impact of sand mining activities on the coastal provinces of Cambodia, implying that there is an urgent need to understand the DPSIR aspects in order to ensure appropriate planning, policy recommendations and environmental protection mechanisms. This understanding is necessary for the long-term protection of coastal community livelihoods and ensuring sustainable development of coastal areas. This study aims to identify the impact of sand extraction and use activities on the Kampot coastal fishery community, by applying a DPSIR model as suggested by the European Environmental Agency 1999 (EEA).

Material and methods

Both quantitative and qualitative methods were used to collect primary data for identification, measurement and analysis of the DPSIR framework components. Research activities were divided into two phases; an action phase and an analysis phase, as listed below:

(i) Field selection: Selection of location, including stakeholder identification;

(ii) Field data collection: Direct observation, informal focus group discussions, key informant interviews, workshop, and household questionnaire surveys with fishing communities, local authorities and other external stakeholders; and

(iii) Analysis: Detailed and systemic analysis of the five DPSIR framework elements.

Study site

The research was conducted entirely within Rolous and Kep Thmey villages, Boeng Tuk Commune in Tuek Chhu District, Kampot Province (Fig. 1), largely at the construction sites of development projects in the KSEZ. Boeng Tuk Commune is located about seven kilometres from Kampot provincial town. The commune area is 2,467 ha area and is characterized by coastal plains, with Bokor Mountains nearby. The area has a

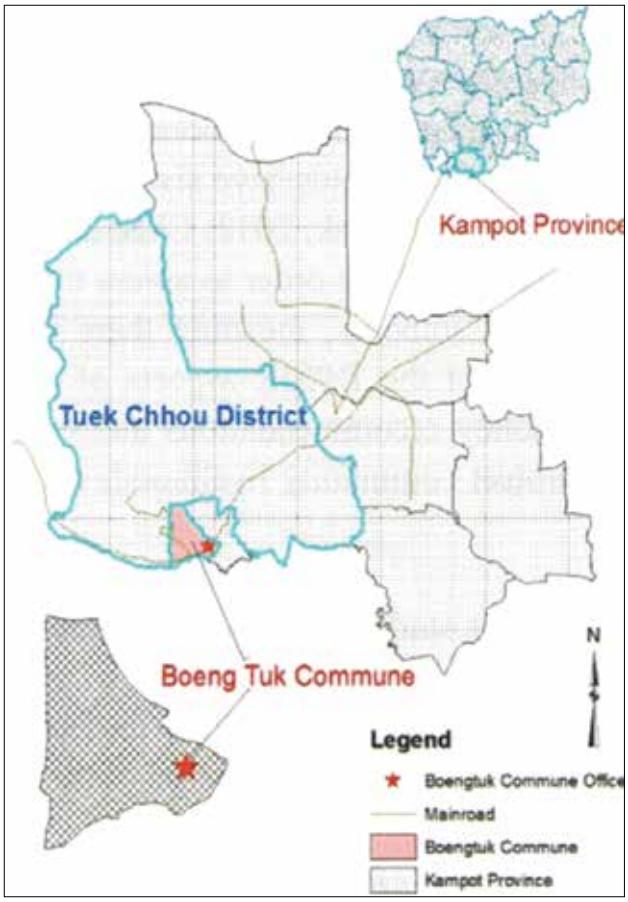

Fig. 1. Map of Kampot Province and the study site

number of construction projects and sand extraction activities. There are two coastal fishing communities in the area: Rolous and Kep Thmey villages, both of which are totally dependent on coastal resources.

Research approach

The DPSIR framework was used to identify and analyze the five key elements (Fig. 2).

The DPSIR framework is a model recommended by the EEA for the development of Integrated Environmental Assessment Strategies, and provides the indicators needed to enable

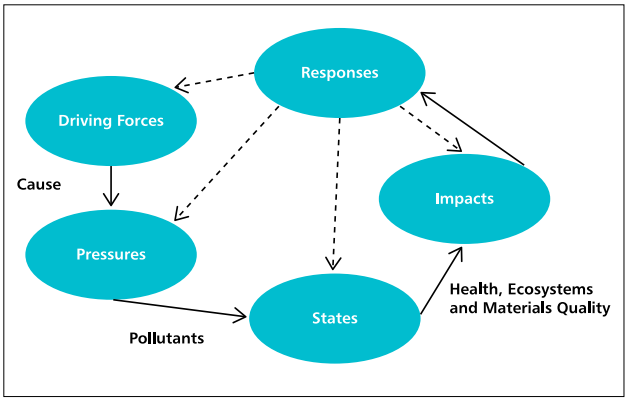

Fig 2. The DPSIR Assessment Framework (adapted from Kristensen, 2004)

