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IFACS INDONESIA FOREST AND CLIMATE SUPPORT

MIMIKA MANGROVE & LOWLAND SWAMP FOREST PLAN

Mimika District Government

USAID IFACS &

Blue Forests

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This Integrated Management Plan was developed in full consultation with coastal communities, government and other stakeholders from Mimika, Papua by Blue Forests (formerly Perkumpulan MAP-Indonesia) This document was commissioned under the USAID supported IFACS project (Indonesia Forestry and Climate Service).

Front Cover Photo: Ben Brown (Mimika River)
Back Cover Photo: Muljadi Tantra (Pomako)
Internal Photos: Robert Hewatt and Ben Brown

Also in this series:

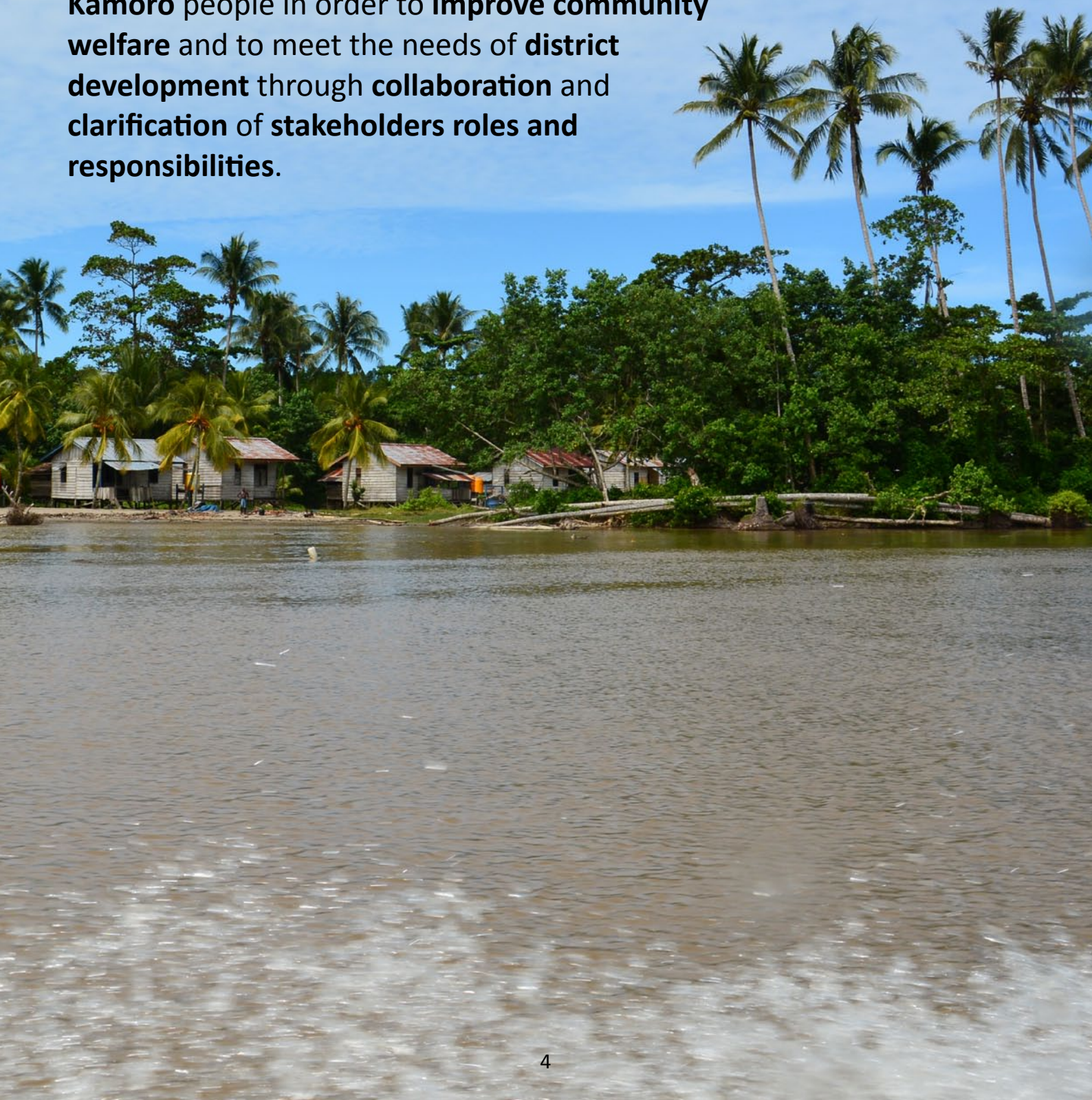
- Integrated Management Plan (IMP) for Mimika's Mangroves & Lowland Swamp Forest - a seven chapter academic reference
- PERDA - Official Mimika District regulations on mangrove and lowland swamp forest management
- KKMD - Articles of Incorporation - a formal document for the initiation of the Mimika multi-stakeholder mangrove management working group
- SDPEM - District level strategy for mangrove and lowland swamp forest management (captured in this document and in the IMP)
- Atlas - Mimika's mangroves and lowland swamp forest depicted through maps and photos

CONTENTS

OUR VISION

The following policy direction was derived from a public consultation of this Integrated management Plan in Mimika to over 75 local stakeholders representing the Kamoro people, government, academia, NGO's and business.

The policy direction that management of Mimika's mangrove and lowland swamp forest ecosystems should take emphasizes **conservation** and **sustainable utilization** of forest areas managed in an **adaptive** manner according to the **custom and culture** of the **Kamoro** people in order to **improve community welfare** and to meet the needs of **district development** through **collaboration** and **clarification** of **stakeholders roles and responsibilities**.



1. INTRODUCTION

Indonesia is home to the world's largest mangrove area of approximately 4,200,000 hectares, yet by the turn of the 21st century less than half of that total remained. Of Indonesia's mangrove resources, approximately 1,500,000 ha historically occurred on the Indonesian side of Papua (formerly Irian Jaya), with 1,382,000 ha remaining as of 1990. (Giesen, 1993)

In terms of productivity and diversity, there is also evidence that Papua maintains amongst the most species diverse mangrove system in the world exhibiting 42 species of true mangroves (Table 1.1) as well as the most productive with above and below ground carbon storage measurements averaging 1000 tons/ha ranging from roughly 600 – 1400. (Warren, 2014).

Recognizing the importance of the natural resources that mangrove forests and adjacent landscapes such as lowland swamp forests provide, Indonesia has for many years shown a strong institutional and legislative interest in achieving planning and management practices that will ensure their conservation. The most recent iteration of this effort is Presidential Decree Number 73 Year 2012 on National Strategy on Mangrove Ecosystems Management (SNPEM), substantiating that any policies, programs and activities related to the mangrove should be conducted under Mangrove Ecosystem Management Coordination Team at the National (KKMN) or Regional level (KKMD). (Ministry of Forestry, 2013)

Purpose of the Plan

This management plan is the result of a cooperative project between USAID - IFACS (Indonesian Forest and Climate Support) and the Government of Indonesia through its Ministry of Forestry, to strengthen the capacity of the Indonesian government to sustainably manage critical mangrove and lowland swamp forest resources, in Mimika District, which are of regional, national and global conservation importance.

Developing the Plan

This plan was developed through a consultative process lead by MAP-Indonesia with full support from the USAID IFACS office in Timika. The consultative process involved numerous site assessments, 8 stakeholder meetings in Mimika resulting in the formalization of a multi-stakeholder mangrove management working group (KKMD). The process also involved a study tour to Sulawesi to meet with two additional KKMD, the implementation of eight (8) coastal field schools with coastal communities in Mimika to empower coastal communities. The results of the above processes were captured in a seven chapter Integrated Management Plan (IMP), which serves as an academic reference to future site managers. After a consultative process with 70 stakeholders from across Mimika, this condensed version of the IMP was developed, in order to make the plan more accessible to coastal communities and other stakeholders. These documents, the IMP and the user-friendly IMP, accompany an Atlas as well as formal regulations for the future integrated management of Mimika's mangrove and lowland swamp ecosystems.

2. THE KAMORO PEOPLE

The concept of Kamoro identity evolved over time. Originally the Kamoro identified themselves with their own clan or Taparu. Only after meeting with outsiders, such as Chinese (Tena-we) or Dutch (Turabaya-we), did Kamoro's identity broaden beyond their clan. Kamoro comes from the word Kamorekuu - meaning "living people." Another term for the Kamoro is wenata - meaning the true people, while some Kamoro call them selves Mimika-we originating from the Mimika river. (Pickel, 2011; Harple, 2002).

For the purposes of this plan - we use the term Kamoro, referring to 18,000 people of a variety of sub-ethnic groups (see Fig 2.1) spreading who live amongst the mangroves, beaches and swamp forests of Mimika District.

Kamoro society is structured based on two key determinants; Paraeko and Taparu. Pareko is a matrilineal relationship, coming down from a Grandmother to her children and grandchildren. Taparu are clusters of Paraeko linked through marriage, coming from the word Tapare which means dirt or land. The Taparu unit live together and are the main by a series of traditions and taboos known as Sasi.

Taparu rules are non-written and delineations between land units are natural; from river to river, creek to creek, sometimes marked by sacred trees, high ground or forest edges.

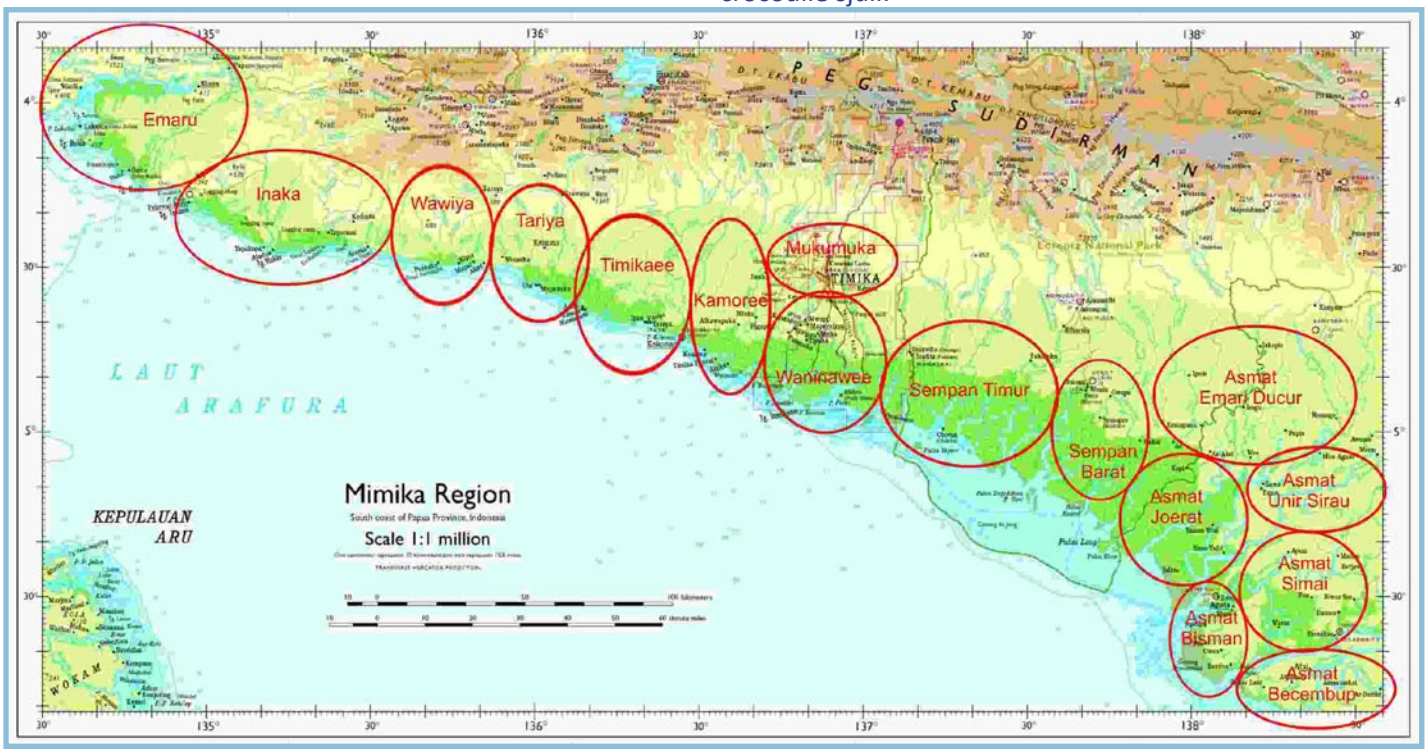
Sasi are a local tradition of taboo, where an area of forest, river or lake is either permanently or temporarily closed off from hunting, fishing or gathering.

