GEF/UNEP PROJECT ON THE DUGONG AND SEAGRASS CONSERVATION

NATIONAL REVIEW OF DUGONG AND SEAGRASS: INDONESIA

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NATIONAL REVIEW OF DUGONG AND SEAGRASS: INDONESIA

PREPARED BY

NATIONAL REVIEW TEAM:
Anugerah Nontji
Tri Edi Kuriandewa
Erix Harryadie

DECEMBER 2012

Acknowledgment

The National Review Team members would like to extend their gratitude to those who has contributed or provided information for the preparation of this document: Rofi Alhanif, (MMAF); Wawan Kiswara, (RCO-LIPI); Malikusworo Hutomo (Lamina); Dwi Supriati (WWF-Indonesia); Ulva Takke (Mimpi Indah Resort); Priti, Nurul Dhewani (COREMAP II).

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1. Introduction

Seagrass is a group of flowering plants (Spermatophyte) which have completely adapted to live submerged under marine environment; posses vascular, leave, rhizome and root system, and propagate generatively by seeds and vegetatively by shoot. The rhizome represents nodded stem that grows horizontally underneath the substrate's surface. The plant is able to cover large area of shallow coastal waters and called seagrass bed or seagrass meadow. Seagrass bed may consists of single species (monospecific) or more than one species (mixed vegetation), densely or sparsely distributed.

Since the last few decades people realize the importance of seagrass beds that play roles as sediment stabilizer as well as coastal protector against wave and current forces. From ecological point of view, seagrass functions as producer of organic substance, as habitat for great variety of animals, as substrate for several kinds of epibenthos, as well as nursery ground for the larvae and jeveniles of fish and other organisms. Most important among the functions is the production of organic matter which is of great value to support the lives of all associated fauna, including dugong and turtle, both are by law protected.

Dugong (*Dugong dugon*, Müller, 1776) is herbivorous marine mammal which has become endangered and is protected under the Ministry of Agriculture Decree No. 327/Kpts/Um/1972. Dugongs depend on the production of seagrass, and they are the only marine mammals which graze intensively on this plant. Its main diet is seagrass, which make up about 90 % of its diet. De Iongh (1995) pointed out that dugong likes to feed on *Halodule uninervis*. Based on his research it became apparent that there is a correlation between the number of dugong and the food available. Moreover, the change of seagrass abundance and nutrient quality will influence the movement and mating cycle of the dugong.

The aims of this review document are to provide picture on the current state of distribution and condition of dugong and seagrass in Indonesian marine and coastal areas, on going projects and studies related to dugong and seagrass conservation, and measures for conserving dugong and seagrass. The document will be compiled with other countries' similar document that participate in the regional GEF/UNEP-CMS Project entitled *"Catalysing the conditions for more robust dugong and habitat conservation measures across the Indian and Pacific Oceans Basins through sustainable community-led stewardship and economic development"* .

2. Distibution and current status of dugong and seagrass

A preliminary dugong assessment for Sumatra, Java, Kalimantan, Sulawesi, Bali, Nusa Tenggara, Maluku and Papua is presented below. The main aim of this assessment is to summarize the (published) information available about the different areas. Each area account includes: a general description, overview of the status and distribution of the dugong and an overview of the status and distribution of the seagrass. The assessment presented below is based on literature reviews only, and since very little literature is available it is difficult to conclude if this assessment gives an accurate overview of the dugong distribution and status in Indonesia.

2.1. Regional synthesis of dugong status and distribution

A preliminary dugong assessment for Sumatra, Java, Kalimantan, Sulawesi, Bali, Nusa Tenggara, Maluku and Papua is presented below. The main aim of this assessment is to summarize the information available about the different areas. Each area account includes: a general description, overview of the status and distribution of the dugong and an overview of the status and distribution of the seagrass. The assessment presented below is based on literature reviews only, and since very little literature is available it is difficult to conclude if this assessment gives an accurate overview of the dugong distribution and status in Indonesia.

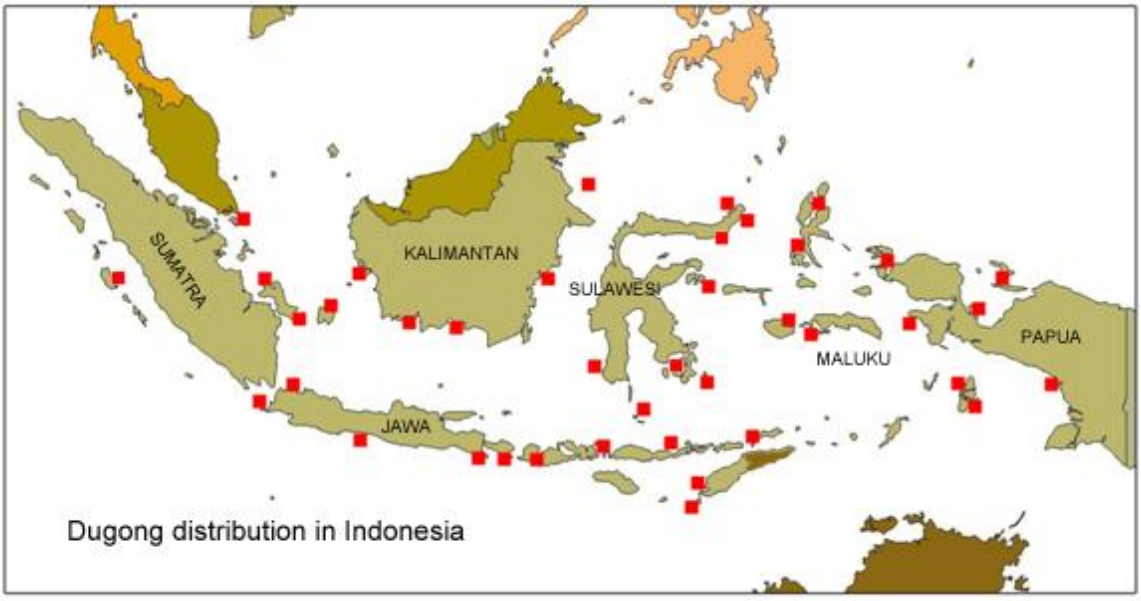

Fig. 1. Distribution of dugong in Indonesia (synthesis from various sources)

Sumatra

In 1976 a survey team from the Jaya Ancol Oceanarium in Jakarta surveyed the islands Bangka and Belitung during which two dugongs were caught in Klabat Bay. In a small town on the shore of Klabat Bay (Blinyu) the survey team found that dugong meat was being sold in the market (Hendrokusumo *et al*., 1976). In 2006 a dead dugong was again found on a local market on Bangka (Adrim pers. comm. 2006). Anecdotal evidence also suggests that dugongs can be found in the Riau Archipelago (Hendrokusumo *et al.,* 1976). During the execution of Unep-GEF-SCS Trismades Program (Trikora Seagrass Management Demonstration Site) in Bintan Island (Riau Archipleago) from 2007 to 2010, four dugongs were reported entrapped in the fisher's fishing trap, but three could be saved and released back to the sea.

Java

Marsh *et al*. (2002) and de Iongh (1997) mention that dugongs have been observed in: Ujung Kulon National Park, Cilegon Coast, Labuhan Coast, south of Cilacap, Segara Anakan, southeast of Blambangan. In October a dugong was accidentally caught by fishers in Cilegon and transferred to the Jaya Ancol Oceanarium. Dugongs have also been reported to occur at Banten Bay in the Banten Province. During a survey study of the Jaya Ancol Oceanarium in 1975 local people in the area of north Serang claimed they caught dugongs in 1974, as evidence they were able to show dugong tusks (Hendrokusumo *et al*., 1976). The research team from the Jaya Ancol Oceanarium also found

anecdotal evidence of dugong presence in West Java, Cilacap, Macassar Strait, Banyuwangi/ Blambangan

Kalimantan

'The Rare Aquatic Species of Indonesia Foundation and Coastal Resource Management Project' surveyed dolphins from Mahakam Delta to Balikpapan Bay in December 2000, during which Danielle Kreb found a dugong in Balikpapan Bay (Marsh *et al*., 2002). In 2005 Kreb (Kreb and Budiono, 2005) again mentioned an occasional sighting of an individual dugong in Balikpapan Bay. She also mentioned the observation of one dugong in the Berau Archipelago around the Island of Derawan. From 2001 till 2007 students from Leiden University in the Netherlands surveyed Balikpapan Bay and recorded a number of dugong sightings and a vast number of dugong grazing tracks in the bay (de Iongh *et al.,* 2006). During this study they also found anecdotal evidence for dugong presence in Derawan Island. In 2007 during an aerial survey over Balikpapan Bay at least one dugong has been spotted. Marsh *et al*. (2002) moreover mentions dugong presence in Kotawaringin, Karimata Island Marine Reserve and Kumai Bay. The Jaya Ancol Oceanarium also mention anecdotal evidence for dugong presence in east, west and south Kalimantan (Hendrokusumo *et al.,* 1976).

Sulawesi

According to Marsh *et al*. (2002) and De Iongh (1997) dugongs can be found in North Sulawesi, around the seagrass bed of Arakan Wawontulap (southern portion of Bunaken Marine National Park). In 1994 around Arakan Wawontalup at the Bunaken Marine National Park dugongs have been observed in groups of between one and four during a snorkeling survey. One hundred dugongs were supposed to be sighted at this seagrass bed over a period of one month. A local NGO, "KELOLA", which has been studying dugongs in northern Sulawesi, estimated approximately 1,000 dugongs in the region (Marsh *et al*., 2002).

The Seagrass Watch Organization (McKenzie *et al*., 2006) also mentions that dugong have been reported in northern Sulawesi, in Blongko Marine Sanctuary. At full moon dugongs should be able to come over from a nearby bay to feed on seagrass meadows, which are only accessible for them during spring tide. Dugongs should also be present at other locations within and outside Bunaken Marine National Park and near Mantehage Island.

Takke (2012) reported that dugongs are sighted by local coammunities at a frequency of about twice per month in the Island of Bankga - Minahasa Utara, North Sulawesi. The area, however, is facing increasing threat from iron mining.

Zacot (2008) during his anthropogical studies at the Bajo communities at Lorosiaje (Gorontalo) reported the catch of dugong and the traditional ceremonies associated with it.

Marsh *et al.* (2002) mentions that in 1997 a Taiwanese fishing company caught and disposed of nine dugongs in the Lembeh Strait and that in Tumbak Village, locals often catch dugongs for their meat. In Central Sulawesi around the Togian Islands Marine Park individual dugongs can often be seen. In 1975 a survey team from the Jaya Ancol Oceanarium caught five dugongs near Ujung Padang (Allen *et al.,* 1976). At that time, the area was thought to support about 15 dugongs. In more recent times, local fishers in the area have said that dugong sightings in this area are now very rare, whereas previously there had been many animals. Dugongs have also been caught around Barrang Lompo Island in the Spermonde Archipelago (Erftemeijer *et al*., 1993)

Bali

According to Marsh *et al.* (2002) Individual dugongs have been sighted by surfers at Uluwatu- and Padang-padang beache on the southwest extremity of the Bukit Peninsular and locals reported that

an individual dugong visits the beach almost every day. The survey team from the Jaya Ancol Oceanarium (Hendrokusumo *et al.,* 1976) mention that according to a report from the service for Fishery and the protection of Natural conditions, two dugong were caught in south Bali during the period 1977-1978.