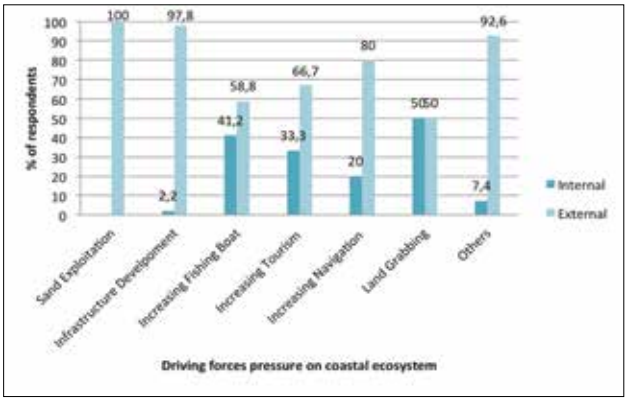

Fig 3. Driving forces which exert pressure on coastal ecosystem (% of respondents)

provision of feedback to policy makers on the environmental impacts of political choices made. This framework focuses on five key areas associated with change: driving forces, pressures, states, impacts and responses, and these five areas are linked (Kristensen, 2004).

Field data collection

Sampling approach: A rule of thumb method was used to ascertain the number of households needed to create a suitable sample from the two coastal fishing villages of Rolous (344 households) and Kep Thmey (432 households), with 25% of the total of 776 households randomly selected, making a sample size of 194 households for the survey. These households were the target for the household surveys.

Focus group discussions: Twelve active fishermen and fisherwomen living in the two villages were selected for group discussion. A visualization technique was used to develop a social map and a natural resources map, to ascertain the zoning areas and to gather other qualitative information.

Key informant interviews: Key informants, such as the village chiefs, the commune council chief, the heads of fishing community, and representatives from government agencies and non-governmental organizations were interviewed.

Results

DPSIR elements analysis

Driving Forces: Based on results from household interviews and focus group discussions, it was identified that sand extraction and infrastructure development in the study site are the key factors behind the problems faced by the local communities (Fig. 3).

Pressures: The above two critical driving forces exerted pressure on coastal biodiversity and communities' livelihoods. All the surveyed households responded that sand extraction activity exerted maximum pressure; 97.8% of the respondents identified infrastructure development taking place within Kampot international port and KSEZ development projects as other driver for exerting pressure.

State: More than 70% of the respondents noticed that seagrasses, seaweeds, flower crabs (*Portunus pelagicus*), mangroves and sea fishes have significantly reduced (Fig. 4), their populations were also observed to have reduced rapidly within a short time span (Table 1). While more than 50% of the respondents reported the populations of several other exploited fish species were reduced , relatively less number of respondents (less than 50%) opined reduction in the populations of marine mammals, marine reptiles and coral reefs. This may be due to conservation measures taken to protect these species.

Besides the decreasing biodiversity, there have been significant changes to the physical characteristics of the ecosystem. High level of changes in water turbidity (41.2%)