Permanent sasi (also known as parta/para or parata) were established in ancestral times. Temporary sasi give a chance for nature to regenerate before being again exploited by humans. (Firin, 2014)

Sanctions for breaking the rules of Taparu and sasi are administered directly by the ancestors; and include memory loss, sickness or becoming lost in the forest.

Fig 2.2 An area of forest under temporary Sasi can be demarcated with wood, fruit, coconut fronds or even a crocodile sjull.

Figure 2.1 Sub-ethnic groups of the Kamoro people across all coastal areas in Mimika District.



3. CULTURAL VALUES

Approximately 18,000 Kamoro live in the lowlands of Mimika District. Surrounded by the world's richest mangrove area, Kamoro live a semi-nomadic lifestyle, shifting their few belongings between the excellent fishing areas near the coast and the sago palm forests (which begin at the furthest inland extension of the tidal zone). The Kamoro made first contact with foreigners much earlier than highland dwelling Amunme. For several centuries Kamoro suffered with slave traders coming from adjacent slands and endured fierce attacks from the Asmat headhunters in the east.

Yet in spite of drastic political change, modernization and immigration, turning the Kamoro into a minority in their own land, there is ample evidence of cultural and social continuity (Harple 2000). In other words, the Kamoro are a resilient people who trace their ancestry to the various forms of animals, plantgs and spirits that surround them in the mangroves, swamp forests , rivers and seas. This is reflected in their art, which depicts crocodiles, monitor lizards, bull sharks and hornbills as well as sago and breadfruit trees, with humans sometimes in transitory forms with these other symbols.

Fig 3.1 and 3.2 Kamoro art represents a deep-seeded belief of humans-=in-nature (above). The internal ties in a Taparu (clan) are kept strong through both ceremony and life's daily stuggles.

4. CONSTITUTIONAL RIGHTS & INDIGENOUS TITLE

Land, sea and mangroves are sacred to the Kamoro. Mangrove forests are their mothers, which protect them and fulfill their needs, while land provides needs and heals the sick (Bauw and Sugiono, 2009).

This indigenous connection to place is reflected in an ethic of use, production, and conservation by the Kamoro. (ibid)

Papua has been granted Special Autonomy described in Federal Law No. 21 of 2001 which was born out of Regulation No. IV/MPR/2000 (from the People's Consultative Assembly) which states;

1. The economy of Papua (currently West Papua and Papua provinces), which are parts of the national and global economy, are mandated and intended to create prosperity and welfare for the people of Papua, to uphold the principles of justice and apportionment.

2. Economic development in Papua which utilizes natural resources is to be carried out while respecting the rights of the traditional people, guaranteeing legal certainty for entrepreneurs, and protecting principles of environmental conservation, as well as sustainable development, to be delineated by Regional policy (Perdasus).

Article 43 under the Special Autonomy Law defines customary rights as the collective rights of the indigenous community (communal vs. individual rights).

Meanwhile, the central government regulates the function and utilization of forest through article 4, 66, and 67 of Law No. 41 on forestry, which states that the implementation of forestry regulations is entrusted to local government and forest utilization by the traditional people is allowed as long as it does not conflict with the law. The difference between customary law and conventional governance then becomes a challenge to forest management, requiring mediation, collaboration and compromise.

In order to help clarify these discrepancies, the Indigenous Peoples' Alliance of the Archipelago (Aliansi Masyarakat Adat Nusantara or AMAN) filed a complaint to the Constitutional Court (MK), which resulted in MK Decree No. 35/PUU-X/2012 regarding mechanisms for indigenous forest establishment and management.

Fig 4.1 Kamoro elder from Kokonao explaining the origin of his Taparu in space and time.

Complaints around Law No. 41/1999	Clarification under MK Decree No. 35/ PUU-X/2012
The word "state" in article 1 number 6, i.e. "Indigenous forest is "state" forest situated in legal indigenous community areas", does not have binding legal power.	Article 1 number 6 of Law No. 41 of 1999 is to mean, "Indigenous forest is a forest situated in a legal indigenous community's area".
Article 4 paragraph (3), i.e. "Forest control by the state shall respect customary laws, as far as they exist and their existence is recognized and not contradicting national interests."	Article 4 paragraph (3) is to mean, "Forest control by the state shall respect customary laws, as long as they exist and are in line with people's welfare and the principles of the unified State of the Republic of Indonesia."
Article 5 paragraph (1), i.e. "Forest shall by status consist of: a. state forest, and b. titled forest."	Article 5 paragraph (1) is to mean "state forest as stated in paragraph (1) item a. not including indigenous forest". Supplement of Article 5 paragraph (1) is against the 1945 Constitution and does not have binding legal power.
Article 5 paragraph (2), i.e. "State forest as referred to in paragraph (1) item a, can be indigenous forest."	Article 5 paragraph (2) is against the 1945 Constitution and does not have binding legal power.
Article 5 paragraph (3), i.e. "The Government shall stipulate the status of forest as referred to paragraphs (1) and (2); and indigenous forest shall be stipulated if any and its existence acknowledged."	The phrase "paragraph (2)" in article 5 paragraph (3) is against the 1945 Constitution and does not have binding legal power, so that it is amended to read "The Government shall stipulate the status of forest as referred to paragraph (1); and indigenous forest shall be stipulated if any and its existence acknowledged."

Table 4.2 List of Decrees Granted by the Constitutional Court in MK Decree No. 35/PUU-X/2012 (Source: The Ministry of Forestry)

5. NATURAL VALUES

The most significant physical processes operating on the topographically flat, Mimika, coastal lowlands are hydrological. These processes are concerned with the regulation and location of surface and groundwater movement of freshwater – a function of rainfall, the nature of the soil surface, tidal movements and drainage in the river systems and the action of offshore tidal currents. The dynamic balance between the seaward influence of freshwater and the land influence of the tides is not as seasonably remarkable as other areas in Indonesia, due to more consistent monthly rainfall, however, differences in monsoon and dry seasons exist. Due to the high level of rains and the runoff they created, high sediment loads in streams draining the upper watershed results in rapid coastal sedimentation, and the growth of the coastline through aggradational processes.

An understanding of the influence of these hydrological processes on the geomorphology, soils, vegetation and the fauna of Mimika's mangroves is essential to long term planning for conservation and resource development.

The Origins of the Coastal Landscape

The island of Papua has been formed and transfigured due to the collision of the Australian plate with the Pacific plate, and several smaller tectonic plates such as the Philippine Sea, Caroline and Solomon. (Polhemus, Marshall and Beehler, 2007). When seas were lower (>20,000 ya), this Southern area was essentially the northern, tropical extension of mainland Australia, and to this day, the two are separated by the very shallow Arafura Sea at the Torres Strait – seldom more than 15m depth.

With specific regards to mangroves, the mangrove forests of the "stable" southern coast are older and more specious than those found in the active subduction zone of the northern coast. Saenger (2002) notes that the mangroves along the northern shore of the island represent more ancient forests than those along the southern coast; the northern flora is derived from the Indo-Malesian mangroves but the southern flora is largely derived from northern Australia.

Patterns of Coastal Change

The most important patterns of change on the Mimika coast as related to mangroves are patterns of sedimentation and accretion. Accretion is occurring along much of the coastline as indicated by the presence of extensive mud banks extending up to 10 km seaward, as well as the formation of micro-deltas in the majority of river mouths. The mudbanks are widest in the vicinity of the largest rivers, which bear sediment throughout the year due to Mimika's high and consistent degree of rainfall.

In these areas, rapid ***accretion*** of the coastline is indicated by an extensive band of *Sonneratia* and *Avicennia* mangroves. Problematic, human-caused accretion of as much as 100 m per year is occurring in the Ajkwa river delta due to fine sediment from Freeport tailings, causing transportation difficulties for the community at Amamapare. Formation of deltas in the Ajkwa are rapidy colonized by a variety of halophytic grasses and mangroves, some of which will likely develop into beach vegetation as accretion continues to lift these deltas out of tidal influence. In some instances, the trees seem to have difficulty adapting to the very dense substrate developed in these mining tailings, evidenced by prominent lenticles on the breathing roots and trunks of the mangroves, and very dense pneumataphore assemblages (see Figure 5.1).

Where major **erosion** is occurring, mature mangrove forests become inundated for too long of a period

Fig 5.1 Adaptation is taking place on a individual plant level. Here, the pioneer mangrove *Avicennia marina* has colonized newly accreted mining tailings. The substrate is more dense than sediment normally found in the Ajkwa delta, however the mangrove has adapted by developing abundant, thick breathing roots (pneumatohpres) to cope in low oxygen soils.

(due to lower substrate surface elevation), after-which the trees die and fall. A switch in mangrove species associations takes place, where halophytic grasses colonize lowered substrate surfaces that remain above mean sea level (MSL), which then capture mangrove propagules of species which are tolerant to longer periods of inundation. **Figure 5.2** depicts an **adaptive cycle** where coastal *Lumnitzera* growing behind a former chenier have died, but are replaced over time with a variety of halophytic grasses followed by pioneer tree species at lower elevations (*Avicennia* spp.) and species of the family Rhizophoracea (*Brugueira* spp., *Ceriops* spp., *Rhizophora* spp.) at slightly higher intertidal elevations. This pattern of recovery occurs due to the rich species diversity exhibited in Mimika. Where elevations are eroded below MSL, sediments remain bare and the system loses value.