Nusatenggara

According to Marsh *et al*. (2002) dugongs are present in Komodo National Park within Selat Lintah separating Flores and Sumbawa. Singleton *et al.* (2002), the Seagrass Watch Organization (McKenzie et *l.,* 2006) and de Iongh (1997) also mention dugong presence in Komodo National Park. During the catching program of the Jaya Ancol Oceanarium team, in 1978, two dugongs were caught in Kupang Bay.

In 1997 in front of the Island of Rote, during a diving trip and during an boat expedition near the Island of Sumba an individual dugong was sighted (personal communication). In 2004, a series of interviews were conducted in the Savu Sea (Mustika, 2005). From the interviews it could be concluded that dugongs in the area are incidentally caught by small scale fisheries. Again during a visit to Rote Island in July 2004 the villagers revealed that the dugong populations there have decreased to insignificant numbers, compared to what they recalled two or three decades ago. Dugongs did not seem to be hunted on purpose; however artisanal fisheries (in addition to coastal ecosystem degradation) were mentioned as a possible cause of the regional dugong population decline.

Maluku

Marsh *et al.* (2002) and de Iongh (1996; 1997) mention that dugongs have been reported in: the Aru Islands (including Aru Tenggara Marine reserve), Lease Islands (Ambon, Haruku, Saparua, Nusa Laut) and south of Halmahera. Anecdotal evidence suggested that the Aru Islands (Maluku Province) once had a large population of dugongs (Marsh *et al.,* 2002.; WWF, 1981). The sighting of dugongs at the Kei Islands has been mapped by WWF.

De Iongh *et al.,* (1995) concluded that the dugong population in East Aru and East Ambon has been severely depleted. Dugong populations appeared to decline between 1978 and 1987. Aerial surveys were conducted in 1990 and 1992 around the coastal waters of the Lease Islands (east Ambon and the Islands of Haruku, Saparua, and Nusa Laut) in Maluku Province. The minimum population of dugongs within the study area was estimated to be between 22 and 37 animals. De Iongh *et al.,* (2006) also found that in Haruku Island dugongs consistently recropped and thus returned to specific sites situated in front of villages. These villages were practicing strong traditional conservation (Sasi Laut). According to De Iongh *et al*. (1995) local fishers have reported the presence of dugongs in the coastal area of North and East Seram. In October 2011 a female dugong was caught by local fishers at East Halmahera with a baby inside (Ivan Silaban, *pers. comm*.).

Papua

Dugongs have been recorded in Biak Island-Padaido Islands, Sorong, Fakfak coasts, Cendrawasih Bay Marine National Park and Wasur National Parks (Marsh *et al*., 2002; de Iongh, 1997). A total of 13 dugongs were recorded in the western beach of the park during an aerial survey in 1982. Also dugongs are rarely found in seagrass beds in Mioswar Island (small Island group near Biak), Anggrameos Island and some mainland beaches in the southern part of the park. A small dugong population has been observed around northern Papua Barat during scientific research cruises (Petocz, 1989). A total of 14 dugongs were counted from the air along a stretch of the mainland and the nearby Large Islands of Roon and Mioswar. Around the Auri reefs in Cendrawasih Bay, two dugongs were seen (WWF, 1981).

2.2. Regional synthesis of seagrass status and distribution

Some 12 species of seagrass are reported to occur in Indonesian waters (den Hartog, 1978; Soegiarto *et al*. 1981; Kiswara & Hutomo, 1985; Kuriandewa *et al*., 2003). Aside from that, two other species i.e. *Halophila beccarii* and *Ruppia maritima* are believed to exist in Indonesian waters, although to date they are known only from old deposited specimens at Bogor Herbarium. *H. beccarii* was without clear information of the site, while *R. maritima* was found from mangrove areas at Ancol-Jakarta Bay and Pasir Putih-East Jawa. But so far the two species have never been rediscovered in the field by present day workers.

Until the past several decades, *Thalassodendron ciliatum* exhibits disjunctive distribution, i.e. it was only observed in eastern Indonesia waters in Maluku and East Nusa Tenggara (den Hartog, 1987; Soegiarto *et al*. 1981; Verheij *et al*., 1993). However, according to Tomascik *et al.* (1997) and Kiswara *et al*.. 1997), it was also found in the western part of the archipelago i.e. in Kangean and Riau Archipelago waters. Two other species, *Halophila spinulosa* and *Halophila decipiens* are only recorded in a few locations. Thus, including *R. maritima,* Indonesian coastal waters are inhabited by 13 species of seagrass.

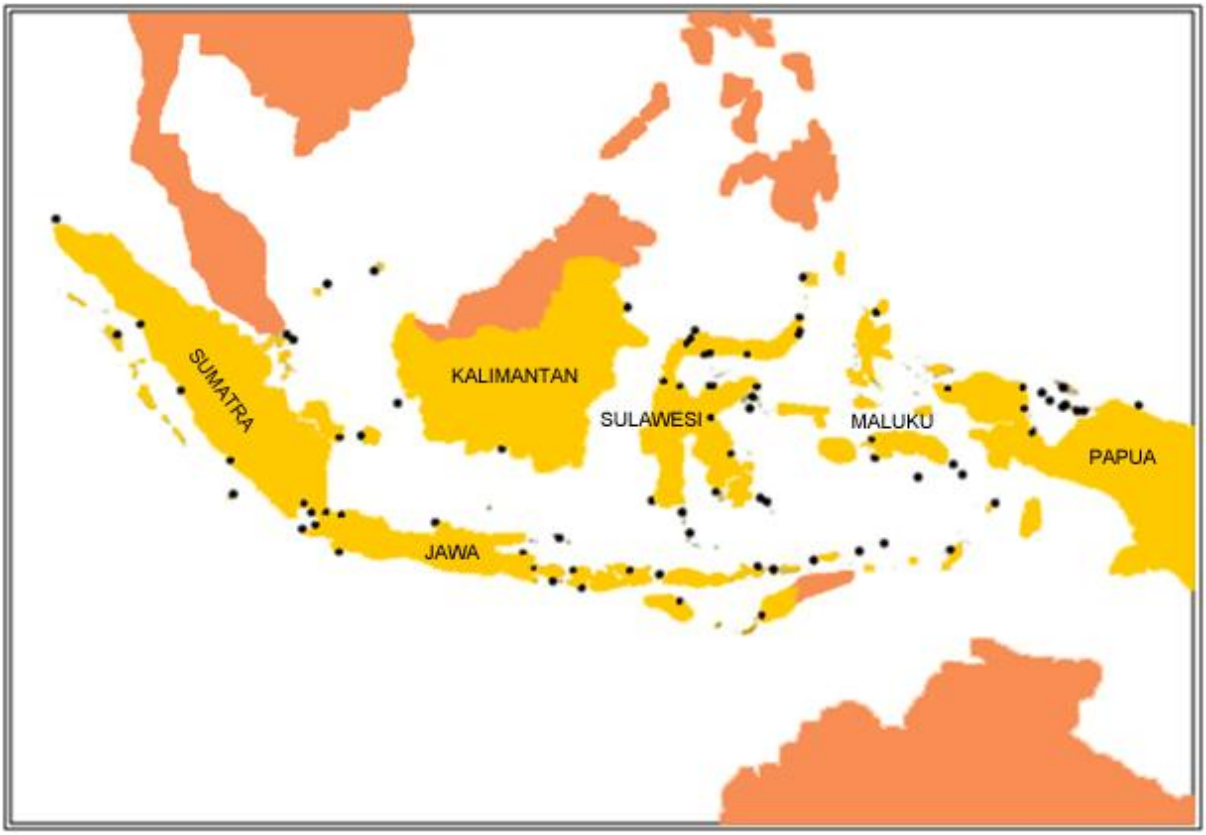

Fig. 2. Location of all seagrass study sites in the Indonesian Archipelago (Kiswara *et al*. 2011)

The Indonesian seagrass communities can be segregated into two types namely monospecific and mixed vegetations. They grow on the muddy, sandy, coral rubble and mixed substrate, even on massive rock (*Thalassodendron ciliatum,* at Kuta Bay Lombok) (Kiswara & Winardi, 1994). Monospecific vegetation refers to seagrass community which consists of one species and grows by forming dense or patches meadows. Meanwhile mixed vegetation consists of two to eight species on the same area. The seagrass species which usually grow as monospecific vegetation are *Thalassia*

hemprichii, Enhalus acoroides, Halophila ovalis, Halodule pinifolia, H. uninervis, Cymodocea rotundata and *Thalassodendron ciliatum* (Nienhuis *et al*., 1989; Kiswara *et al*. 2003.

Muddy substrates on the seaward edges of mangrove formation often have a single species meadow of high biomass. Multi species meadows mostly occur in the lower intertidal and shallow subtidal. Such meadows grow best in well-sheltered sandy (not muddy), stable and nearly horizontal sediments (Hutomo *et al*. 1988; Nienhuis *et al*., 1989). High bioturbation, for example by burrowing shrimps, tends to decrease seagrass density and favour pioneering species. Seagrass on terrigenous (land derived) sediment is more influenced by land run off (turbidity, fresh water flooding, nutrient pulses and salinity fluctuations) and subsequent light limitation than those of carbonate (reef derived) sediments of reef island with less seasonal dynamics (Erftemeijer, 1993).

The most important area for seagrasses is in the lower intertidal and upper subtidal zones, where heterogeneous vegetation sometimes appears with 7 to 8 species in the same bed. The intertidal zone is characterized by pioneer (colonizer) vegetations, dominated by *Halophila ovalis, Cymodocea rotundata* and *Halodule pinifolia*. However, *Thalassodendron ciliatum* in some areas is dominant in the lower subtidal zone. It can grow in silty sand as well as in medium to coarse grain of sand and coral rubble.The most widespread and dominant species of seagrass in Indonesia is *Thalassia hemprichii*. It can be found on the muddy, sandy and coral rubble substrates. This species commonly formes both homogenous and mixed vegetations. Its vertical distribution range from the intertidal down to lower subtidal zone to a depth of 15 m (Hutomo *et al*., 1988; Brouns, 1985). The distribution of *Enhalus acoroides* is also widespread. This species can grow well in medium to coarse-grained sediment but seems to prefer muddy and silty sediment. It mostly forms monospecific stand in silty subtidal area or localities with heavy bioturbation and mixed vegetation on the more stable habitat. The species shows considerable morphological variations, with the average length and width of leaves generally being greatest in muddy substrate, which has a higher nutrient content (Verheij & Erftemeijer (1993).

Halodule uninervis and *H. pinifolia* are pioneer species. They forms a monospecific vegetation in disturbed open spot of the inner reef flat, or on steep sediment slopes, from silty substrate to coarse grained sands both in the intertidal and subtidal zones. *Halodule uninervis* can be found in mixed vegetation stands with *E. acoroides, C. rotundata, C. serrulata, S. isoetifolium* and *T. hemprichii* on sandy substrate.