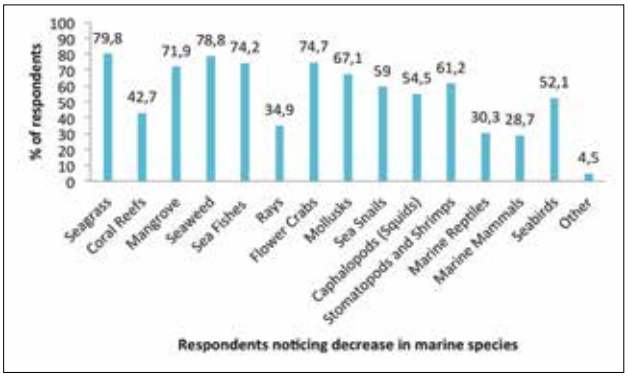

Fig 4. Percentage of respondents noticing decrease in marine species

Table 1. Respondents' view (%) on decrease of marine species in the study area

Marine Species	Percentage Decrease (%)				
	Very Small	Small	Medium	Large	Very Large
Seagrasses	7.1	9	17	35.9	31
Coral reefs	14	15	23	25	23
Mangroves	7	7	12.4	34.5	39.1
Seaweeds	2	1	18	44	35
Rays	22	4	10	34	30
Other sea Fishes	2	2	28	49	19
Stomatopods and prawns	3.2	1	24.4	51.4	20
Flower Crabs	2	2	17.4	57.1	21.5
Sea snails	0	4	13	48	35
Cephalopods (squids)	2	1	24	50,5	22,5
Other molluscs	1	3.3	13.5	42.5	39.7
Marine reptiles	18	8	29.5	29.5	15
Marine mammals	22	9	27.5	27.5	14
Seabirds	5.5	3	20	42.9	28.6

and salinity intrusion (41.7%) have been identified by the respondents (Table 2).

In addition to the environmental problems, social problems have started to occur. For instance, 90.4% of the respondents

Table 2. Respondents' views (%) on changes in physical characteristics of ecosystem

Characteristics	Levels of change (% respondents)		
	Low	Medium	High
Erosion	36.8	52.6	10.5
Water turbidity	35.3	23.5	41.2
Wind strength	57.3	32	10.7
Noise pollution	38.2	47.1	14.7
Air pollution	13.1	53.1	33.8
Salinity intrusion	27.8	30.6	41.7

were professional fishers, of which 56% had to change their occupation to construction and factory workers outside of their home land. However, 38.8% of the respondents said that being a fisherman had a higher level of livelihood stability than that of a waged worker.

Impacts: In terms of changes to the environment, the surveyed households rated pollution as having from a very low to a very high level of impact. For instance, 36.4% of households recognised water pollution while 22.5% complained of air and noise pollution (Table 3).

Of the households surveyed, 27.5% said that the habitats of the flower crabs have altered in recent years (Fig. 5), and

Table 3. Respondents' views (%) on types and levels of pollution impact

Types of pollution	%	Impact Levels				
		Very Low	Low	Medium	High	Very High
Air pollution	22.5	10.3	7.7	38.5	35.9	7.7
Water pollution	36.4	14.5	9.7	37.1	21	17.7
Land pollution	18.5	10.7	17.9	25	35.7	10.7
Noise pollution	22.5	22.9	20	28.6	11.4	17.1

of these 64.2% stated that the impacts have been high. In addition to Flower Crabs, 22.8% said that some of the sea fish are facing habitat loss. All the respondents noted that the loss of marine mammal habitats is a serious problem.

Significant impacts were reported on livelihoods, with 54.5% of the households surveyed complaining that their daily

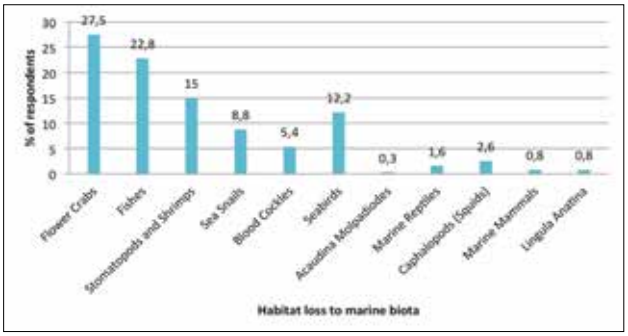

Fig 5. Respondents' views (%) on habitat loss to marine biota

income had reduced following a decrease in abundance of economically important species. About 57.9% claimed that incomes have decreased along with fishing yields when compared to the past (Fig. 6). In addition, about 45.5% claimed that they now face difficulties having lost their traditional occupation as fishers, 29.2% said they are in debt and 39.9% stated that a number of fishermen have had to move to other provinces or abroad in order to find new jobs. Another significant impact felt by the local communities has

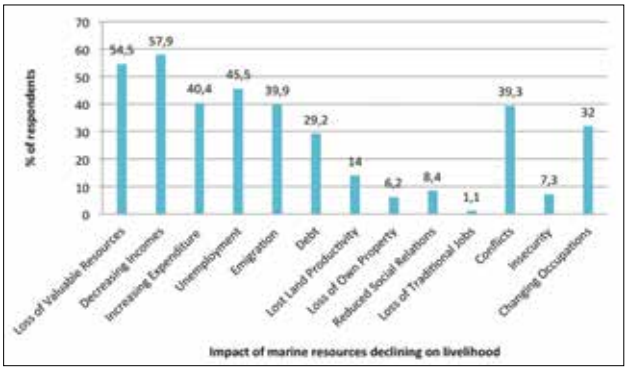

Fig 6. Respondents' view (%) on livelihood

been the rise in the number of conflicts; 39.3% said that conflicts now occur within the communities due to sand extraction activities and development projects.