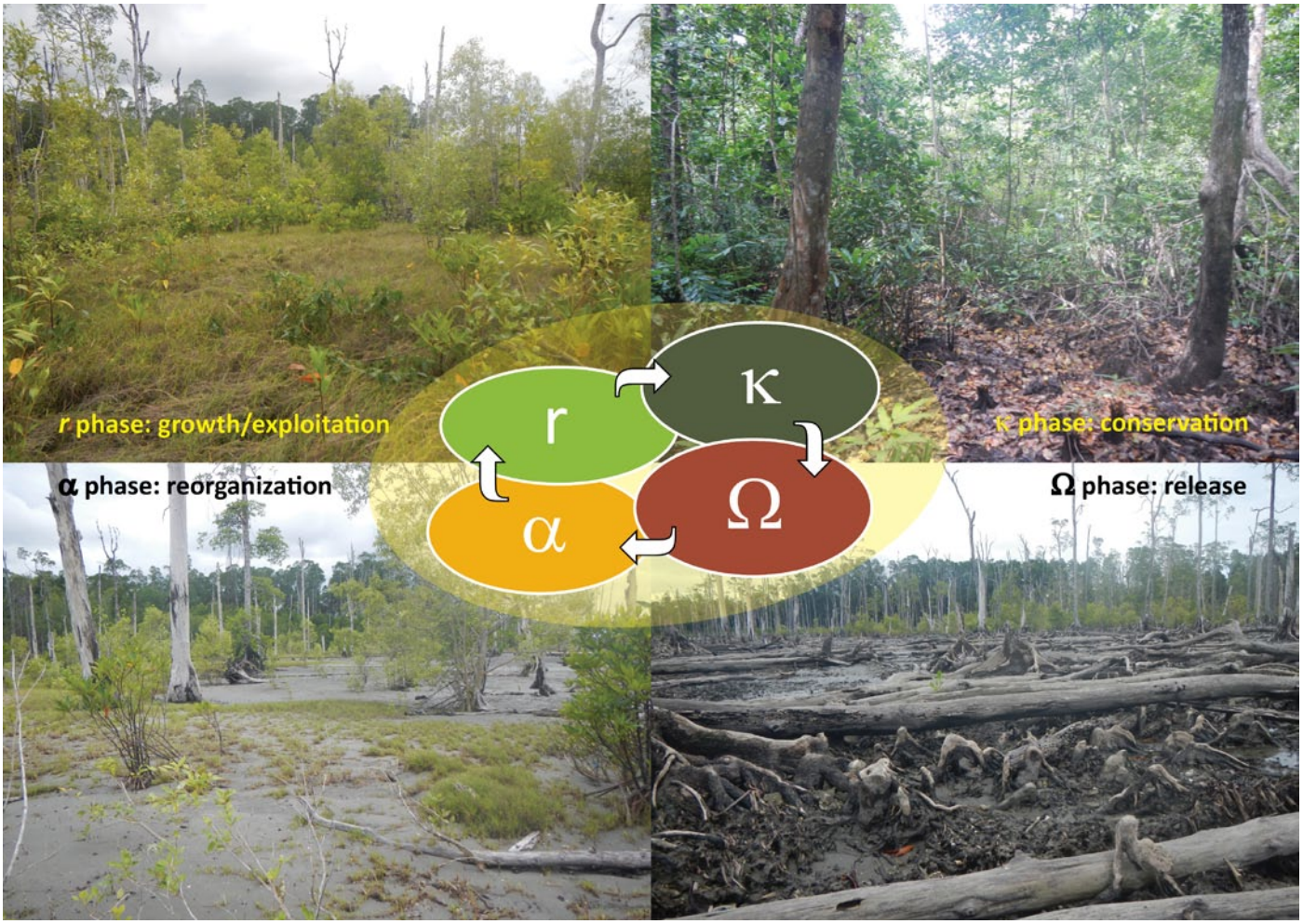
Hydrology

Freshwater enters the coastal lowlands directly from incident of rainfall and indirectly via a number of rivers which drain either lowland coastal catchments or upland catchments including significant parts of the Makoe mountain chain. Rainfall is monsoonal with a wet season from October to April. Data from Timika show mean monthly precipitation exceeds 250 mm for 4 months of the year with the driest months of June and July still yielding an average of about 100 mm. Average annual rainfall is 2250 mm. (Mimika Dalam Angka, 2012).

The major rivers in the region which drain the uplands are the dominant forces driving coastal geomorphic processes and also effecting mangrove distribution along the coastline. The extensive peatlands, formed as backswamps behind the advancing coastline, act as a reservoir from which the gradual release of groundwater maintains the freshwater influence so obvious in the coastal vegetation, in both mangroves and halophytic grasses.

Mimika's mangroves and lowland swamp forests need to be understood and managed as a single hydrological unit.

Fig 5.2 The Adaptive Cycle. The release phase in this case was triggered by rising seas/coastal erosion, which led to longer periods of tidal inundation, killing the adult mangroves roots (through H_2S toxicity in an increasingly anaerobic substrate). However, due to the richness of the system in terms of biodiversity, natural recovery (community adaptation) takes place, and the resulting forest is of equal value as the previous forest.



Flora

True Mangroves

Of the 32 species that Tomlinson (1986) records for the 15 degree longitudinal section (135°E – 150°E) containing Mimika's mangroves, 10 additional species have been recorded either in Mimika bringing the total to 42 species of true mangroves (see Fig 5.3 and Table 5.4)

Mangrove Associates

When moving to slightly higher elevations, we encounter what are termed Mangrove Associates. As a rule of thumb, there seem to be about 5 times as many mangrove associates as there are mangroves in any given region (ibid), meaning there could be upwards of 200 "mangrove associates" in the Mimika region.

Lowland Swamp and Peat Vegetation

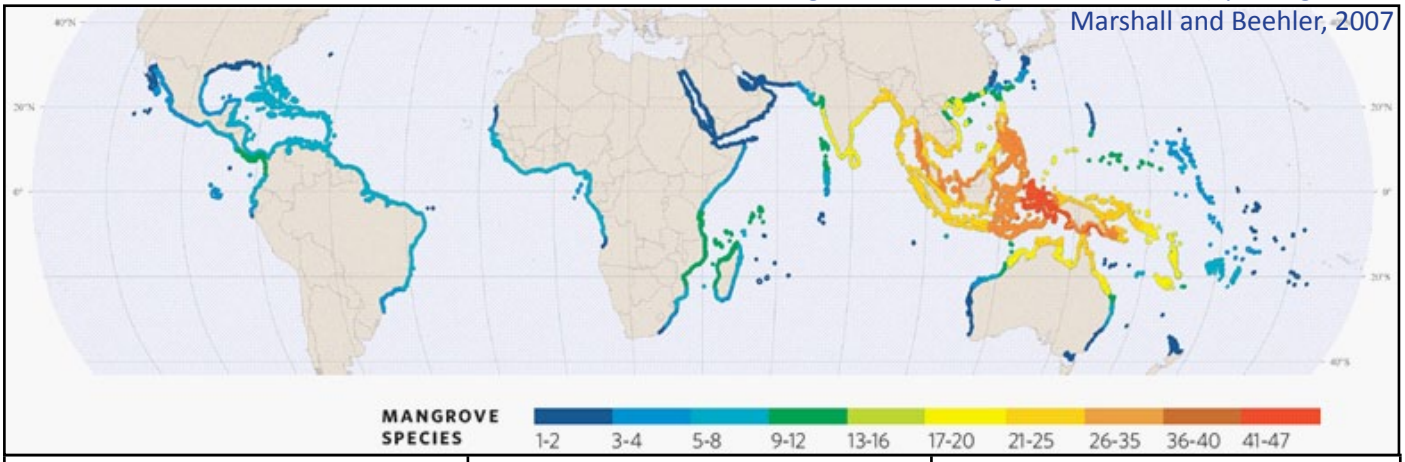
Swamp vegetation and peat swamps occur from the lowlands up into the mountains in Papua, but are most extensive in the lowlands from 3-35 meters above sea level. (Marshall and Beehler, 2007). Several dominant monospecific types of lowland forested swamp exist such as; *Campnosperma* (30-40m tall), sago swamp (*Metroxylon sagu*) and Pandanus swamp. Where soil levels are higher, species diversity increases and are known as Mixed Lowland Swamp Forests (ibid).

A total of 22 monospecific and mixed swamp forest types from across Papua but well represented in Mimika are depicted in Table 5.4 Lowland swamp forests at slightly higher elevations with good drainage/low levels of soil water, mark the transition into mixed lowland tropical rainforest.

Peat Swamp

Peat may be a component of the soils of lowland swamp system, found in layers between 50 cm – 20 meters deep elsewhere in Indonesia, peat has already been measured to 10 meters depth in Papua. The peat is formed as organic matter builds up behind the mangroves, primarily in areas which are not flooded and drained regularly as part of larger rivers. Mineral poor rainwater builds up over organic matter, slowing down the rate of decomposition (due solely to anaerobic, not aerobic bacteria).

Fig 5.3 True Mangroves of Mimika (Spalding, 2010; Marshall and Beehler, 2007



Acanthus ebracteatus,	*Brugueira hainesii*	*Rhizophora apiculata*
A. ilicifolius	*Brugueira parviflora*	*Rhizophora x lamarckii*
A. volubilis	*Brugueira sexangula*	*Rhizophora mucronata*
Acrostichum aureum	*Campostemon schultzii*	*Rhizophora stylosa*
A. speciosum	*Ceriops australis*	*Scyphiphora hydrophyllacea*
Aegiceras corniculata	*Ceriops decandra*	*Sonneratia alba*
Aegialitis annulata	*Ceriops tagal*	*Sonneratia caseolaris*
Avicennia alba	*Exoecaria agallocha*	*Sonneratia lanceolata*
Avicennia eucalyptifolia	*Heritiera littoralis*	*Sonneratia merauke*
Avicennia marina	*Lumnitzera littorea*	*Sonneratia ovata*
Avicennia officinalis	*Lumnitzera racemosa*	*Sonneratia xurama*
Brugueira cylindrica	*Nypa fruticans*	*Xylocarpus granatum*
Brugueira exaristata	*Osbornia octodonta*	*Xylocarpus mekongensis*
Brugueira gymnorrhiza	*Pemphis acidula*	

Lowland Swamp Forest Types		Dominant canopy species
Mono or few species Dominant		
	1	*Campnosperma* swamp forest
	2	*Melalueca* swamp forest
	3	*Erythrina* Swamp
	4	*Barringtonia/Leptospermum* Swamp
	5	*Pandanus* Swamp
	6	*Metroxylon sagu* (Sago) Swamp
Mixed Species Swamp and Swamp Forest	7	*Alstonia scholaris, Hopea novoguineensis, Garcinia dulcis, Terminalia copelandii*
	8	*Vatica russak, Stemonurus, Terminalia copelandii, Campnosperma brevipetiolata*
	9	*Hopea novoguineensis, Terminalia copelandii, Pandanus tectorius, Alstonia scholaris*
	10	*Hopea novoguineensis, Terminalia copelandii, Alstonia scholaris, Polyosma*
	11	*Terminalia copelandii, Hopea novoguineenis, Garcinia dulcis, Polyosma*
	12	*Campnosperma brevipetiolata* and *Intsia* with a *Pandanus substratum*
	13	*Hopea novoguineensis, Terminalia copelandii, Alstonia scholaris, Garcinia dulcis*
	14	*Metroxylon sagu, Terminalia copelandii, Alstonia scholaris, Hopea novoguineensis*
	15	*Metroxylon sagu, Terminalia copelandii, Syzgium argentea, Alstonia scholaris*
	16	*Metroxylon sagu, Terminalia copelandii, Hopea novoguineensis, Garcinia dulcis*
	17	*Metroxylon, Campnosperma, Instia, Pandanus,* and sago
	18	*Metroxylon sagu, Palaquium, Octomeles, Diospyros*
	19	*Instia bijuga, Hopea novoguineensis, Artocarpus, Palaquium* with a *Metroxylon sagu* substratum
	20	*Pimelodendron, Vatica, Sloanea, Myistica*
	21	*Pometia pinnata, Celtis, Octomeles sumatrana, Syzgium*
	22	*Nauclea, Cryptocarya* and *Palaquium* with a *Pandanus* substratum

Table 5.4 Dominant Community Associations in Lowland Swamp Forests - Collated from Marshall and Beehler, 2007, and an example of a lowland swamp forest along the Mimika river (Fig 5.5)

FIG 5.6: FLORISTIC DIVERSITY IN MIMIKA'S MANGROVES (OPPOSITE PAGE)
Both *Lumnitzera littorea* (top left) and *L. racemosa* (middle left) are abundant in Mimika, their flowers adding color to the forest. *Avicennia marina* var. *eucalyptifolia* is one of three varieties of *A. marina* available to colonize newly accreted intertidal surfaces (bottom left). Members of the KKMD study group collected 17 species of mangroves and associates in as many minutes during a field trip to the Tipuka delta (top and middle right). The deciduous leaves of *Xylocarpus moluccensis*, bright orange against a background of pure green, are a sign to Kamoro fisherfolk that mud crabs (*Scylla* spp.) are mating.