Genus *Halophila* has a wide vertical range and occurs from the intertidal zone down to the lower subtidal zone more than 20 m depth. It especially grows on disturbed sediments, such as mounds of burrowing invertebrates. *Halophila decipiens is* only encountered in deep-water reef based sediments at a depth between 5 and 35 m. It forms monospecific meadows or occurs in mixed beds with *H. ovalis* (Verheij & Erftemeijer, 1993). *Halophila minor is* found in sheltered or open localities on sandy bottom in the lower part of eulittoral and the uppermost part of sublittoral to 2 m depth. *Halophila spinulosa* grows on the sandy substrate from intertidal zone to a depth of 10 m. It forms both monospecific and mixed vegetation. *Cymodocea* is found in shallow-water habitat (up to 5 m depth, but is mainly confined to the upper 2 m) on both carbonate and terrigenous sediments ranging from coral rubble, coarse sand to sandy mud. *Cymodocea rotundata* and *C. serrulata,* they are found both as a monospecific and mixed vegetation, but mainly they grow as mixed vegetation.

Syringodium isoetifolium is found on muddy and sandy substratum to a maximum depth of 6 m. The species does not occur in places, which experience long-lasting exposure during low water of spring tide.

Thalassodendron ciliatum appears to favour coral substrate, where dense stands are found, but also occurs in mixed vegetation (e.g. with *E. acoroides, C. rotundata, C. serrulata, S. isoetifolium* and *T. hemprichii*) on finer carbonate sediments. Until the past several decades (den Hartog, 1970; Kiswara & Hutomo, 1985) this species was known as a disjunctive species, it is distributed only in the eastern Indonesian waters. Recently, however, it is also found in the western Indonesian waters i.e. Tanjung Bira, south eastern of South Sulawesi; Kangean, Riau Archipelago; and Bujur Island, Bangka (Tomascik *et al*., 1997; Kiswara et al., 1997).

The biological processes and function of seagrasses are generally recognized. Seagrasses fix organic carbon, the majority of which enter the food chain through direct consumption by herbivorous organisms as well as through decomposition as detritus. The broken seagrass leaves and shoots are partly drifted to surrounding waters and decomposed by microorganisms. Decomposition processes produce materials which are directly consumed by detritus feeder. Meanwhile, the particulate detritus in the water column serves as food for filter feeding organisms. The estimated material of Indonesian seagrass exported to other ecosystem is only 10 % (Nienhuis *et al*., 1989).

The key to a better understanding of the function of seagrass ecosystem lies on the growth regulating factors, production, decomposition and regeneration processes. Whereas light is considered to be one of the most important limiting factors to seagrass growth in the often turbid coastal waters of the temperate region, this is unlikely to be the case in most tropical seas, which usually are characterized by low turbidity. In these waters, seagrass growth is often limited by the availability of nutrients.

Quantitative and detailed study on nutrient concentrations and on the resources in seagrass beds at six different localities in Spermonde Archipelago and adjacent coastal waters in South Sulawesi indicated significant structural and functional differences between seagrass beds of terrigenous sediment along the coast (sand and mud deposited by rivers) and seagrass beds of carbonate sediments on the shallow reef flats of the various coral reef island (Erftemeijer, 1993). Seagrass communities at coastal sites (on terrigenous sediments) usually grow better than do those which develop in the offshore reef flat.

The seagrass beds in Indonesia maintain a high productivity despite the low nutrient availability. It is hypothetical, therefore, that these seagrass beds are largely self-sustaining and that most nutrients are efficiently re-used within the system. Due to the dynamic character of coastal habitats, however, seagrass ecosystem is considered to be open system with regard to nutrient fluxes. The long-term persistence of seagrass meadows obviously depends on the replenishment of these nutrient losses.

Seagrass of coastal habitat receives ample nutrient replenishment provided by river discharges or diffuse terrestrial run-off. So far, no data exist on the processes of nutrient losses and gains for these seagrass systems. The studies in Spermonde Archipelago, South Sulawesi by Staple (1997) provide data on the conservation and loss of nitrogen and phosphorus in such meadows.

Most of the nutrients that are lost by leaf fragmentation are translocated to the sediment surface or into the sediment. About 80% of the nitrogen in deposit of leaf fragments is denitrified. The remaining 20% of the nitrogen that is regenerated from leaf fragment deposit is released into the water column, presumably along with a large portion of the nitrogen that is regenerated from leaf litter in burrows of alpheid shrimps that is pumped out to the water column by bio-ventilation. However the major portion of the N for seagrass growth is absorbed by the roots. The presence of this considerable sediment nitrogen input, most likely arising from N-fixation. It is reported that the pore water nutrient ratio contains larger phosphate than ammonium. This is probably due to differences in microbial process that play a role in the N- and P-cycles. The important role of

seagrass leaves probably is that of capturing “new” nutrient, carried with the water current from external sources to the meadow, a process that may counterbalance any nutrient losses. More important role of the leaves is in recapturing nutrient that is regenerated by mineralization processes within the seagrass systems.

Information on the ecology and biology of Indonesian seagrasses has grown considerably within the past few years, however vast areas of the archipelago (e.g., north coast of Papua, southwest coast of Indonesia, south and west coast of Kalimantan, etc.) have yet to be studied. Habitat diversity in Indonesia is among the highest in the world. With 13 species and seven genera, Indonesian seagrass diversity is surprisingly low. The low species diversity may be partly related to the relatively homogeneous seawater temperatures throughout the archipelago, and the dominance of the tropical genera, although *Halophila ovalis* is rather eurythermic (Zieman & Wetzel, 1980).

3. Threats, root causes and causal chain analysis

3.1. Threats

The characteristics of dugongs such as long-lived with a low reproductive rate, long generation time, and a high investment in each offspring, makes the dugongs facing diffilculties in ensuring their sustainability against various environmental pressures. A simulation study indicates that even if the dugongs live ideally and naturally, and without disturbances from human, the growth of the dugong population will not exceed 5 % per year (Marsh *et al*., 2002). This makes the dugong vulnerable to over-exploitation. Even a slight reduction in adult survivorship as a result of habitat loss, disease, hunting or incidental catch, can cause a chronic decline of dugong population.

In Indonesia, no reliable and accurate dugong population estimates are available. In 1970s the dugongs population in Indonesia was estimated around 10,000 and again in 1994 the population was estimated at about 1,000 (Marsh *et al*., 2002). Since both estimates are based on guesses this could not be considered as evidence for a population decline. Anecdotal information from many parts of Indonesia, however, indicates that dugong population is declining drastically.

There are several causes that make the dugongs under threat. Beside anthropogenic causes, natural phenomena such as severe cyclone has been reported to cause disaster to the dugongs and their habitat as occurred in Hervey Bay, Australia (Preen *et al*., 1995; Marsh *et al*., 2002). It is fortunate that Indonesia, which lies directly on the equator, is not the place for the ocurrence of the destructive tropical cyclone. The high frequency of tropical cylone is usually found in the region between 10 to 30 degrees North and South Latitudes (Wyrtki, 1961).

Volcanic eruption discharges considerable amount of terrigeneous materials that might cover wide area of coastal zones. The eruption of Mount Tambora, Sumbawa, was reported to cover extensive coastal areas with thick terrigenous sandy sediment that caused the coastal area devoid of seagrass vegetation. The same was true with the eruption of Krakatau Island (Sunda Strait) that caused the surrounding coastal area sterile from any form of life.

Several anthropogenic threat factors have been identified to have a major negative impact on the present dugong population in Indonesia (Marsh *et al*. 2002; de Iongh, 1997).

Coastal development
Building of coastal construction such for harbour, industrial estates or settlement cause the loss of habitat and degradation of water quality. Increase of sedimentation and water turbidity are harmful

for the seagrass ecosystem, the essential habitat of the dugongs. The construction of the industrial estate in Banten Bay (West Java) has wiped out 30 % of the seagrass cover in the area (Tomascik *et al*, 1977).

Logging and mining

In West Papua, logging and mining give threat to the seagrass environment in the coastal area. In Teluk Cenderawasih National Park, for instance dugong become harder and harder to find as their seagrass habitat has been degraded by siltation from the logging activities (Marsh *et al*. 2002). Sea sand mining can also cause destruction of seagrass beds by increasing the turbidity of the water that harms the seagrass beds. Sea sand mining was formerly heavily done surrounding Bintan and Batam Islands. Although the sea sand mining has been prohibited, the control is still a problem.

Coastal pollution

Coastal pollution is caused not only by land based sources, but also by sea based sources, which may both have an impact on the dugong and their seagrass habitat. Land based pollution may originate from domestic sewage, agriculture, and industries. Tourism if not properly manage may become another source of pollution. In Bintan (Riau Archipelago), for instance, a lot of tourist cottages are built on stilts directly on the seagrass meadows without any sewage treatment. The seabased pollution may come from harbour activities, and ballast water discharged from ships.Tar balls have been frequently reported stranded at the coast of Bintan Island, facing the busiest sea lane to and from the Singapore Strait.

Oil spill

Oil spill from tanker accidents is another potential threat to the seagrass ecosystem. The grounding of the supertanker *Showa Maru* in the Striats of Singpore in 1975, spilling about 5,000 tons of crude oil had caused a great environmental damage to the coastal areas of Indonesia, Singapore and Malaysia. A more recent case is the collision of supertankers *Evoikos* and *Orapin Global* in the Singapore Strait in Octrober 1997, spilling over 28.500 ton of crude olil to the surrounding environment.

Destructive fishing

The practices of destructrive fishing methods such as the use of sodium cyanide and explosive for coral fishing might have negative impact on the dugong as well as the seagrass environment. Unselective bottom trawling is another type of destructive fishing practice that might harm the bottom environment. These destructive fishing are occurring in many parts of Indonesia. Although there have been many efforts to halt this practice, but the control is still facing problems.

Accidental catches

Accidental catches can occur from the use of shark nets, gill nets or tidal traps (*belat* or *sero*). During the last four years (2008-2012), four dugongs were reported entrapped in fisherman's tidal trap in Bintan island, but three could be relieved and released back to the open sea. The use of shark nets by industrial fisheries was reported from Aru Islands, where 80 – 200 dugongs were accidentally caught in 1979 and decreased to 20 – 40 individulas in 1989. It was also reported that during 1979 – 1980 about 500 dugongs were caught yearly by Taiwanese fishers using shark nets (de Iongh & Wenno, 1992).

Indigenous hunting

The deliberate harpooning of dugongs is reported from Aru Islands, but since the eighties this practice has been abandoned in some areas. The indigineouus people used to hunt the dugongs, for their meat, blubber, and hides. Compost (1980) estimated that in 1970 the total amount of dugong in Aru is in the range from 545 – 1,020 which he considered to be still abundant. But later, Brasseur

and de Iongh (1991) reported that only 59 –90 individuals remained in 1989, and this figure decreased again to 29 – 36 individuals in 1990 (Moss & van der Wal, 1998). Aerial dugong survey in Lease Islands (Maluku) in 1990 - 1992, indicated that there were about 22 – 37 individuals in this area (de Iongh *et al.* 1995) but later Moss & van der Wal (1998) concluded that dugong in this area had decreased to only about 10 individuals.

Boat strike

Dugongs usually swim very slowly, and have to come to the surface to take breath after every 3-5 inutes. Therefore it is diffcult for them to avoid the fast approaching boat. Mortality of dugongs by impact of outboard engines has been reported in Balikpapan Bay and in Ambon (de Iongh *et al,* 1997). The potential threat from boat will become more important in heavy boat traffic.

3.2. Root causes

Lack of information and awareness

Lack of awareness drives the communities to take actions by ignorance so that finally can degrade their own environment. A baseline survey on awareness level of the village community in Bintan Island, for instance, indicates that most of the coastal community did not understand the important functions of the seagrass beds and the consequent need for their conservation (Trismades Tech. Report). Without adequte information and awareness, it is hard to call the community to participate in conservation endeavour.