Moreover, health and sanitation issues have also started to cause problems. Of the respondents, 47.2% stated that they now suffer from fever and headache due to the noise pollution coming from the construction activities (Table 4). A significant percentage of the respondents also reported not having proper toilets.

Table 4. Respondents' views on health and sanitation problems

Health Problem	Percentage	Level of impact (%)		
		Low	Medium	High
No proper toilet	48.3	65.1	26.7	8.2
Dirty water	10.1	33.3	38.9	27.8
Malnutrition	28.1	42	34	24
Mental problem	3.9	42.9	0	57.1
High blood pressure	19.7	57.1	20	22.9
Headache and dizziness	47.2	78.6	11.9	9.5
Throat inflammation	6.7	75	16.7	8.3
Irritated eyes	11.8	71.4	14.3	14.3
Gastritis	28.1	66	20	14
Skin problems	5.1	44.4	44.5	11.1
Malaria	16.3	51.7	27.6	20.7
Dengue fever	21.9	41	35.9	23.1

In terms of social-cultural issues within the study communities, conflicts have become a problem in recent times, and 79.8% of the households surveyed said that conflicts regularly take place between villagers and the developers (private investment companies), and 69% said it is having a significant impact on their lives (Table 5). A low percentage of villagers mentioned that conflicts take place between local authorities and developers, as well as among villagers, though 44.4% and 55.6% of the respondents, respectively, said that this has a low impact.

Responses: There were large differences on how the interviewees responded to the challenges. More than half of them (53.4%) said that they have decided to face to the problems, with 12.4% saying that they are proactive in replanting mangroves, though 47.9% said this has not been very effective (Table 6). About 24.7% stated that the communities have responded by cleaning the surroundings themselves, with 61.4% saying that this response has been reasonably effective. The communities' advocacy rights are supported by local NGOs, though 87.7% of the respondents said they are not very effective.

On the issue of conflict, 40.4% said they have noticed conflicts taking place between the villagers and the developers, and that mediatory efforts are very effective in settling the disputes (Table 7).

Table 5. Respondents' view (%) on social and cultural impacts and their severity

Social and Cultural Impacts	%	Severity of impact (%)		
		Low	Medium	High
Breakdown in solidarity	15.2	40.7	44.5	14.8
Insecurity	11.8	50	31.8	18.2
Conflicts between the authorities and developers	5.1	44.5	11.1	44.4
Conflicts between the authorities and villagers	18	28.1	37.5	34.4
Conflicts between villagers and the developers	79.8	15.5	15.5	69
Conflicts among villagers	5.1	55.6	22.2	22.2
Lost place of worship	3.4	0	28.6	71.4
Loss of fishing culture	4.5	25	25	50

Table 6. Responses (%) to issues and their effectiveness

Responses	%	Effectiveness levels		
		Low	Medium	High
Mangrove replanting	12.4	47.9	39.1	13
Loans	11.2	70	20	10
New occupations	18	53.1	43.8	3.1
Community financing	18.5	54.5	27.3	18.2
Cleaning the local environment	24.7	18.2	61.4	20.4
Advocacy	59	87.7	9.5	2.8
Mediation	20.8	64.9	27	8.1
Legal solutions	23	81	14.3	4.8
Migration	12.4	63.6	27.3	9.1

Table 7. Respondents' views (%) on conflict types and effectiveness of mediation efforts

Conflicting parties	Roots of conflict	(%)	Effectiveness of Mediation		
			Low	Medium	High
Between authorities and developers	Overlapping territory	1.7	100	0	0
Between villagers and authorities	Protests and responses	7.9	76.9	23.1	0
Between villagers and developers	Development activities	40.4	90.3	6.9	2.8
Among villagers	Land-grabbing	0.6	0	100	0

Discussion

Two main driving forces (sand extraction and infrastructure development) in addition to a number of others have led to environmental problems amongst the local fishing communities. Rizvi and Singer (2011) and Johnsen and Munford (2012) have noted that human development activities are one of the key driving forces behind the negative environmental trends in Cambodia's coastal zone, and have identified sand dredging around the Koh Kong and Kampot coastal areas as the main issue. The dredging of sand without the use of adequate safeguards also is a risk to life. A related issue is the reported incidence of oil spills from the dredging vessels, leading to water pollution in the area.