Invertebrates

Molluscs

Three groups of molluscs which inhabit the mangroves are of particular importance to the Kamoro, snails, shipworms and clams.

A trio of snails are preferentially gathered and eaten by the Kamoro people; *Nerita balteata, Telescopium telescopium* and *Naqueita capulina*. The Kamoro derive nearly 100g of protein from these three species per week. (Hardinsyah et al. 2006). The diversity of bivalves in the forest are less than gastropods, but still significant. with *Geloina cf coaxan* being preferred and providing on average 150g of protein per person per week. (ibid) The "shipworm" *Bactronophorus thoracites* (locally: tambelo) also provides a meaningful source of protein, on average 290 g per week, with teenagers eating on average 433g and up to 1000g (1kg) per week. (ibid) This mollusk lives in a calcareous tube within old and dead mangrove wood. Communities harvest the tambelo using an axe to pry apart large woody debris on the forest floor. The tambelo is then eaten raw after removing the head, or collected for consumption in the village, either raw or cooked.

Crustaceans.

Crabs, shrimp and other crustaceans are also important members of Mimika's mangroves. *Scylla* spp., the mud crab, is the most commercially important fisheries genus in the region alongside the Barramundi.

There are at least three species of *Scylla* crabs which both scientists and the Kamoro distinguish, (*Scylla serratus, S. tranquebrancia* and *S. olivacea*) that frequent different parts of the mangrove and inter-tidal system. All three species spend part of their life cycle offshore, where they likely engage in spawning activity.

Both Panaeid shrimp and the Giant Freshwater Prawn (*Macrobrachium rosenbergii*) use the mangroves as a nursery during early stages in their life history. The Panaeid shrimp are many, with *Panaeus merguiensis* (Banana Prawn) being the most common commercially important variety and the less common but more valuable *Panaeus monodon* (Tiger Shrimp) also targeted by fishers.

The Mud Lobster (*Thalassina anomala*) builds large mounds in the back mangrove, which are often colonized by the mangrove fern (*Acrostichum aureum* or *A. speciosum*)

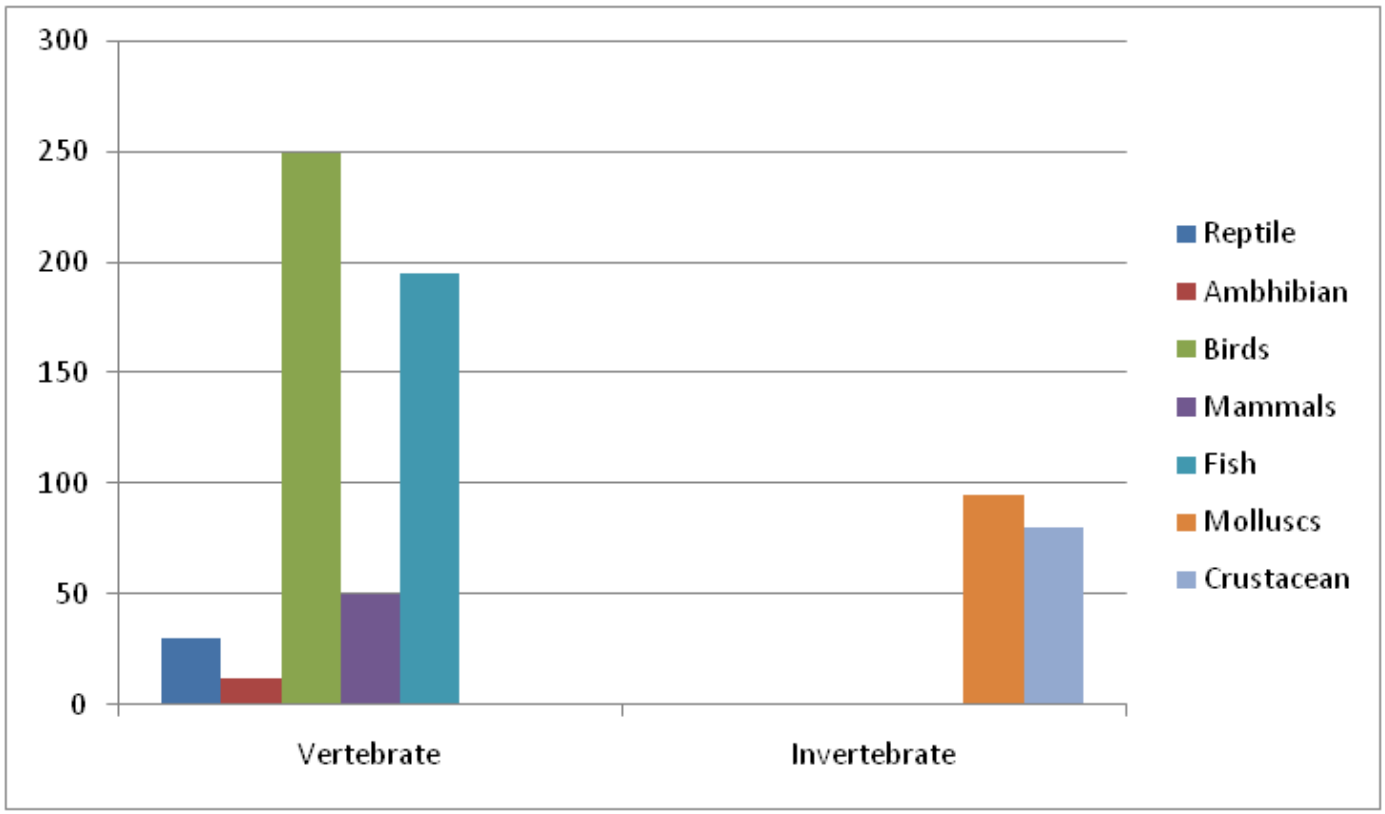


Fig 5.7 Diversity of Vertebrates and Invertebrates in Papua/PNG Mangroves – Marshall and Beehler, 2007






FIG 5.8: FAUNAL DIVERSITY IN MIMIKA'S MANGROVES

The lives and livelihoods of the Kamoro people are intricately linked to the diversity and abundance of fisheries and wildlife which abounds in Mimika's mangrove and lowland swamp forests. A Kamoro woman gathers mud crabs (*Scylla* spp.) as her main livelihood activity (top left). The pig nosed turtle, *Carettochelys insculpta*, lays her eggs burried in seasonal sandbars which line the rivers of the swamp forest (top right), a habitat shared with Siebenrock's snake-neck turtle, *Cheodina siebenrocki* (top oval). The fruit bat (Pteropodidae - middle oval))is often hunted for food, while the diversity of sesarmid crabs indicate mangrove ecosystem health (bottom oval). This Kamoro leader shows off a harvest of *Gelonia* spp. clams (middle right). Clams, wood-boring bivalves (Teredinidae) and gastropods (bottom right) make up at least 10% of Kamoro protein consumption. The cuscus (*Phalanger maculatus*) inhabits both mangrove and swamp forest - and although charismatic, sometimes the dinner table. as well.


Macrobrachium spp. and other freshwater shrimp are abundant in the major rivers of Mimika. These young women simply lift their net from below a set of tied Pandanus or Ficus tree leaves for a fresh catch (top left and oval). All the while, shrimp trawlers ply the nearshore for valuable Paeneid prawns. These boats are currently under-regulated. (middle left)

Other fishing opportunities include use of a cast-net (top right) or gill net, which landed this pair of Barramundi (*Lates calcifer*), the areas most lucrative fishery. (middle right)

The fully aquatic Arafura File Snake (*Acrochordus arafurae*), which feeds on catfish, is prized for its skin used for making drums. The Asian Giant Freshwater Turtle (*Pelochelys cantorii*) although considered endangered worldwide, is locally abundant due to low human population pressure, excellent forest condition, and traditional regulations known as *Parata.*

The link between the Kamoro and indigenous wildlife transcends subsistence or livelihoods, intertwined in myth, spirituality, ritual and art (below left). Many Kamoro have crocodilian ancestors, blurring the line between human and nature.

6. ECONOMIC VALUES

The goods and services provided by coastal systems and the natural capital stocks that produce them are critical to the functioning of the earth's life support systems. They also contribute significantly to human welfare, both directly and indirectly, and therefore represent a significant portion of the total economic value of the global environment.

Total Economic Value

Perhaps the most appropriate differentiation of mangrove values is use of the Total Economic Value framework. TEV represents the monetary measure of the change in an individual's well being due to a change in environmental quality. It is not environmental quality that is being measured per see, but people's preferences for changes in quality and quantity. Economic valuation of ecosystems tries to assess the preferences held by people, and the value determined by an exchange or transactions in the market.

The TEV of the mangrove ecosystems is the sum of direct use value, indirect use value, option value and non-use value (bequest value and existence value).

Participatory Economic Value

As many environmental goods (particularly those utilized for subsistence) are rarely traded, are often undervalued by market prices and have characteristics of public goods, Participatory Environmental Valuation (PEV) can be applied to help local villagers express the value of different mangrove products within the context of their own perceptions, needs and priorities rather than through conventional cash-based techniques.

PEV follows a number of steps (Emerton, 2006):

1. Recording the main mangrove goods collected by the household on cards – one card for each good
2. Deciding on a numeraire. Should be something that: indicates a value, which can be translated easily into a cash amount; has local and individual value; and has a defined lifespan
3. Ranking the cards depicting the different mangrove goods according to their economic importance
4. Distributing a specified number of counters between the cards (including the numeraire) according to their perceived economic importance to the household




Direct Values

Production and consumption of goods such as:

Forest resources
Wildlife resources
Agricultural resources
Genetic resources
Energy resources
Forage resources
Medical resources
Water supply
Water transport
Recreation
Landscape
Research
Education

Indirect Values

Ecosystem functions and services such as:

Shoreline protection
Storm protection
Nutrient retention
Sediment regulation
Treatment of pollution
Water quality maintenance
External support of fish and habitat
Provision of migration habitats
Carbon sink
Micro-climate stabilization
Groundwater discharge

Options Values

Premium placed on possible future uses of applications such as:

Agricultural
Industrial
Leisure
Pharmaceutical
Water use
...etc...

Intrinsic Values

Intrinsic significance of resources & ecosystems in terms of:

Biological and genetic diversity
Uniqueness
Cultural value
Aesthetic value
Heritage value
Bequest value
...etc...

Fig. 6.1 The TEV framework highlights the full range of economic values provided by mangroves/wetland forests.

It is hypothesized that Participatory Mangrove Valuation will reveal, among other things, that the value of mangrove goods for subsistence use is higher in absolute terms for poor households compared to richer households. It is thus important, that mangrove managers interested in the welfare of local communities begin to employ participatory valuation methods to more accurately reflect the value of mangrove systems to the people who are the target beneficiaries of mangrove management.

Estimating Total Economic Value

Estimates of the value of mangrove ecosystem services vary widely, but all studies concur on the fact that the benefits of mangrove conservation and rehabilitation far outweigh their exploitation for other uses (Spalding et al. 2010, Russi et al. 2013). Table 6.2 highlights the various types of ecosystems services that mangroves provide and their value when it is available. It presents services according to the MA classification and according to the nature of the interaction people have with them (direct/indirect, consumptive/non-consumptive).