Poverty

In some areas dugong is caught because of poverty, where the people have limited choice for livelihood. In pressing condition, they can do anything that can make money although it violates the law. It was reported, for intance, that in Bangka dugong was sold in the local market place (de Iongh *et al*. 2009). The very high price of the tusk of the dugong stimulate the fishers to hunt for the dugong. In Tual (South East Maluku), for instance, a piece of dugong tusk was priced as high as Rp 350.000 which is higher than the average monthly income of a fisher (Moss & van der Wal, 1998). This economic attraction drive the fishers to hunt for dugongs eventhough they understand that this practice has been prohibited.

Weak law enforcement

Actually dugong has been protected under Indonesian Law No. 7 (1999) concerning the Conservation of Flora and Fauna. The monitoring and enforcement of the law, however, is still very weak. The personell and facilities for the law enforcement are considered inadequate to control the extensive area of Indonesian waters.

Lack of institutional capacity

Lack of institutional capacity is considered as one of the root of the problems. Even with the existence of good plan, if the capacity to undertake the plan is weak will not give appropriate results.

Improperly planned coastal development and inapropriate land-use practices

The improper planned and inappropriate land use practices will mostly lead to the seagrass habitat degradation both directly and indirectly. For example, direct impact emerges through dredging and reclamation from poorly planned infra-structure development for tourisms. Indirect impact can also comes from land-based pollution that produced by poor treatment of sewage disposal from domestic area. This may lead to phosphate and nitrate enrichment which can cause eutrophication. Untreated industrial liquid/solid disposals decrease the water quality such as dissolved oxygen, temperature, salinity and pH. Run off caused by deforestation for plantation or property/ industrial

development produces silt that in certain level will disrupt photosynthetic process of seagrass. Low marine waters quality and heavy metal pollutant from industrial waste could directly affect the health of dugong especially very young ones.

3.3. Causal chain analysis

Based on the information of the root causes as described before, then a causal chain analysis leading to the decline of the dugong population could be briefly mapped as shown in the following diagram. It is clear that the major risk to dugong population may come indirecly from the loss of habitat, and degradation of seawater quality, and to certain extent also from direct impact such as from destructive fishing, hunting, accidental catch and boat strike.

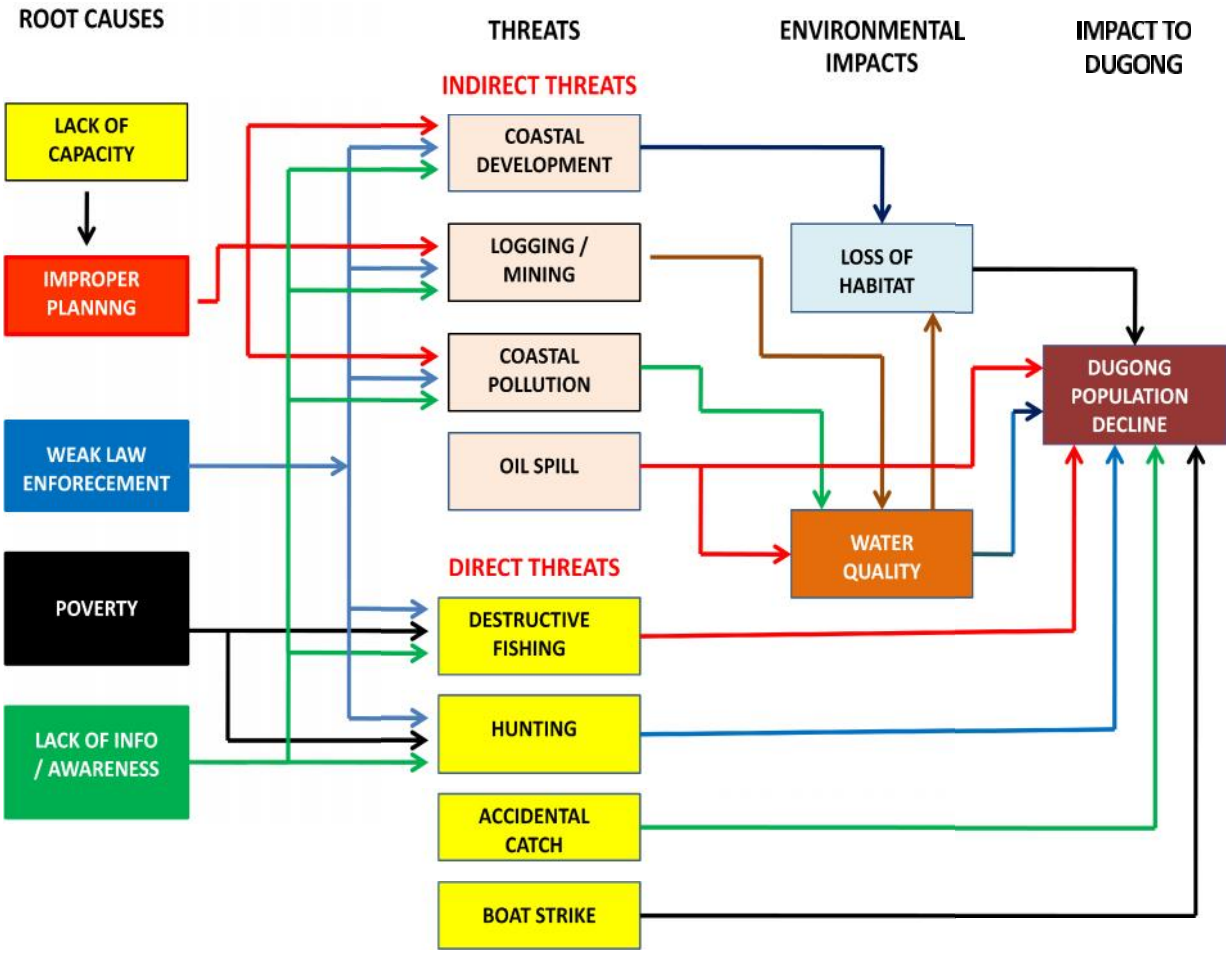

Fig. 3. Causal chain analysis leading to the decline of dugong population

4. Suggested management approach and project sites

4.1. Suggested management approach

From the overall view of the inter-related factors underlying the causal chain then it may be suggested to consider the folowing approach of mangement for the dugong and seagrass conservation:

1. Increase the quality and the quantity of data and information on dugong and its habitat through scientific approaches;
2. Improve the management capacity through training in management skill and basic knowledge to decision makers and other relevant stake holders.
3. Strengthen law enforcement at all level;
4. Increase awareness on the important functions of seagrass habitat and associated animals through effective campaign;
5. Enhance community involvement in all conservation efforts;
6. Improve and diversified environmentally sustainable alternative income generation schemes through trainings and lessons learnt from other community success story.

4.2. Suggested priority for project sites

Based on the available information it is suggested to give priority for the dugong and seagrass management project at two sites, namely at Pulau Bintan (Riau Archipelago) and Pulau Kei (Maluku). The following are the background reasons for each site.

Pulau Bintan (Riau Archipelago)

- Seagrass bed condition in the area (especially the north-eastern part of the island) is extensive and in good conditions;
- Existence of dugong in the area has been confirmed. During the last four years four dugongs were entangled in fisher's fish trap, but three could be saved and released back to the sea.
- Local community has had experience in seagrass management (from earlier Trismades Project), and has managed community-based seagrass sanctuary;
- Strong support from the Local/ District Government (dugong has been adopted as flagship species of the District).
- Easily accessible (daily flight from Jakarta, about one hour by ferry from Singapore).

Pulau Kei (Maluku)

- Extensive seagrass bed in the northern part.
- WWF-Indonesia recent report on the frequency of dugong sightings in the area.
- Existence of a Marine Research Station in Tual under LIPI (Indonesian Institute of Sciences) which could support the project.
- Support from WWF-Indonesia which has already had marine observation activities in the area.
- Although the location is rather remote but easily accessible. There is daily flight from Ambon.

5. On-going Projects and Studies

Sulu-Sulawesi Marine Ecoregion (SSME)

Sulu-Sulawesi Marine Ecoregion (SSME) is a regional cooperation involving three neighboring countries (Indonesia, Malaysia and the Philippines) to collaboratively manage vast marine biodiversity and fisheries resources in the Sulu and Sulawesi Seas. This regional cooperation has been initiated since 2004, and has come with a solid institutional arrangement and plan of actions documents. The Tri-National Committee is the highest body to take decision and guidance under this cooperation, and three Sub-Committees were formed to provide technical inputs, establish plan of actions and to ascertain any activities within the respective countries as well as at regional level. Those three Sub-Committees are: 1) Sub-Committee on Marine Protected Areas and Networks, 2)

Sub-Committee on Sustainable Fisheries, and 3) Sub-Committee on Threatened, Charismatic and Migratory Species.

Currently, the three Sub-Committees have been equipped with a Comprehensive Action Plans documents with the list of goals, objectives, activities and indicators. Activities addressing the trans-boundary problems identified in the region have been implemented through the activities at national level in the respective countries as well as through regional projects with the funding support from donors and partners. Eventhough the turtle has become a flagship species since the beginning of the cooperation, the issues related to the management and conservation of dugongs and their habitats (seagrass) has also had a strong base and has become part of Marine Mammal issues stated in the Short Term Goals by the Sub-Committee of Threatened, Charismatic and Migratory Species.

Under the umbrella of SSME, at the moment two regional-scale projects are in progress, namely the Sulu-Celebes Seas Sustainable Fisheries Management with support funding from GEF through UNDP, and with the support from the German Government through GIZ for the project "Support to the Implementation of the Tri-National Sulu-Sulawesi Marine Ecoregion Comprehensive Action Plans, SSME Project ", addressing three main objectives: climate change issues in the region, support to the implementation of ecosystem approach to fisheries management, and support the establishment of MPA networks based on turtle migration corridors.

Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security

The Coral Triangle Initiative on Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF) is a multilateral partnership of six countries in the Southeast Asia and Western Pacific to working together to sustain the unusual marine and coastal resources by addressing crucial issues such as food security, climate change and marine biodiversity. The coral triangle area is a home for more than 500 coral species to make it the most diverse coral reefs ecosystem in the world. At the leaders' summit in 2009, CTI-CFF was formally launched where the six countries (Indonesia, Malaysia, Philippines, Timor Leste, Papua New Guinea and Solomon Islands) have come to the high commitment to safeguard the marine and coastal resources of the region for the welfare of the people and preserving the natures' existence for future generations.

Indonesia is one of the initiators of this cooperation and had been providing considerable role in the development of this cooperation. Indonesia has also been agreed by member states to host the Regional Secretariat, and so far Indonesia has served as Interim Regional Secretariat until a permanent Regional Secretariat is formed.

A 10-year CTI-CFF Regional Plan of Actions has been established and approved by the member countries. There are five defined overarching goals of CTI-CFF: strengthening the management of seascapes, promoting an ecosystem approach to fisheries management, improving the effectiveness of MPAs management, improving coastal community resilient to climate change, and protecting threatened marine species. Of those, Goal # 5 is particularly relevant to the efforts on dugongs and their habitat protection. In fact, dugong is a species that has been identified as one of the threatened species in the region and has also been addressed as target species to be managed in cooperation within CTI-CFF particularly under Goal # 5.