As highlighted in an initial environmental impact assessment carried out by the CES (2008), the coastal resources and community livelihoods are under significant pressure in the study area. Biodiversity levels have been reduced by construction activities such as drainage and the reclamation of mangrove wetlands in order to expand the harbor, as well as land fill activities. These activities have also had an impact on livelihoods, degrading marine fishing resources, creating obstacles for saltpan irrigation, fragmenting the fishing zones, damaging crab nurseries, as well as creating dust and noise pollution.

These pressures have led to changes in the state of the ecosystem. Sek Som (2007) reported that turbidity of seawater has increased and debris from construction sites and drainage pipes pollute the area. Transportation activities also tend to pollute the water with waste and oil. Based on information from the focus group discussions held in Rolous village, some of the most valuable marine resources such as seaweeds, rays, sea snails (*Noble volute*), blood cockles (*Arca granosa*), sea cucumbers (Holothuroidea), sharks, whales, sea turtles and blue-barred parrot fish (which has declined most rapidly), mangroves, sea grasses, shrimp and squid in addition to the leopard cat (*Prionailurus bengalensis*) are in jeopardy. Since 2002, the leopard cat has been placed on the Least Concern (LC) list by the International Union for the Conservation of Nature (IUCN). Based on interviews with local communities, the leopard cat was earlier seen inside the mangrove forest, but there have been no recent sightings due to habitat loss and hunting. In addition to these species, cranes, moorhens, Lesser Whistling Duck (*Dendrocygna javanica*) sea snakes and the crab (*Galene bispinosa*) are also declining in numbers at a rapid rate. From communities' perceptions, Seak (2011) reported that the development projects in Boeng Touk Commune had a negative effect in both community livelihoods and the environmental quality.

According to the findings of Johnsen and Munford (2012), there are strong indications of widespread sea grass habitat destruction due to the degradation of water quality as a result of increased turbidity caused by forest clearing, sand dredging and reclamation activities. During the focus group discussion in Rolous village, the villagers said that dust from the construction activities has caused significant air pollution problems in the village, and that this is having large impact on the environmental quality and the health of locals. Otay *et al.* (2003) reported that extraction from shallow areas may modify near shore wave conditions, affect erosion and deposition rates, and alter benthic habitats and near shore circulation. Due to mangrove and sea grass habitat degradation along with decreasing fish yields, 40.4% of the surveyed households said that they needed to change their traditional fishing practices, having to go further offshore to catch fish, and spend more on gasoline as a result. Beside the natural environmental impacts, local communities are also facing a number of social problems. The household survey and focus group discussions revealed that each village has its own social network, plus groups such as savings groups, fishery community groups, crab banks, mangrove forest groups and funeral support associations. Unfortunately, some of these groups have recently been dissolved, and in fact, the fishery community group in Rolous village had to be dissolved because around 800 ha of community land around the village was taken over for one of the development projects. Seak (2011) states that because of tourist resort and international sea port development projects, Roluos fishery community disappeared in 2010, as the village's fishing ground was granted to the port developers. As a result of these developments, conflicts occurred between the fishers and developers, and among the fishers.

Sek Som (2007) has expressed concerns of relevant provincial departments and local authorities over the likely impacts of the projects. The villagers tried their best to protect their fishing grounds against the developers by organizing protests, but were not considered. A number of local people responded by finding alternative jobs and/or have migrated outside, while those remaining have continued to advocate for compensation to be paid for the loss of jobs and earnings due to the development projects. The local authorities, in particular, have played an important role in helping to mediate between the developers and villagers. However, thus far only verbal agreements have been made by the developers promising to provide job opportunities, introducing electricity to the villages, developing a small fishing port, building toilets and compensating the villagers with 500 US dollars each in cash.

There are a number of ways in which the issues may be addressed, these are listed below:

- A mediation mechanism and formal agreement between community and developer should be established.

- Local communities and authorities should be involved in development planning.
- Ecosystem based approach should be integrated into Environmental Management Planning of the port.
- A full Environmental Impact Assessment should be strictly in place.
- Scaling up Integrated Coastal Management (ICM) approach should be considered.

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