Category of ecosystem service	Average value (Int.$/ha/year, 2007) **	Description of benefits
1. Direct Values		
Food	1111	Fish, fowl, vegetables, fruits for consumption
Water	1217	Drinking water
Raw materials	358	Timber for construction, fuel wood, fibers, organic matter
Genetic resources	10	Material from wild plants and animals
Medicinal resources	301	Chemicals for pharmaceuticals and drugs
Ornamental resources	n/a	Handicrafts, decorations, souvenirs
2, Indirect Values		
Climate regulation	65	Carbon sequestration, regulation of CO2/O2 balances
Disturbance moderation	5351	Storage capacity and surface resistance
Water regulation	n/a	Maintenance of aquatic zones, buffer for river discharges, Filter sea water infiltration
Waste treatment	162,125	Dilution, assimilation and chemical recomposition of waste
Erosion prevention	3929	Coastal protection, buffer against storms
Nutrient regulation	45	Cycling of nitrogen, sulfur and phosphorus
Pollination	n/a	Pollen transfer, increases in crop production
Biological control	n/a	Regulation of pests
Nursery habitat	10,648	Breeding and nursery areas for aquatic species, maintenance of off-shore fisheries
3. Regulating services = "services", with non-consumptive indirect use value		
Pharmaceutical	n/a	Future sources of pharmaceutical drugs
Water use	n/a	Future energy generation, potential agriculture...
4. Intrinsic Values		
Genetic diversity	6490	Refuge for biodiversity, including transitory (migrating) animal species
Aesthetic information	n/a	Enjoyment of natural areas and landscape scenery
Recreation and tourism	2193	Opportunities for walking, fishing
Inspiration	n/a	Interactions with nature, folklore and cultural knowledge
Spiritual experience	n/a	Religious and spiritual sanctuaries
Cognitive development	n/a	Opportunities for scientific research, environmental education
Total Economic Value	**$193,845**	

Table 6.2 Summary of monetary values for coastal wetlands* ecosystem services (values in Int.$/ha/year, 2007 price levels). Source: De Groot et al. 2012 for figures; MA 2005, Wilson et al. 2002, De Groot et al. 2002, Barbier 2007 and Van Lavieren et al. 2012, for the description of ES benefits. Compiled by Brugere and Bosma, 2014.

Valuing Sustainable Utilization

The Integrated Management Plan recommends that stakeholders including decision makers adopt two analytical tools to assist in decision making around commodity development. These tools include a system diagram and a decision tree.

These tools will help managers analyze the following questions:

1. What are the highest values that can be achieved from available resources?
2. What kinds of investments are needed?
3. Where are the markets?
4. How can distribution best be handled?

After these decisions are made around specific commodities to be developed, detailed business and management plans are created. Principally, the main goal of the management plan from a development stand-point is to;

1. Maintain or enhance the resilience of local communities.
2. Provide a structure and baseline analysis for sustainable utilization of mangroves and lowland swamp forest in Mimika
3. Provide a tool-kit for policy makers and other stakeholders to make wise and sustainable economic, social and ecological decisions.

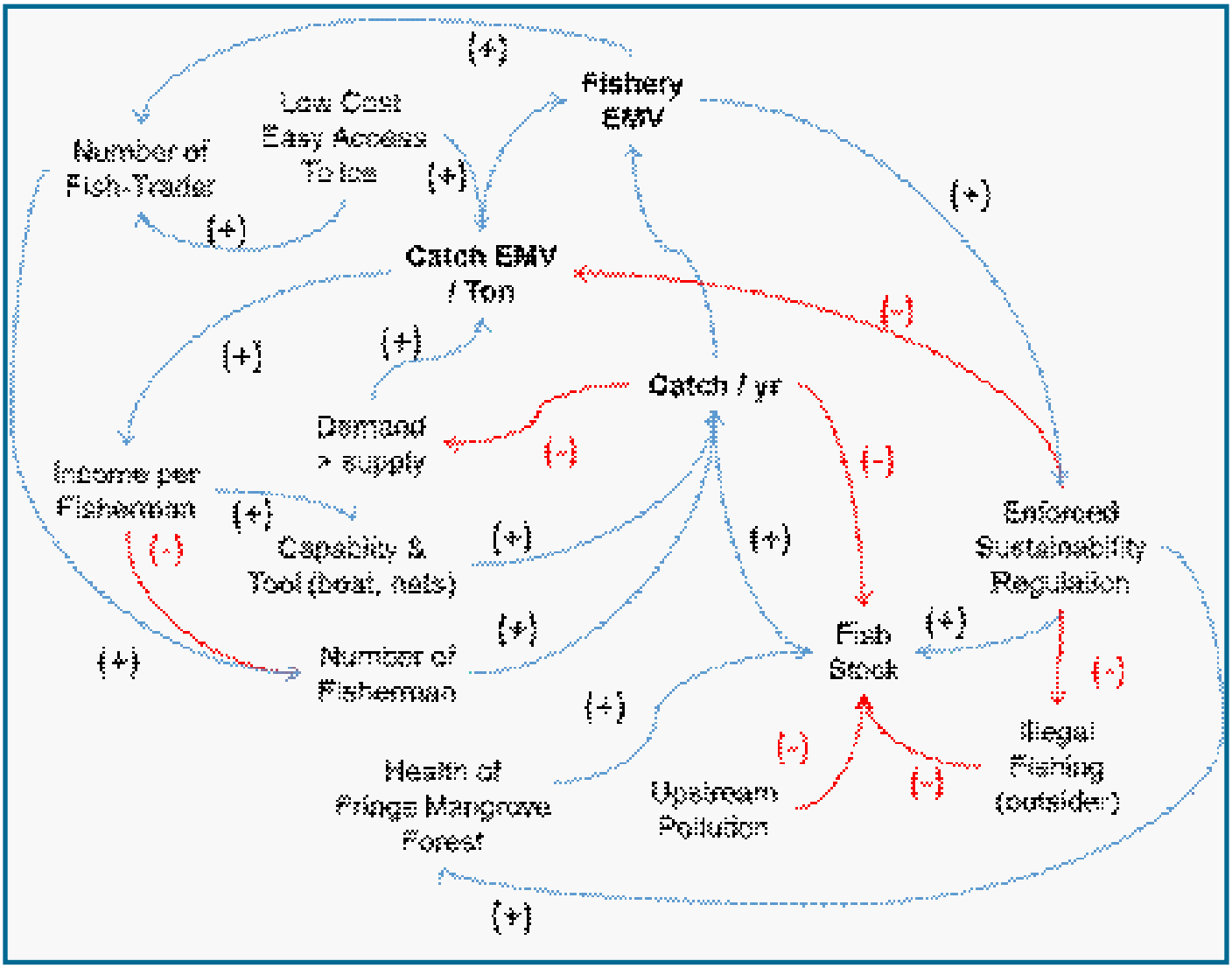


Fig. 6.3 The Expected Monetary Value (EMV) System Diagram helps decision makers analyze potential commodity development from economic, social and ecological aspects. This particular diagram depicts three aspects of the Barramundi fishery which can be improved to enhance value of the Barramundi fishery a) increasing total catch per unit effort, b) increasing size per catch or c) improving storage and handling for freshness. (Tantra, 2014)

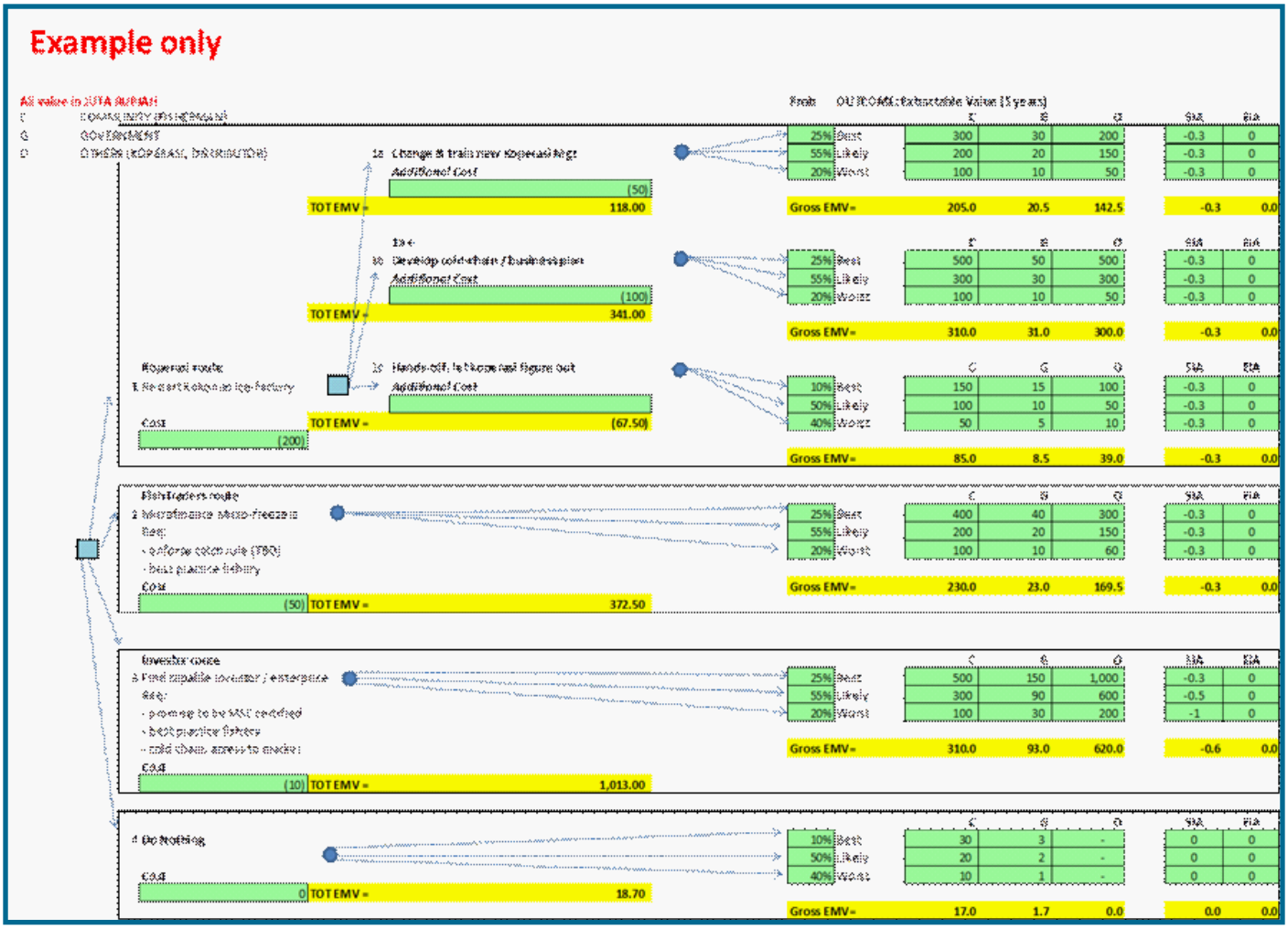


Fig. 6.4: Decision Tree for analyzing the benefit of three cold-chain development options in Mimika

A decision tree can be applied in order to make economically viable choices for future investment. In this example the question following questions are asked; Is a central ice-making facility needed, or are distributed small-holder ice-production facilities more efficient? Should collection boats be employed with larger freezer holds or can local fishers prepare and preserve their catch more effectively (removal of gills and guts, use of small amounts of chipped ice).