Given that the six CTI-CFF countries are part of 'dugong range states', and with the strong commitment of the six member countries of CTI-CFF to promote marine resources conservation and management of marine biodiversity in the coral triangle area, stronger regional cooperation to promote sustainable conservation of dugongs and their habitat is potential to be developed in the future.

Coremap

Coremap (Coral Reef Rehabilitation and Management Program) is a comprehensive long-term program on coral reef rehabilitation and management in Indonesia funded by World Bank (WB) and Asia Development Bank (ADB). The program comprised of three phases: Phase I (Initiation) from 1998 to 2004, Phase II (Acceleration) from 2007 to 2012, while Phase III (Institutionalization) is still under preparation which is planned to be conducted from 2013 to 2018. Currently Coremap is under the coordination of the Ministry of Marine Affairs and Fisheries. Coremap Phase II has seven programs namely: Information and Training; Education; Public Awareness; Community Based Management; Monitoring, Control and Surveillance; Institutionalization; and Marine Partnership. The regions under WB funding includes seven districts (Selayar, Pangkep, Buton, Sikka, Biak, Raja Ampat and Wakatobi) while those under ADB five districts (Batam, Bintan, Nias Selatan, Tapanuli Tengah, and Mentawai). The coming Phase III will have a slight modification from the original plan, as it is anticipated to also accomodate the CTI (Coral Triangle Initiative) Regional Plan of Action. CTI is a multilateral partnership among six countries i.e. Indonesia, Malaysia, Philippines, Papua New Guinea, Solomon, and Timor Leste, to address crucial issues covering food security, climate change and marine resources. Among the five goals of CTI, two have close relevancies to Coremap, namely a) marine protected areas established and effectively managed, and b) threatened species status improving.

ATSEA

Arafura and Timor Seas are considered as semi-enclosed sea bordering three countries: Indonesia, Australia and Papua New Guinea. This region is one of the remaining centers of tropical marine biodiversity. However, this region has relatively less available information and data. UNCLOS (United Nation Convention on the Law of the Sea) encourages states bordering semi-enclosed sea to work together in implementing their rights and responsibilities. In this context Indonesia has commitments to support regional efforts in integrating research and environmental interests, and for this ATSEA (Arafura and Timor Sea Action) program was developed. To manage the vast resources as well as to overcome existing problems, Arafura and Timor Sea Expert Forum (ATSEF) was established with objective to assist the stakeholders who depend upon Arafura and Timor Seas in achieving the goals of sustainable development. As the outputs of the activities, ATSEF delivered (a) Arafura and Timor Seas Action Plan for sustainable development for 2006 - 2015, and (b) Capacity development programs. ATSEF has also developed five Strategic Plans and Programs: 1) to combat IUU (Illegal, Unresponsible, Unreported) fishing; 2) to sustain fish stocks, *marine habitat and biodiversity* in coastal areas of Arafura and Timor Seas; 3) to improve coastal community welfare; 4) to understand the systems of dynamics of ocean, coast and catchment areas: 5) to improve ATSEF information capacity, management and exchange. Strategic Plan and Program # 2 is relevant to the conservation of dugong.

Sea World Indonesia

Sea World Indonesia (SWI) is currently the only installation in Indonesia which is keeping dugong in captivity for public show. The dugong was originally came from nature and now kept in a big tank. The water of the tank originated from the Bay of Jakarta and piped into the reservoir. Preliminary water treatment includes filltration, and sterilization. Water quallity is routinely monitored covering physical, chemical and bacteriological parameters. The dugong is fed with seagrass *Syringonium isoetifolium* collected from Banten Bay, and additional food supplement. Medical health of the dugong is routinely monitored including the using of modern medical instruments, such as ECG, USG and radiology. Recently a study on the behaviour and sound production by the dugong in the tank was conducted by Khalifa (2011) who demonstrated that the dugong produce squeaking, barking, or snoring sound responsive to external stimuli.

Research Centre for Oceanography

Research Centre for Oceanography, under the Indonesian Institute of Sciences (LIPI), is one of the major research institutions in Indonesia dealing with marine and coastal waters. According to Pusat Penelitian Oseanografi (2012) the research program for the year 2012 – 2014 is based on four major pillars:

- Diversity of marine resources (biological and non-biological)
- Marine environmental health and protection
- Deep-sea and climate change
- Marine bioprospection.

Research on the diversity of marine resources includes: 1) studies on marine ecosystems: mangroves, seagrass and coral reefs; 2) marine biological diversity covering various taxonomic groups, and 3) genetic studies.

Research on environmental health and protection covers: 1) modelling studies for the protection of ecosystem, and 2) conservation of biota and its ecosystem.

Although studies on dugong is not specifically mentioned, but the studies on its habitat (seagrass ecosystem) as well as its conservation is clearly given.

Universities

Several universities in Indonesia such as University of Indonesia (Jakarta), Bogor Agricultural University (Bogor, West Java), and University of Hasanuddin (Makassar, South Sulawesi) have been conducting studies on seagrass ecosystem. The studies are executed by the university's staffs and or the graduate students. Several topics that currently are gaining interest concern among others with ecological functions of the seagrass ecosystem, economic valuation, carbon stock and carbon budget.

Non-Government Organization(NGO)

Currently there are some NGOs now active in Indonesia that work to some extent on seagrass and dugong studies. Generally, however, the seagrass and dugong studies or observations are not their specific projects but become part of their wider scope of natural conservation studies or observations. To mention a few: WWF- Indonesia, Wetlands International – Indonesia Program, Conservation International.

6. Dugong and seagrass conservation measures

6.1. National Biodiversity Policy

The global awareness on benefit of and threat to biological diversisty was reflected by the enactment of UN Conventuion on Biological Diversity (CBD) in 1992 in the Conference on the Environment and Development held in Rio de Janeiro, Brasil. A year later, in 1993, Indonesia facilitated by Bappenas (National Development Planning Board) was able to prepare a ducument entitled Biodiversisty Action Pland for Indonesia (BAPI). In 1994, Indonesia ratified that convention and legalized under the Law No.5, 1994 concerning ratification of CBD. Beside that, other conventions related to biological diversity were also ratified, i.e. RAMSAR Convention concerning wetland (including mangrove) as water bird habitat, and CITES (Convention on International Trade of Endangered Species of Wild Flora and Fauna).

Due to increasing environmental threats on marine and coastal biodiversity and ecosystem, the CBD signatory countries through the Conference of the Parties held in Jakarta in 1995 succeeded to prepare a document, "The Jakarta Mandate". The document contains global concensus on the sustainable use of marine and coastal biodiversity. In 1997, Indonesia hosted the First Expert

Meeting on Marine and Coastal Biological Biodiversity that was able to prepare action plan of the Jakarta Mandate.

Ten years after the launching of BAPI document, based on the availabe data and information, the rate of degradation of biological diversity in Indonesia was in serious situation. However, this was not to ineffectiveness of BAPI, but due many factors that influence the management in Indonesian biological diversity. Since 1998 Indonesia experienced multidimensional cricis, both politically and financially. But, on the side, there were positive changes to democratic era, local autonomy and decentralization of power. Opportunity to involve community in biological diversity management was developing. In line with those changes, there was a need to change the paradigm and system of management in biologilogical diversity. New strategy and action plan, therefore, shall be prepared which was more contextual with the existing situation.

To address those challenges, in 2003, a new strategy was prepared called "The Indonesian Biodiversity Action Plan" (IBSAP). The activities in preparinrg the document was supported by grant from Global Environment Facility (GEF-TF 023957) and facilitated by Bappenas.

6.2. Policy, strategy and action plan for dugong

Following a three series of workshops held in Jakarta, Manado and Bali concerning dugong conservation in Indonesia during 2007 and 2008 a document was published which is known as the National Conservation, Strategy and Action Plan for Dugong in Indonesia (NCSAPDI) (de Iongh *et al.* 2009 a, 2009 b). The main goal of NCSAPDI is to develop a conservation strategy which will be a viable basis for the long term conservation and management of dugong population in Indonesia. The document consists of two parts. Part I covers the scientific report and is focused on technical and scientific background information regarding the ecology, population size, distribution, and legal, socio-cultural and socio-economic aspects of the dugong in Indonesia, while Part II covers the management aspects. The document gives a follow up to the Global Status for Countries and Territories prepared by Marsh *et a*l. (2002). The report also builds on the Policy, Strategy and Action Plan for Management of Seagrass Ecosystems in Indonesia (UNEP-GEF, 2003). An Indonesian version of the NCSAPDI was just published by synthesizing and updating the two parts into a single volume (Hutomo *et al.* 2012).

The general policy for the conservation and management of dugong population in Indonesia has been defined as follows: "*To conserve, manage and sustainably use dugong populations and their habitat; this conservation and management should be implemented in a synergic and integrated manner by local government, communities, private sector, universities and non-governmental organizations*".

The conservation and management of dugong population in Indonesia aims ultimately at the protection of both dugongs and seagrass ecosystems as a life support system. Specific objectives of the National Conservation Strategy and Action Plan for Dugongs in Indonesia have been defined as follows:

a) to establish a management framework for implementation of the Strategy, with a national NGO network, selection of pilot projects and establishment of regional task forces;
b) to make National Dugong Database operational and establish a national research and monitoring program of dugong and seagrass;
c) to establish and implement pilot projects for community based conservation of dugong and segarass habitat;
d) to establish a national communication and awareness program on dugongs and seagrass.

Hutomo *et al*. (2012) put forward five strategies for the conservation of dugongs in Indonesia. The following are the strategies and the action plans under each strategy.

Strategy 1: Improve the level of protection of dugongs in and outside of the Marine Protection Areas.
Action plans:

- Improve the level of protection of dugong in the existing Marine Protected Areas.
- Establish dugong sanctuaries or community-protected areas in sites currently unprotected and unmanaged.
- Ban the gill-nets and in-shore trawling activities.
- Provide incentives and alternatives to gill-net fishers as well as the capacity of the government to review existing policy and enforce regulation.
- Promote trans-boundary conservation collaboration and partnership initiatives.
- Integrate dugong conservation activities and actions with existing or proposed coastal management and development initiatives.
- Promote the establishment of Local Working Group on dugong conservation.
- Develop partnership between national and international NGOs working in coastal areas, national and regional governments and local communities.

Strategy 2: Promote public awareness campaign.
Action plans:

- Initiate public awareness campaign in pilot areas.
- Adopt dugong as local “flagship species”.

Strategy 3: Strengthen capacity of relevant (provincial) authorities to enforce legislation.
Action plans:

- Provide technical training and resources necessary to relevant government authorities to enforce the law, monitor illegal activities.
- To maximize effectiveness along the coast, surveillance and monitoring of illegal activities by involving tour operators, commercial and private air passenger services, NGOs and local communities.

Strategy 4: Research, survey and monitoring of dugong population
Action plans:

- Conduct local aerial survey in the region.
- Carry out site-based aerial surveys in priority dugong areas.
- Initiate catch-monitoring programs, focusing on gill nets, trawlers and fence traps.
- Initiate dugong satellite tagging programs to track fine scale and long distance movement of dugongs.
- Map seagrass habitats and monitor health and carrying capacity in key dugong areas.
- Establish and develop National Dugong Database.
- Develop monitoring system on dugong population in pilot areas.

Strategy 5: Establish a national network for NGOs and general conservation practitioners and researchers.
Action plans:

- Encourage the establishment of a national NGO network and of regional dugong conservation task forces in each pilot province.
- Promote the use of Sirenian International websites.