A thorough discussion of all options in an appropriate forum is required in order to select several good and practical options for deeper analysis.

In the end there are four options or scenarios which are compared; 1) Cooperative route, 2) Fish traders route, 3) Investors route and 4) the "Do nothing," option. The Cost of investment is calculated for each option and probabilities are prescribed to each potential outcome, for example, on the first line a 25% probability was prescribed to the Best case scenario that communities (C) would receive 300 million rupiah extra over 5 years. After understand the likelihood of all outcomes, the most likely/most desirable outcome can be selected.

Mangrove and lowland swamp forest managers from Mimika are being trained in the use of these economic decision making tools, in order to increase the likelihood that sustainable economic development can occur.

Fig. 6.5: What to do with the disused ice-making facility at Kokonao? A decision-tree can help find the answer.

7. POSSIBLE THREATS

The current largest driver of Mimika's economy is the PT Freeport Indonesia - gold and copper mine operating in the Highlands. Although impacts to the lowland swamp forest, mangroves and community from the tailings are significant, perhaps the largest impact of Freeport will be the closure of the mine around 2040.

Freeport is the single largest tax-payer in the country, and its presence has very substantially led to economic development in Mimika and development of cash economies amongst the Kamoro.

In anticipation of evenutal closure of the mine, government at National, Provincial and District levels are all preparing alternative economic development plans. The fear is, to offset the closure of the world's most lucrative gold mine, there will be extreme pressure to develop large alternate economic options - which may cause degradation several scales larger than the current impact of the mine.

Fig. 7.1
This oil palm plantation develop on along the mid-reaches of the Mimika River was halted by the Mimika government due to excessive downstream impacts and community complaint. In combination with IFACS achievements, this case of avoided deforestation should rightfully contribute to National emission reduction targets.

Oil Palm

Oil Palm plantation development is the single largest current threat to forests of Indonesia and SE Asia and Papua is no exception. Fortunately, Mimika District government has shown resolve in the face of oil palm development, enforcing early closure of a concession which had already cleared 9000 hectares of a planned 39,000 hectare venture (Fig.7.1), after responding to community complaints about negative downstream impacts.

The direct impacts of oil palm on lowland swamp forest are clear, in the form of conversion leading emission of CO_2 and other greenhouse gases, loss of biodiversity and downstream erosion.

The impacts of inland oil palm development on mangroves are less clear, but equally threatening. As an example, we can look to the impacts of the Syme Darby plantation on the Kuala Gula Wildlife Sanctuary in Malaysia. Conversion of the upper mangrove, and subsequent development of seaward and landward dikes, led to total mortality of 500 hectares of mangroves in the wildlife sanctuary after a major flooding event - due to lack of drainage (see Fig. 7.2)

Fig. 7.2
Near total mortality of mangroves in the Kuala Gula Wildlife Sanctuary, Malaysia after a flooding event demonstrates how oil palm development in the lower watershed decreases the resilience of mangrove forests making them vulnerable to floods and sea level rise.

Port and Infrastructure Development

Pomako has already been zoned for port and economic development. But excessive development of small ports, and ad-hoc villages of laborers to serve the ports are resulting in loss of mangroves, through conversion, road building, and hydrological impacts. Industrial development at this port, such as a planned cement factory, are being questioned by communities, who doubt that this form of economic development is of benefit to their traditional livelihoods.

Fig. 7.3: Last Trees Standing, Kampung Asmat, Pomako

There has also been movement in terms of splitting Mimika District into three smaller districts, East, Central and West. Immediate development impacts would take the form of construction of new government centers. Subsequent disturbance to mangrove and lowland swamp forests would undoubtedly take place - as these governments strive to meet economic development targets.

Especially at risk would be the coastal forests of Lorentz National Park - which would dominate the Eastern Mimika District landscape. It is unlikely that eco-tourism alone could sustain the economic needs of a young developing district.

Illegal Logging

There are already spots of both mangrove and lowland swamp forest being illegally logged across Mimika. The "rights" to these forests are often granted by a village head, but without proper consultation with other Taparu, let alone the Mimika government. Identification of illegal logging sites and issue resolution is a priority in the immediate future.

Fig. 7.4: Illegal Logging at Amar?

Brackish Water Aquaculture

Sixty percent (60%) of Indonesia's mangroves have been lost historically due to the development of shrimp and milkfish aquaculture ponds. There is debate in the fisheries department as to whether or not expansion of ponds into Papua would be beneficial for economic development. What is clear is that world-wide, brackish water aquaculture development has been disastrous to mangrove forests, and also leads to increased vulnerability and impoverishment of local communities.

That being said - the Minister of Fisheries, in a 2012 statement, spoke of a directive to continue to develop up to 2.3 million hectares of Brackish Water fish ponds in Indonesia, putting Papua's mangroves either directly or indirectly at great risk (Viva News, 2012).

Fig. 7.5: Is Industrial Aquaculture coming to Mimika?

8. COLLABORATION

As mandated in the 2012 National Mangrove Strategy, (SNPEM), mangrove management at the Province and District levels are to be coordinated by a multi-stakeholder mangrove management working group.

In 2014, a stakeholder analysis was performed in order to derive a list of the key stakeholders to be involved in mangrove and lowland swamp forest management (Fig 8.1). These stakeholders were then facilitated over a 10 month period, learning about mangrove management issues and practices. Today they form the Mimika KKMD who are tasked with oversight of mangrove and lowland swamp forest management in coordination with other lead district agencies.

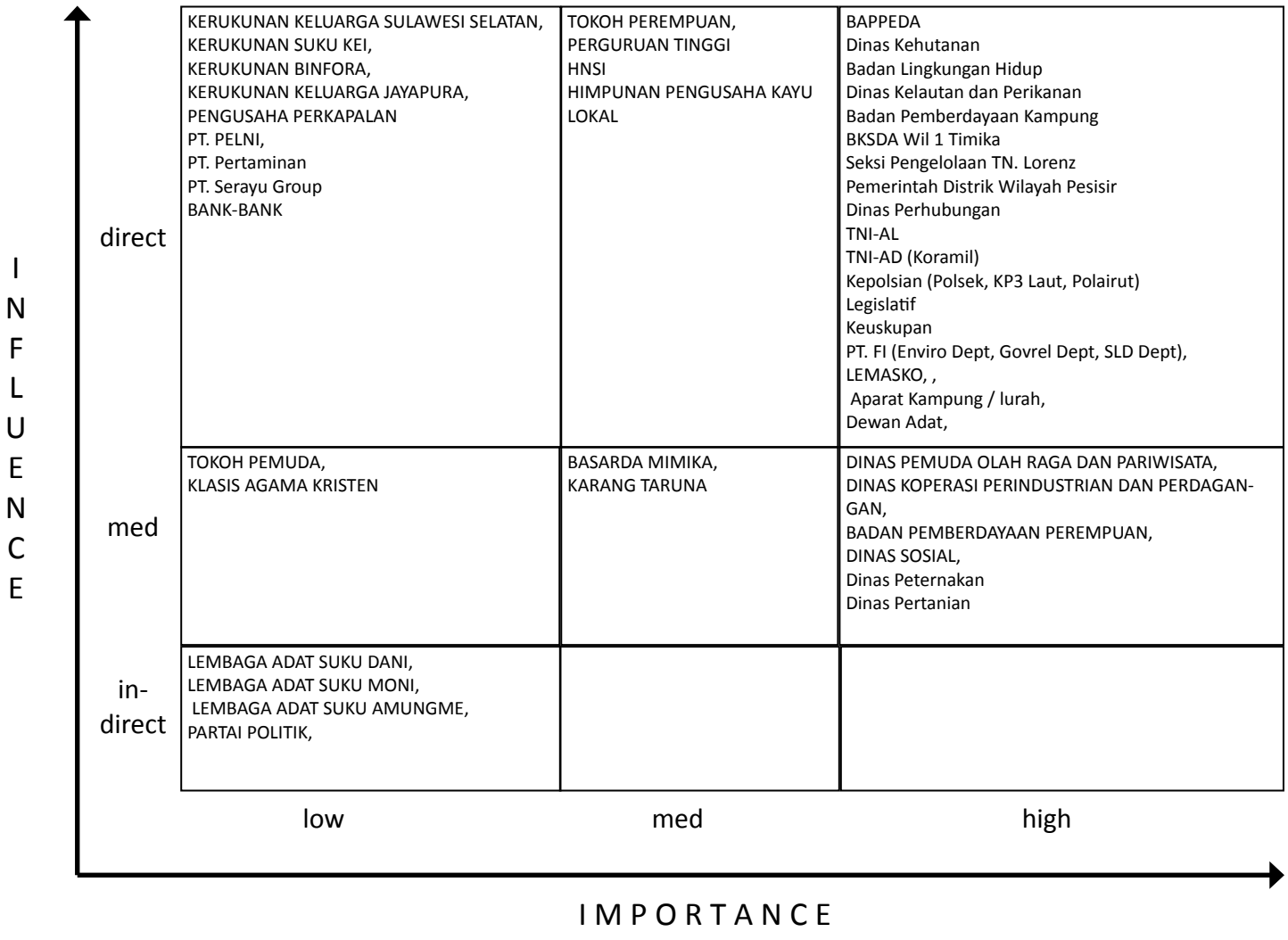
USAID IFACS AND LESTARI

USAID Indonesia Forest and Climate Support project ran from 2010 - 2015 in 12 districts across three eco-regions (Aceh, Kalimantan and Papua) in Indonesia In 2014, Mangrove Action Project - Indonesia was contracted to support IFACS in the Mimika District to 1) develop a Mimika Mangrove and Swamp Forest management plan incorporating input from local and provincial government, private sector actors,and civil society representatives that achieves sustainable biodiversity conservation, climate change adaptation through coastal resilience, and climate change mitigation through carbon sequestration and reduced carbon emissions; and 2) Develop the local capacity needed for the implementation of this adaptive management plan.

This work will be continued from 2015-2020 under the USAID LESTARI project which will reduce land-based greenhouse gas (GHG) emissions and conserve valuable biodiversity in carbon rich and biologically significant forest and mangrove ecosystems in Indonesia. Blue Forests (formerly MAP-Indonesia) will continue to build the capacity of local stakeholders in delivering and monitoring this management plan during LESTARI.

It is expected that implementation of the management plan from 2015-2020 will provide a major contribution to emissions reductions in coordination with the National REDD+ Agency (BP REDD+) specific cally under their Coastal REDD+ program.

Fig 8.1 Stakeholder Analysis to determine multi-stakeholder mangrove management working group members.



PT Freeport Indonesia is also committed to continuing to support implementation of this management plan through support of grassroots initiatives, contribution to the operation of the KKMD, and technical support around environmental monitoring.

In 1996 - PT Freeport Indonesia began to allocate 1% of their gross income to community development in Papua, known then as the Irian Jaya Fund.

Today - with regards to the Kamoro, this fund is administered by two people's organizations; LPMAK and LEMASKO.

LPMAK (Organization for Amungme and Kamoro Community Development) serves as representatives of both of Mimika's main ethnic groups (upland and coastal) mainly focused on providing youth education (through the support of schools) but also facilitate development, religious and health programs.