6.3. Legal aspects

The Government Regulation No.7/1999 concerning protection of Indonesian Flora and Fauna is the only legislation which protects Indonesian dugongs and seagrass directly. In Appendix no.20 of the regulation, *Dugong dugon* is listed as protected fauna. In article 4, Verse 2 measures are dictated for protection by: a) *in situ* management, through identification and inventory of species and habitats, monitoring, management and research and b) *ex situ* management through research, rehabilitation and protection of species and habitats.

However, a wide range of laws and regulations covering the coastal zone are relevant for the dugong and its principal habitat, seagrass ecosystems. Among these regulations are the Act of the Republic of Indonesia No. 5, 1990 concerning the conservation of living resources and their ecosystem; the Act of the Republic of Indonesia No. 24, 1992 on spatial planning; the Act of the Repbulic of Indonesia No. 5, 1994 concerning the ratification of the United Nation Conservation on Biodiversity and the Act of the Republic of Indonesia No. 23, 1997 on the management of the living environment. The Act of Republic of Indonesia No. 27 of 2007 on the Management of Coastal Zone and Small Island gives directions on the integrated coastal zone management.

Other form of regulations, apart from Acts or Statutes, include Decrees of the People Consultative Assembly; Government regulations, Presidential decrees and Ministerial decrees. The Directorate of Marine Affairs and National Marine Parks of the Ministry of the Marine Affairs and Fisheries has the mandate to protect and manage dugong populations in Indonesia. However, the management of marine national parks is the mandate of the Ministry of Forestry and some of these marine national parks support dugongs and their habitat. The Directorate General for Marine, Coastal and Small Island Affairs of the Ministry of Marine Affairs and Fisheries has also received mandate to manage marine protected areas and marine biota resource conservation. This Directorate General received its mandate based on 1) the Fisheries Act No. 31 of 2004; 2) the Management of Coastal Zone and Small Island Act No. 27 of 2007; 3) Government regulation No. 60 of 2007 regarding Fisheries Resource Conservation. Under the legislation mentioned, the esblishment of Regional Marine Conservation Areas (Kawasan Konservasi Perairan Daerah – KKPD) has been made possible.

6.4. Protected Area Network and Management Plan

The Act No 5/1990 concerning the Conservation of Biological Resources and their Ecosystems promotes two types of “nature protection areas”: nature reserve areas and nature sustainable areas (Articles 14 and 29). Subsequent to this Act, a government regulation was enacted that specified the types of nature reserve areas and nature sustainable areas. Indonesian Government Regulation No. 68 of 1998 divides the nature reserve areas into two types of nature protection areas: (i) nature reserve area (*kawasan cagar alam*) and (ii) wildlife reserve area (*kawasan suaka margasatwa*). The nature sustainable area is divided into three types: (i) national park area (*kawasan taman nasional*), (ii) grand forest park area (*kawasan taman hutan raya*) and (iii) nature recreational park area (*kawasan taman wisata alam*). Further Article 1 of Government Regulation No. 68 of 1968 defines:

- Nature Reserve Area is “the specific area in land or waters which has function as the area for prevention of biodiversity of plants and animals and its ecosystems.”
- Wild Reserve Area is “the area that because of it nature has specific plants, animals and their ecosystems that need to conserve.”

- National Park is “the nature preservation area on land and/or waters which consists original ecosystems of plants animals that are managed by zoning system and used for research, education, tourism and recreation.”
- Grand Forest Park Area is “the nature preservation area on land and/or waters that purposed for the collection of origin or non-origin plants and animals that are used for research, education, tourism and recreation.”
- Nature Recreational Park Area is “the nature preservation area on land and/or waters that purposed for tourism and recreation.”

Fig. 4. Map of Marine Conservation Areas in Indonesia (KKP/KKJI 2012)

Based on the Act No.5/1990 on ratification of UN Convention of Biological Diversity, Ministry of Forestry had developed marine protected areas in Indonesia which consist of National Marine Park, Marine Nature Recreation Park, Marine Nature Reserve and Marine Nature Wildlife Reserve. Further development of marine protected area was managed by Ministry of Marine Affair and Fisheries based on the following acts, government regulation, ministerial regulation and guideline:

- Act No. 31/2004 concerning Fisheries
- Act No.32/2004 concerning Local Government of which local government has the authority to manage marine resources
- Act No.27/2007concerning the management of coastal area and small islands
- Government Regulation No.60/2007 concerning Fishery Resource Conservation
- Minister of Marine Affair and Fishery Decree No.2/2009 concerning Procedure for Establishment of Aquatic Conservation Area
- Minister of Marine Affair and Fishery Decree No.18/2008 concerning Conservation Area in the Coastal Zone and Small Island Area
- Minister of Marine Affair and Fishery Decree No.38/2004 concerning General Guideline of Coral Reefs Management and its Related Ecosystems
- Grand Strategy of Marine Biodiversity Conservation
- Grand Strategy of Marine Conservation Area Networks

Marine Protected Area is one way to protect and preserve for sustainable use of marine and coastal ecosystems. Through the existing regulation, the Government of Indonesia has conducted some efforts to conserve its marine and coastal resources and ecosystems.

Implementation and Achievement

Based on the Act No.5/1994 and Government Regulation No.68/1968, Ministry of Forestry had developed several types and numbers marine protected area namely National Marine Park, Marine Nature Recreation Park, Marine Nature Reserve and Nature Wildlife Reserve). The total extent of marine protected area designated by Ministry of Forestry is about 4.7 million ha.

Since 2001 Ministry of Marine Affair and Fishery, in cooperation with its related partners, had initiated the development of marine protected areas to continue which were carried out by Ministry of Forestry. Currently, this effort has resulting of approximately 11.4 million ha the total extent of MPAs in Indonesia by 2012. Most of the MPAs established are Regional Marine Protected Areas. Further target for 2020 is the establishment of 20 millions ha marine protected area. Recently, a very large Marine National Park, i.e. Sawu Marine National Park, had been gazetted covering about 5 million hectares of marine area. Therefore, the total area of established Marine Conservation Areas in Indonesia is around 16.1 million ha (KKP/KKJI, 2012).

Table 1. Marine Conservation Areas in Indonesia (KKP/KKJI, 2012)

No.	Conservation Area	Number of Areas	Area extent (Ha)
A	**Managed by Ministry of Forestry**	**32**	**4,694,949.55**
	National Marine Park	7	4,043,541.30
	Marine Nature Recreation Park	14	491, 248,00
	Marine Nature Reserve	5	5,678.25
	Nature Wildlife Reserve	6	154,480.00
B	**Managed by Ministry of Marine Affairs and Fishery**	**81**	**11,420,599.34**
	National Marine Park	1	3,521,130.00
	Marine Nature Reserve	3	445,630.00
	Marine Recreation Park	6	1,541,040.20
	Regional Marine Protected Area	71	5,912,799.73
	TOTAL	**113**	**16,115,547,49**

In the early planning stage the Ministry of Marine Affair and Fisheries and partners have decided the target of the Indonesian Marine Protected Area development as the followings:

(i) Short tem target (2009-2010)

- Improvement of the existing MPAs towards its functional management
- Finalization of establishment status of the existing MPA to reach 10 million ha by 2010
- Adoption of MPA grand strategy for Indonesia

(ii) Mid term target (2010-2014)

- Achievement of 14 million ha of MPA by 2014
- Effectiveness of management as a model in priority locations
- Integration of MPA within ICM implementation

(ii) Long term target (2015-2020)

To expand, scaling up and developing Marine Conservation Area to reach 20 million ha by 2020.

With the current progress, the achievement for 2012 is already above the target. It is most likely the target to reach 20 million ha by 2020 will be met earlier. However, the most important thing is to achieve its functional management which is more difficult.

6.5. Awareness programmes, impact and effectiveness

Awareness programs concerning marine and coastal conservation have been implemented by several institutions or projects. Several examples are described below.

Trismades

Trismades (Trikora Seagrass Management Demonstration Site) is under the UNEP-GEF South China Sea Project: Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand, officially conducted from 2017 to 2010. The first step in Public Awreness Campaign of the Trismades Project in Bintan Island (Riau Archipelago) was to make a base-line survey on the level of awareness of the community and the influencers (government, private officials). The same survey was repeated every year to see the impact of awareness campaign. The result of the survey indicated that after intensive intervention of awareness campaign, the level of awareness increased significantly in all the villages surveyed (Trismades Tech. Report). Awareness campaign includes:

- Focus group discussions with local communities.
- Publication and distribution of leaflets, brochures, booklets, posters, T-shirts, bags, calenders etc containing messages for seagrass conservation.
- Production and enstallment of banners and bill-boards at strategic places.
- Radio broadcast with interactive dialogue with listeners.
- Establishment of Information Centers at pilot villages.
- Encouraging local poetry recital art (*pantun*) and by inserting messages to conserve the seagrass ecosystem.
- Writing competition for high-school students on marine conservation issues.
- Beach cleaning up with local communities and school children.
- Support sustainable tourism which ensure the protection of natural ecosystems, and support the establishment of two tourism villages.
- Writing of articles for newspapers on seagrass conservation issues.
- Commemorate the International Year of Biodiversity 2010, by involving coastal communities and school children.
- Develop and distribute bilingual Newsletter, published quarterly.
- Develop bilingual website as portal for seagrass Indonesia.

The most significant outcome of the awareness campaign is that the local community are willing enthusiastically to take part in the seagrass conservation, or even with their own initiatives. In all three pilot villages each head of the village issued decree on community-based seagrass sanctuaries. This was later on strengthened by the higher level decree of the Bupati (Head of District of Bintan) concerning the need to save the dugongs and their seagrass habitat in the District. The Bupati also decided to adopt dugong as the icon or flagship species of the District. Following up, the regional Tourism Service of the District of Bintan encourages the use of the dugong icon for various tourism activities and for souvenirs. A big welcome gate to the village of Teluk Bakau was built by the local community with dugong as the main decoration.

Coremap

The implementation of Public Awareness program under Coremap (Coral Reef Rehabilitation and Management Program) was started since the early beginning of Coremap Phase I (1998 – 2004). During Coremap Phase II (2007 – 2012), the awareness program is continued and is aimed to change the attitude of the coastal people from destructing the ecosystem to building awareness in keeping and nurturing coral ecosystem. Achievement for Coremap Phase II has been reported in Coremap (2011). Several achievements are as follows:

- Perception of community on the importance of protecting coral ecosystem increased about 75 %.
- Various socialization materials distributed to 310 villages.
- Talk show, TV and radio broadcast.
- Providing local contents for education from primary schools to high schools.
- Supporting responsive research for 33 topics.
- Providing fellowship for 618 high school students.
- Providing support for university paper and thesis report writing for 310 students.
- On the job training for 660 students.

The main outcomes can be seen from the high participation of the community at all pilot sites in various activities for the protection and conservation of coral reefs.

6.6. Experiences of incentive mechanisms for conservation

Coremap ADB experience

Coremap (Coral Reef Rehabilitation and Management Program) under ADB funding during Phase II (2007 – 2012) dealt with enhancement of community welfare and incomes in eight districts: Nias, Nias Selatan, Tapanuli Tengah, Mentawai, Batam, Bintan, Natuna and Lingga. Starting from 2007, the AIG (Alternative Income Generation) projects were implemented through a community contract system. The AIG beneficiaries were provided input assistance using ADB loan proceeds. Through NGOs and extension workers, technical, financial, and marketing assistance were provided to the *pokmas* (community groups). The performance target for technical and financial assistance was 10,000 persons. At loan closing date, 7,300 persons had been covered. The AIG projects covers many kinds of activities such as grouper cage culture, mud-crab culture, seaweed culture, sea cucumber raising, smoked fish, local ecotourism, handicraft and souvenir business, poultry production, coconut oil processing, production of fish cracker, boat repair (Asia Development Bank, 2012).

About 50% of the microenterprises established were successful. The major factors that contributed to the success of some livelihood enterprises were cooperation among the *pokmas* members and the PIUs (Project Implementation Unit) and NGOs, good technical skills, extension services, and management, including transparent bookkeeping. Furthermore, livelihood enterprises were found to be successful in the project areas where the LPSTK's (Coral Reef Management Body) leadership was active, technical and marketing support provided by the extension workers and the local government was strong, and where feasibility studies of project proposals were properly and thoroughly conducted. On the other hand, business failures were caused by (i) improper site selection, (ii) the poor quality of the project feasibility study, (iii) marketing problems, (iii) high mortality rate of fingerlings, (iv) fish diseases, (v) climatic changes, and (vi) the high cost of commercial feed and fish as raw materials for fish cracker processing (Asia Development Bank, 2012).

Trismades experience

During the execution of Trismades (Trikora Seagrass Management Demonstration Site) project in Bintan Island from 2007 to 2011, several activities on AIG (Alternative Income Generation) were performed. The initial steps was to survey the local potential resources and types of AIG suitable for the local communities and discuss the problems with the communities. Some alternative types of AIG were then identified, and trainings for the types of activities were prepared. Types of AIG that had been developed included: naga fruit cultivation, weaving of *pandanus* and coconut leaves for various kinds of handicrafts and souvenirs, sewing skill, and preparation to develop marine ecotourism. Initial capital and to some extent also the marketing of products were assisted by the

project. Post project evaluation indicated that handicraft production and sewing skill were regarded by the communities as fruitful to help their livelihood.

6.7. Ecosystem services related to carbon capture

The ocean's vegetated habitats, in particular mangroves, salt marshes and seagrasses, cover < 0.5 % of the sea bed. These form earth's blue carbon sinks and account for more than 50 %, perhaps as 71 %, of all carbon storage in ocean sediment. They comprise only 0.05 % of the plant biomass on land, but store a comparable amount of carbon sinks on the planet. Blue carbon sinks and estuaries capture and store beween 235 – 450 Tg C yr^{-1} (Nellemann *et al.* 2009). Absorbed carbon was stored as carbon stock and distributed in various compartments such as in sediments, herbivores and other ecosystems (Supriadi, 2012).

Study on carbon stock and budget in Indonesian seagrass ecosystem was only recently started. Kiswara (2010) initiated the study in Pari Island (Jakarta) at a mixed vegetation of *Enhalus acoroides*, *Cymodocea rotundata* and *Thalassia hemprichii*. The study showed that the carbon stock varied from 30.63 to 545.33 g C m^{-2} and their carbon sink varied from 0.20 to 1.83 g C m^{-2} . In a later study at the same island on a mono-specific vegetation of *Enhalus acoroides,* Rahmawati and Kiswara (2012) showed that carbon stock in this monospecific vegetation was 72.51 g C m^{-2} and 154.55 g C m^{-2} respectively. The ability of *Enhalus acoroides* vegetation to absorb, release and store carbon were 1.75 g C $m^{-2}d^{-1}$; 0.55 g C $m^{-2}d^{-1}$ and 1.20 g C $m^{-2}d^{-1}$ respectively.

Study on carbon budget was also initiated by Supriadi (2012) in the Island of Barranglompo, Makassar. The aim of his research was to analyze the carbon stock, productivity and carbon budget through herbivore grazing and leaf litter. The research was conducted from December 2010 to November 2011. Carbon stock was obtained by conversion from seagrass biomass using carbon contents of seagrass tissues. Productivity was measured using marking method, while leaf litter production used cages. Grazing rate was determined in the laboratory for sea urchins and *in situ* for other herbivores. Seagrass community had leaf and rhizome productivity of 0.187-1.494 g C $m^{-2}day^{-1}$ and 0.013-0.050 g C $m^{-2}day^{-1}$, respectively. The total carbon stocks were as much as 73.86 tonnes from overall 64.3 ha of seagrass bed areas. Total production of leaf litter was 0.18-1.30 g C $m^{-2}day^{-1}$, consisted of 0.13-0.86 g C $m^{-2}day^{-1}$ of burial leaf litter, while floating litter was 0.05-0.54 g C $m^{-2}day^{-1}$. Total grazing of herbivores ranged between 0.04-0.10 g C $m^{-2}day^{-1}$. Grazing by sea urchins was 0.003-0.023 g C $m^{-2}day^{-1}$, relatively low compared to the grazing by other herbivores i.e. 0.015-0.236 g C m^{-2} day^{-1}. Mean carbon budget through floating litter was as much as 22.0% of the total leaf production, 50.6% of burial litter, 1.4% of sea urchin grazing and 7.9% of other herbivore grazing or total carbon that flowed to other compartments achieved 81.8%.

At the Marine Science and Technology Graduate Program of the Bogor Agricultural Univerity (Bogor, West Java) there is currently a study on the economic valuation, including carbon stock of seagrass ecosystem at Kotania Bay (Ceram Bay, Maluku), under the investigator Mintje Wawo.

6.8. Key stakeholders' roles and their capacities

There are many types of stakeholders relevant to dugong and seagrass conservation. Several government ministries play important roles in producing important regulation and management measures in various levels of involvement. The most important one is the Ministry of Marine Affairs and Fishery which has the mandate to issue regulations and control over the Marine Protected Areas and on the conservation of marine species. Complementary to this, the Ministry of Forestry

has also the mandate to manage the National Marine Parks and law enforcement within the area of the parks. Other Ministries are engaged in relatively lower level of involvement which shown on Tabel 2 .

Among several of the Government non-ministerial bodies, the Indonesian Institute of Sciences (LIPI) plays important roles as provider of scientific data and information on seagrass and other marine biodiversity.

The role of the Local Government is inevitable in the implementation of projects in the local areas. The Local Government plays determinant roles in this era of autonomy. Certain District such as Bintan, has issued regulation on the conservation of dugong and its habitat, and adopted dugong as flagship species of the District. The community group in a local area is important in involving the community in the seagrass and dugong conservation.

To some extent universities (Government and non-Government) contribute in studies or research on various aspects marine conservation.

There is a number Non Government Organizations (NGOs) working on marine biodiversity with different approaches, and only one (LAMINA) which is specializing in seagrass and dugong conservation.

Table 2. Stakeholders and their functions relevant to seagrass and dugong conservations

Stake holder	Functions relevant to seagrass and dugong conservation	Relative level of involvement
Central Government		
Ministerial		
Ministry of Security and Defence	Law enforcement	+
Indonesian Police	Law enforcement	+
Ministry of Marine Affairs and Fishery	Regulation, Marine Proctected Areas, Species conservation	+++
Ministry of Forestry	Regulation, National Marine Park, law enforcement	+++
Ministry of Environment	Environmental policy, focal point CBD, external cooperation	++
Ministry of Tourism	Marine ecotourism	+
Ministry of Internal Affairs	Regulation, coordination of local government	++
Ministry of Education	Environment education, local content for coastal regions	+
Ministry of Public Works	National Spatial Plan Development; Public works and construction standard and regulation	++
Ministry of Energy and Mineral resources	Regulation on of Offshore OIL and Gas and other mineral resources Mining Activities	++

Ministry of Transportation	Regulation on development and operation of port and shipping including marine dumping.	++
Ministry of Finance	Financing of government projects	++
National Planning Board (BAPPENAS)	National development planning, financial plan	++
Non-Ministerial		
Indonesian Institute of Sciences (LIPI)	Coastal and marine research and information, studies on seagrass ecosystem and related aspects, community-based management	+++
National Geospatial Agency	Geographic Information System, Develop and provide base-map of marine and coastal environment and resources	++
Local Government		
Kabupaten (District) and Municipal	District regulations and control. Coastal and Small Islands Zoning Plan.	+++
All government agencies /offices related to the central government ministries	Control, monitoring and evaluation	+++
Community groups in local areas	Involved in the implementation of various coastal projects.	+++
Universities		
State and non-government universities	Research on seagrass ecosystem and related aspects	++
Non-Government Organizations		
WWF Indonesia	Conservation, biodiversity	++
TNC / The Nature Conservancy	Conservation, biodiversity	++
CI / Conservation International	Conservation, biodiversity	++
Walhi	Environment advocacy	++
Yayasan Terangi	Coral reef management	++
Yayasan Lamina	Seagrass and dugong studies and conservation	+++
Yayasan Mangrove	Mangrove conservation	++

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Annexes

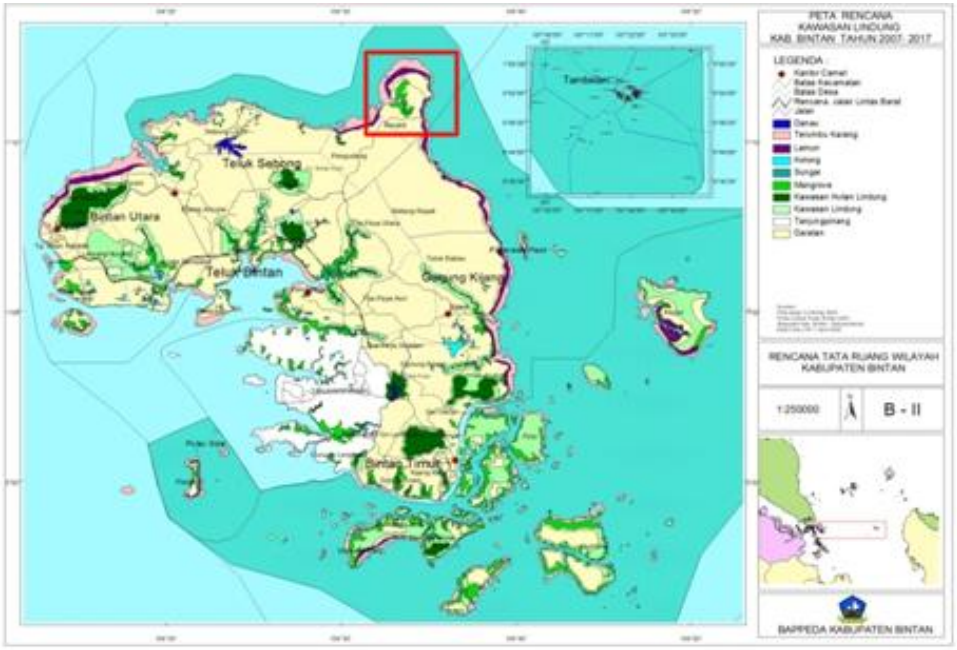
Annex 1.