LEMASKO (Organization of the Kamoro Group) is focused on the preservation and proliferation of Kamoro cultural heritage. LEMASKO maintains four commissions;

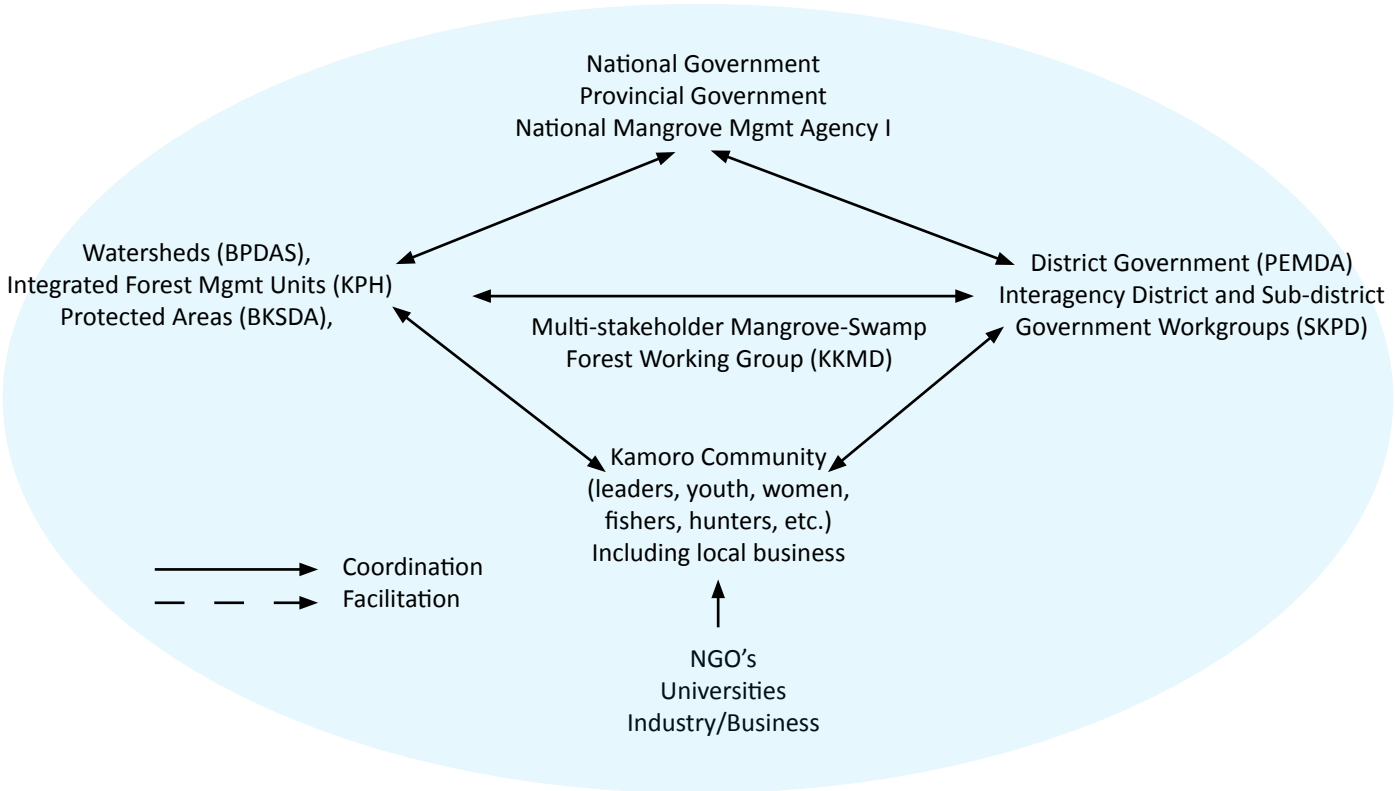
1. Cultural, tradition and land rights.
2. Arts and adornments.
3. Carving and weaving.
4. Human resources

Due to threats to the environment, LEMASKO is looked upon to play a large role in nature conservation in the future, negotiating with both government and industry, and as such have a key position in the implementation of this management plan.

Institutional Strategy

1. Identify key stakeholders and develop a matrix of roles (who, what, where, resources, program, time, authority) in order to synergize inter-institutional cooperation. Overlap (*tumpang-tindi*) of roles to some extent is OK.
2. Clarify the work relationship between around mangrove and lowland swamp forest management between Province (based on SK Gubernur Papua No.225, 2013 - Mangrove Ecosystem Management Strategy) and Mimika District (based on SK Bupati Mimika No. 132, 2014 about the formation of the Mimika Mangrove Ecosystem Management Coordination Team).
3. Formalize and operationalize the Multi-stakeholder Mangrove Management Working Group (KKMD - Mimika) as a consultative consortium, with the capacity to meet with and make recommendations to all relevant local institutions.

Fig 8.2 Proposed Institutional Form - for Integrated Mangrove and Lowland Swamp Forest Management



9. DISTRICT STRATEGY FOR MANGROVE AND LOWLAND SWAMP FOREST MANAGEMENT (SDPEM)

The Kamoro have done an excellent job historically – managing their lives and the lives of the wetland forest around them, through traditional family structures (taparu) and the wise use of regulations (parata) and taboo (sasi). In present day, however, pressures in the form of population growth and external mandate for economic development mean that Kamoro ways need to be integrated with other management strategies, in order to maintain the broad range of social, cultural, environmental and economic values that are demanded of the forest.

A Kamoro leader, during the consultation of this Integrated management plan in November, 2014 added another key ingredient required for successful management of Mimika's mangroves and lowland swamp forests:

It is not the forest, but trust between people which needs to be conserved, because without that trust we will die.

The 2012 National Mangrove Strategy (SNPEM) calls for the development of locally appropriate District level Strategy (SDPEM). A District strategy was developed by Mimika stakeholders during KKMD meetings and consultations in Timika in October and November, 2014 which underscored the following four principles:

The District Strategy (SDPEM) must;

1. be locally relevant,
2. be oriented towards improve human welfare,
3. be holistic; and
4. be sustainable

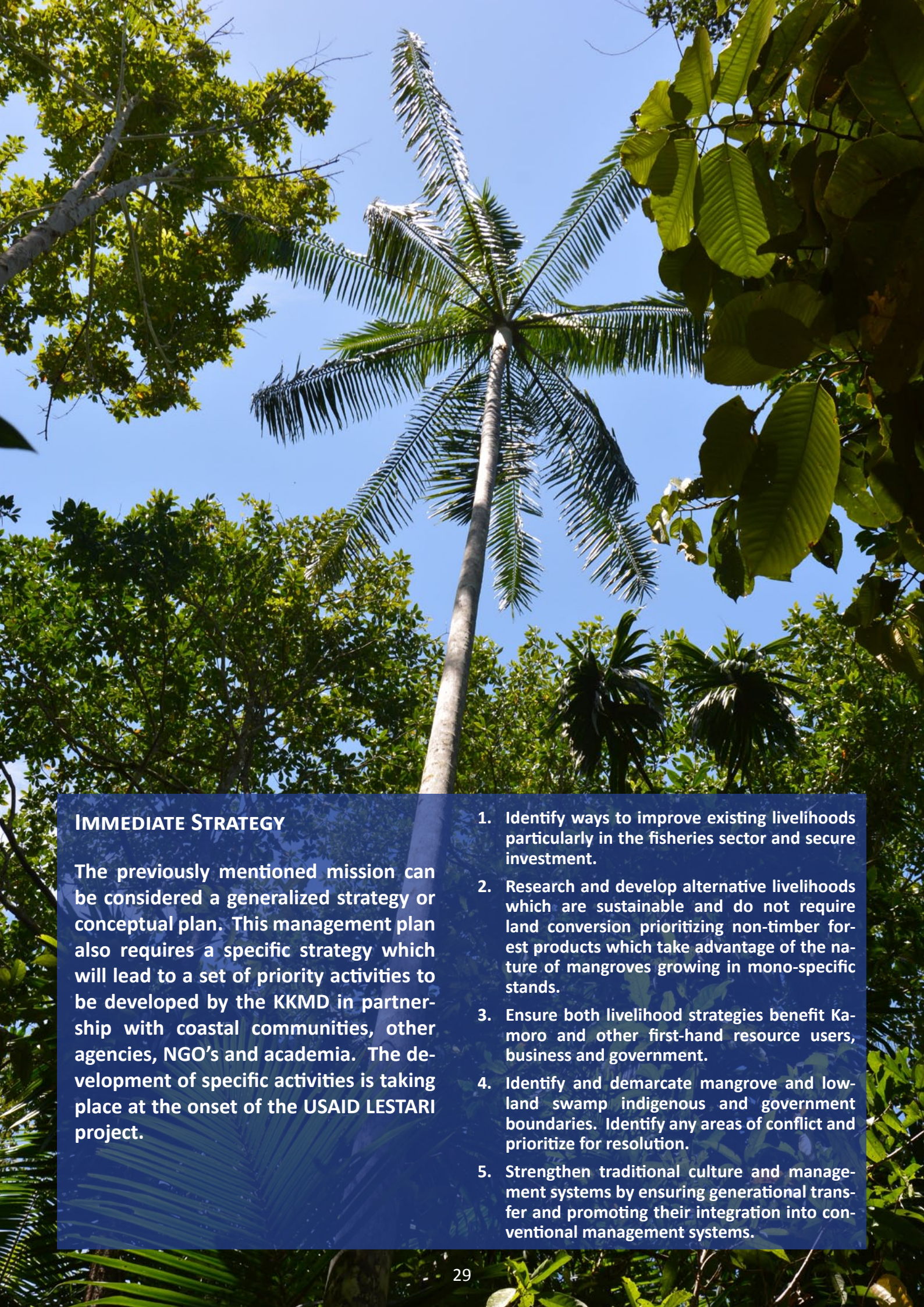
Given the fact that the Kamoro, constitutionally, are required to be consulted by all levels of government regarding Mimika coastal forest management, trust between the Kamoro and external stakeholders will be an integral part of a strategy which intends to reconcile societal and environmental well-being, now and in the future.

Vision

Achievement of landscape level management of mangrove and lowland swamp forest resources for the welfare of the Kamoro and the community at-large of Mimika.

Mission

1. Conserve the richness and diversity of Mimika's mangroves and lowland swamp forests – at the landscape level
2. Develop awareness about the value of Mimika's mangrove and lowland swamp forests through youth and adult education, promotion and advocacy campaigns
3. Revitalize local traditions and knowledge around mangrove and lowlands swamp forest use and management.
4. Promote use of sustainable economic decision making models for any development in or impacting upon Mimika's mangroves and lowland swamp forest.
5. Enhance the adaptive capacity of the mangrove and swamp forest system by modeling and understanding change, and maintaining diversity.
6. Develop the capacity of the multi-stakeholder mangrove management group to advise on resilient forest management and engage relevant stakeholders in line with the National Mangrove Strategy (SNPEM).



Immediate Strategy

The previously mentioned mission can be considered a generalized strategy or conceptual plan. This management plan also requires a specific strategy which will lead to a set of priority activities to be developed by the KKMD in partnership with coastal communities, other agencies, NGO's and academia. The development of specific activities is taking place at the onset of the USAID LESTARI project.

1. Identify ways to improve existing livelihoods particularly in the fisheries sector and secure investment.
2. Research and develop alternative livelihoods which are sustainable and do not require land conversion prioritizing non-timber forest products which take advantage of the nature of mangroves growing in mono-specific stands.
3. Ensure both livelihood strategies benefit Kamoro and other first-hand resource users, business and government.
4. Identify and demarcate mangrove and lowland swamp indigenous and government boundaries. Identify any areas of conflict and prioritize for resolution.
5. Strengthen traditional culture and management systems by ensuring generational transfer and promoting their integration into conventional management systems.

10. POLICY DEVELOPMENT

There has been an evolution of natural resource management policy in Indonesia, which used to be primarily concerned with economic development or conventional conservation, and now is more focused on sustainable development, which seeks win-win-win scenarios across ecosystem conservation, economic development and equitable social benefit.