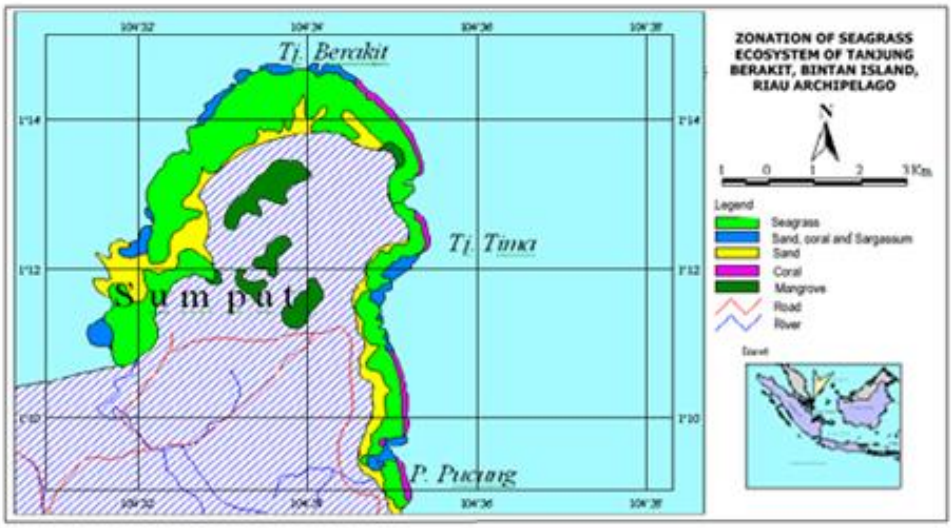
Seagrass recorded in Indonesian waters with brief ecological notes

Family/Genus	Species	Notes
Hydrocharitaceae *Enhalus*	*E. acoroides*	Common on silty/muddy to medium and coarse sediments and areas with high bioturbation; found in estuarine habitats and low salinity anchialine lagoons; forms monospecific meadows and dominates in mixed communities where it often grows with *T. hemprichii*; wide depth distribution to ca. 30 m; important shelter for juvenile fishes, shrimps-prawn
Halophila	*H. decipiens*	Known as dugong food; found in lagoonal environment on fine to medium sands
	H. minor	Found in shallow lagoonal environments with sandy substrates, often with *H. ovalis*
	H. ovalis	Dominant species in the intertidal; wide depth range to a maximum of ca. 40 m; pioneering species common in areas with high bioturbation; frequently follows *Halodule* species in succesion; often found just seaward of mangroves
	H. spinulosa	Found in deep lagoonal environments with fine sand; it may be confused with two species of green algae, *Caulerpa sertularioides* and *C. mexicana*
Thalassia	*T. hemprichii*	The most abundant and widespread species; often dominates in mixed communities; depth range from intertidal to 30 m; grows on a variety of substrates such as silty sand, medium coarse sand or coarse coral rubble
Cymodoceaceae *Cymodocea*	*C. rotundata*	One of the dominant species in the intertidal; pioneering species; known as d*ugong* food from eastern Indonesia
	C. serrulata	Known as dugong food; frequently found just seaward of mangroves
Halodule	*H. pinifolia*	Fast-growing, pioneering species often occurring in the intertidal; forms monospecific stands on muddy substrates
	H. uninervis	Often forms monospecific meadows in disturbed inner reef flats and steep sediment slopes
Syringodium	*S.isoetifolium*	Common in shallow subtidal sand/mud/silt sub-strates; food for dugong*D*in captivity
Thalassodendron	*T. ciliatum*	Often dominates in the upper sublittoral in association with corals; depth ranges from reef crest to ca. 4 m; common in atoll lagoons where it forms large monospecific meadow

Annex 2.

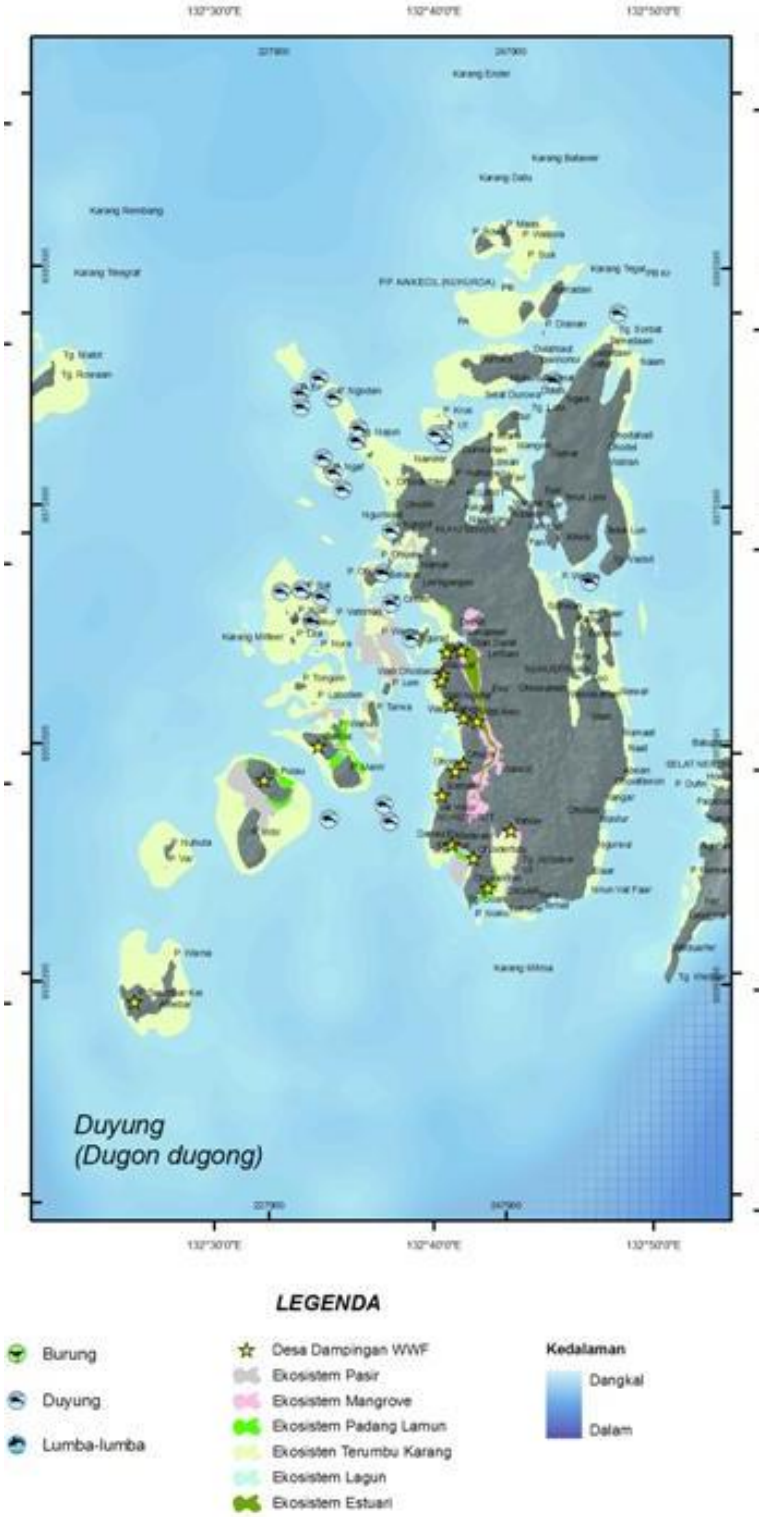
Map of Bintan Island, Riau Archipelago. One of the suggested sites for the dugong and seagrass conservation project.
Above: Bintan Island (Riau Archipelago) showing the suggested project site for dugong conservation.
Below: Detail map of the seagrass ecosystem of the suggested project site.





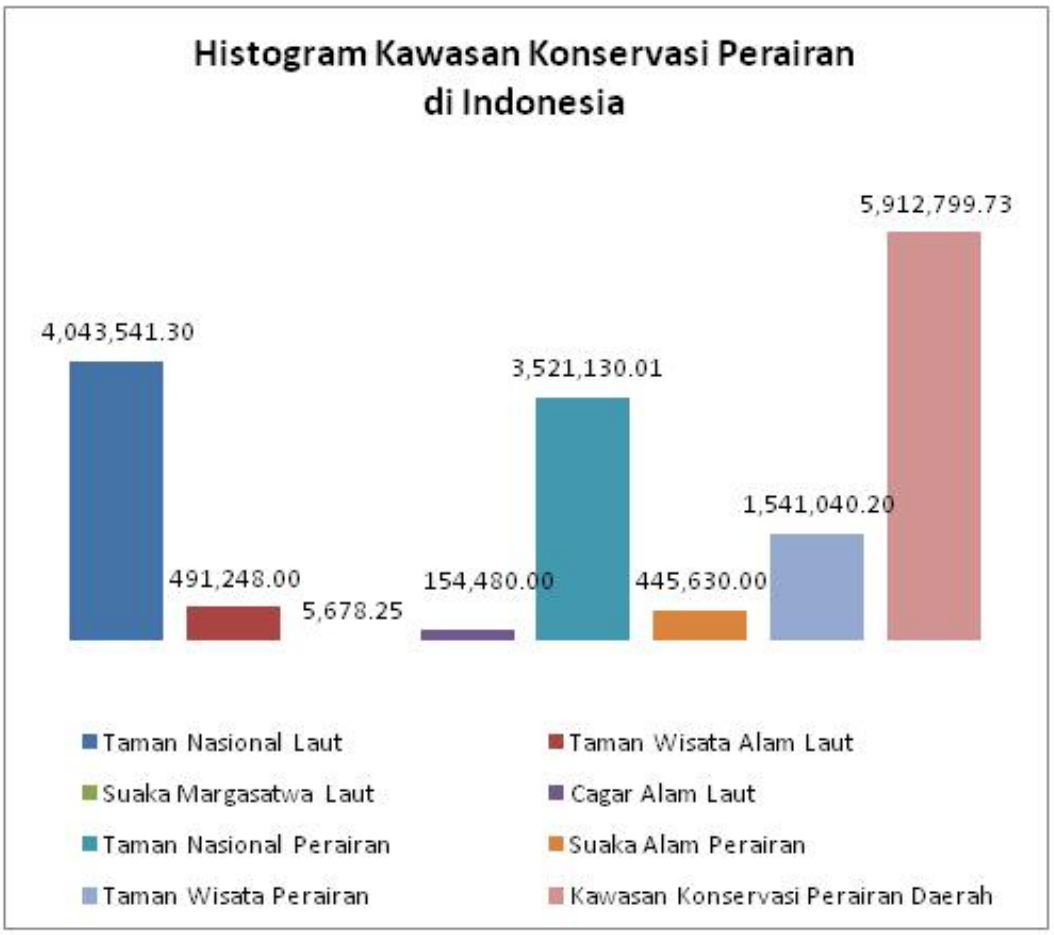
Annex 3.

Map of Kei Island of the suggested Project site. Frequencies of dugong sighting are indicated in map. (Source: WWF Indonesia)



Annex 4

Histogram of Marine Conservation Areas in Indonesia (KKP/KKJI, 2012)



Remarks: Last update December 2012
Under the management of Ministry of Forestry:

- Taman Nasional Laut (*National Marine Park*)
- Taman Wisata Alam Laut (*Marine Nature Recreation Park*)
- Suaka Margasatwa Laut (*Marine Nature Reserve*)
- Cagar Alam Laut (*Marine Nature Wildlife Reserve*)

Under the management of Ministry of Marine Affairs and Fishery

- Taman Nasional Perairan (*National Marine Park*)
- Suaka Alam Perairan (*Marine Nature Reserve*)
- Taman Wisata Perairan (*Marine Recreation Park*)
- Kawasan Konservasi Perairan Daerah (*Regional Marine Conservation Area*)