Another shift in the policy landscape has made room for what is termed adaptive collaborative management. Broken down into its constituent parts, the adaptive nature of management allows for learning about a socio-ecological system which is discussed in section 10 of this management plan. Collaboration was discussed previously in section 7.

This section on policy development adheres to a three tiered approach to achieve effective management of Mimika's mangroves and lowland swamp forest;

1) Top-down approach
2) Bottom-up Approach
3) Meeting in the middle

This approach was recently adopted by the United Nations as a best-practice approach for Delivering Coastal Wetland Carbon Projects which in turn has been adopted as a Coastal REDD+ strategy by the National REDD+ Agency (BP REDD+). Adoption of this approach by the Mimika District government aligns the district strategy with national emissions reduction priorities.

Top Down Approach

- Acknowledgement of indigenous forest management by central government (in line with Papuan Special Autonomy) and Formalization of a Regional Strategy.

National Strategies on Mangrove (SNPEM) and Wetlands Management (SNPER) were created without consideration of the special autonomy offered by the constitution for Papua. Because of regional nuances, the SNPEM mandates that Provincial and District level strategies be developed (SDPEM). The strategies developed during public consultations and meetings with the KKMD in Mimika and presented in section 8 of this report, should be formalized as an SDPEM. The SDPEM, although in name focusing on mangroves, should include lowland swamp forest as another District specific consideration to capture the integrated nature of the two ecosystems in Mimika.

- Development of PERDA (district regulations) in both formal legal and locally accessible languages

PERDA are District level regulations. During the IFACS program, a PERDA for management of Mimika's mangroves and lowland swamp forest was developed and is in the process of adoption by the Mimika District government. In order to be accesible to communities, a condensed version of the PERDA, using colloquial terminology, should also be developed and socialized to the public, primarily in traditional Kamoro villages.

- Improved Coordination between Communities and Government in Management of Lorentz National Park.

Collaborative management in National Protected Areas including National Parks was delineated in the Ministry of Forestry Regulation P. 19/Menhut-II/2004. Coupled with Papuan Special Autonomy, policy should be developed to clarify community access to and control over mangrove and lowland swamp forest resources in Lorentz National Park. Formal policy should be developed with the BKSDA offices in Mimika (and potentially Mimika Timur District if Mimika District splits into three Districts) and Jayapura, and acknowledged by PHKA office in Jakarta.

Bottom Up Approach

- Grassroots community organizing

Individual and community empowerment takes place when villagers focus on identifying an issue of mutual concern and take action to resolve that issue. A trio of programs have been developed to engage small community groups in that action-research, problem solving process which are 1) Coastal Field Schools (CFS), 2) Ecological Mangrove Rehabilitation (EMR, see Lewis, 2005, 2009; Lewis and Brown, 2014; Brown, 2014) and 3) Forest Management Learning Groups (FMLG see Miagostovich, 2002).

These three programs should continually be supported by Integrated Local Government Working Unit (SKPD run in Mimika. Involvement in Coastal Field Schools will focus on improved livelihoods of participants, and potentially link to small business and cooperative development. Involvement in Ecological Mangrove Rehabilitation will restore degraded forests using globally proven best-practices. Involvement in Forest Management Learning Groups will involve Taparu members in developing sustainable utilization plans for the forests in full coordination with government officials.

- Involvement of communities in village and subdistrict level planning and budgeting

After involvement in government sponsored programs such as CFS, EMR and FMLG, community groups can be facilitated to understand village level planning and budgeting processes (such as MUSRENBANGdes and RPJMdes), in order to access annual and mid-term (5 year) support to achieve mutual natural resource management and community development goals. Special consideration for integration of traditional planning and management (Parata and Sasi) can be accounted for at this time. Clear Roles and Responsibilities of community and government also need to be considered during planning.

- Improve small-scale economic and business development programs at the community level.

Following on from programs such as CFS and FMLG, economic programs such as cold-chain, post-harvest processing, book-keeping, and business planning can be supported with SKPD support. Special fuel subsidies for the fisheries sector should also be considered for remote villages in Mimika.

Meeting in the Middle

- Formalization of the KKMD

The KKMD - Multi-stakeholder Mangrove Management Group was brought together under IFACS, and engaged in eight meetings around capacity building as well as a study tour to Sulawesi to visit other functioning KKMD. Formalization of the KKMD in line with the National Mangrove Management Strategy needs to be completed. Integration of lowland swamp forest management under the mandate of the Mimika KKMD is recommended as a special consideration, given the natural integration of these two ecosystems in Mimika District.

- Capacity Building for Government

Capacity building for Mimika government should be focused on three institutions:

1) Integrated Local Government Working Unit (SKPD) to provide budget and planning support and also facilitation of community development programs

2) Specific training for Government Extensionists (from Forestry, Fisheries, Agriculture, Social Dinas, and Climate Change Agency) to engage community in programs like Coastal Field School and Forest Management Learning Groups. Many of these extension agencies are currently housed under one roof at the Integrated Extension Agency (BP4K).

3) Integrated Forest management Agency (KPH)

Management of forests through the KPH is a priority focus on the Ministry of Forestry for the next mid-term cycle (2015-2019). One key way to engage KPH is again through capacity building for forestry extensionists, to develop village level forest management plans through programs like FMLG. These plans should be geared to support sustainable utilization of timber and non-timber forest products, and also to resolve nascent issues of illegal logging.

- Improved Spatial Planning around Infrastructure Development

Infrastructure development, such as port development or the development of new government district centers, needs to take into consideration environmental protection, primarily avoiding hydrological disturbances to mangroves and swamp forests.

11. ADAPTIVE MANAGEMENT AND MONITORING

Management can be summarized as a process of "planning, doing, analyzing and learning and adjusting" (Fig 11.1). Our Integrated Management Plan for Mimika Mangroves and Lowland Swamp Forests begins by describing the landscape in Part I (its natural resources and people) (analysis), followed by strategic and tactical plans (planning) in Part II. The management plan will then be implemented, and there will be procedures for checking on implementation, likely in the form of annual meetings and reports (control).

In the past, the 'control' mechanisms were often designed merely to check that the planned activities were carried out. When 'control' mechanisms are expanded to provide information for a new analysis phase, it can be considered 'monitoring'. When monitoring provides feedback in this way, we have a complete 'management cycle'.

Fig 11.2 gives an overview of the Project Cycle as an iterative process, with each cycle providing the starting point for the next. There is also a good deal of integration between the various steps, so that working on one step may suggest ideas and improvements for the previous step. Step C 'Develop Monitoring Plan' is the focal point for our purposes here: you will see that monitoring is planned before the management plan is implemented.

The steps relevant to monitoring are shown in detail in Table 11.3. The monitoring plan sets out to gather information on various indicators, each of which is related to specific objectives or activities. Information gathered is clearly linked to management decisions about the activities carried out and the extent to which objectives are being met. Monitoring pinpoints problems, related to implementation and to the assumptions underlying management decisions, which are made explicit in the Conceptual Model (see below).

Fig.11.1
Students involved in eco-system analysis as part of Coastal Field School in Kokonao. (Opposite page)

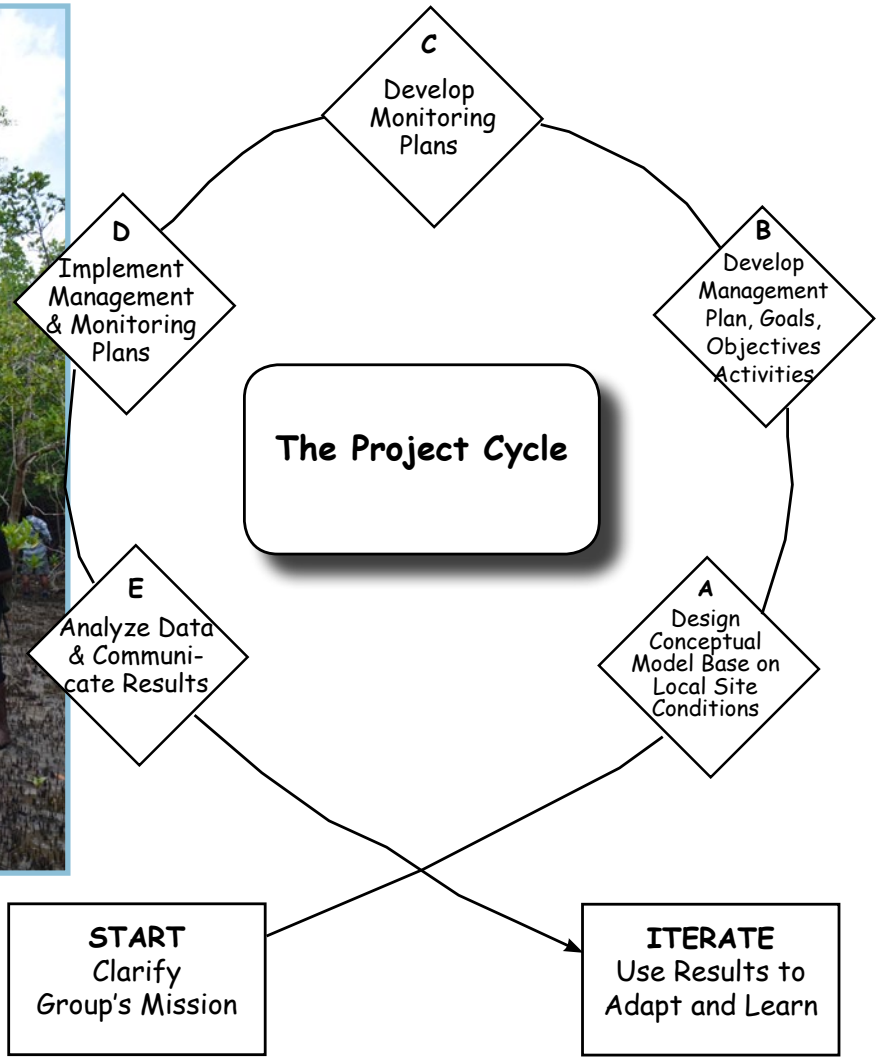


Fig. 11.2
The iterative project cycle, takes us from assessment to action to evaluation. Learning which takes place during monitoring and evaluation is captured during analysis - to inform a new cycle of management. (right)

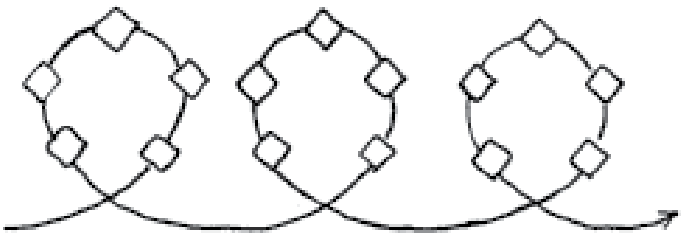


Fig. 11.3
Following the detailed steps of developing and implementing a monitoring plan is essential to ensuring that the main purposes of management are achieved. (below)

Developing a Monitoring Plan	
Mission	Purpose, Strategy, Values
Conceptual Model	Drivers, Pressures, Ecological Processes, Attributes Measured, Ecosystem Services.
Goal	General, Brief, Measurable
Objectives	SMART = Specific, Measurable, Achievable, Relevant, Time-limited
Activities	Linked, Focused, Feasible, Appropriate
Information needs	
Indicators	Measurable, Precise, Consistent, Sensitive
Methods	Accurate and reliable, Cost-effective, Feasible, Appropriate
Tasks (operationalizing)	What? When? Who? Where? With what resources? Integrated to what pre-existing processes?

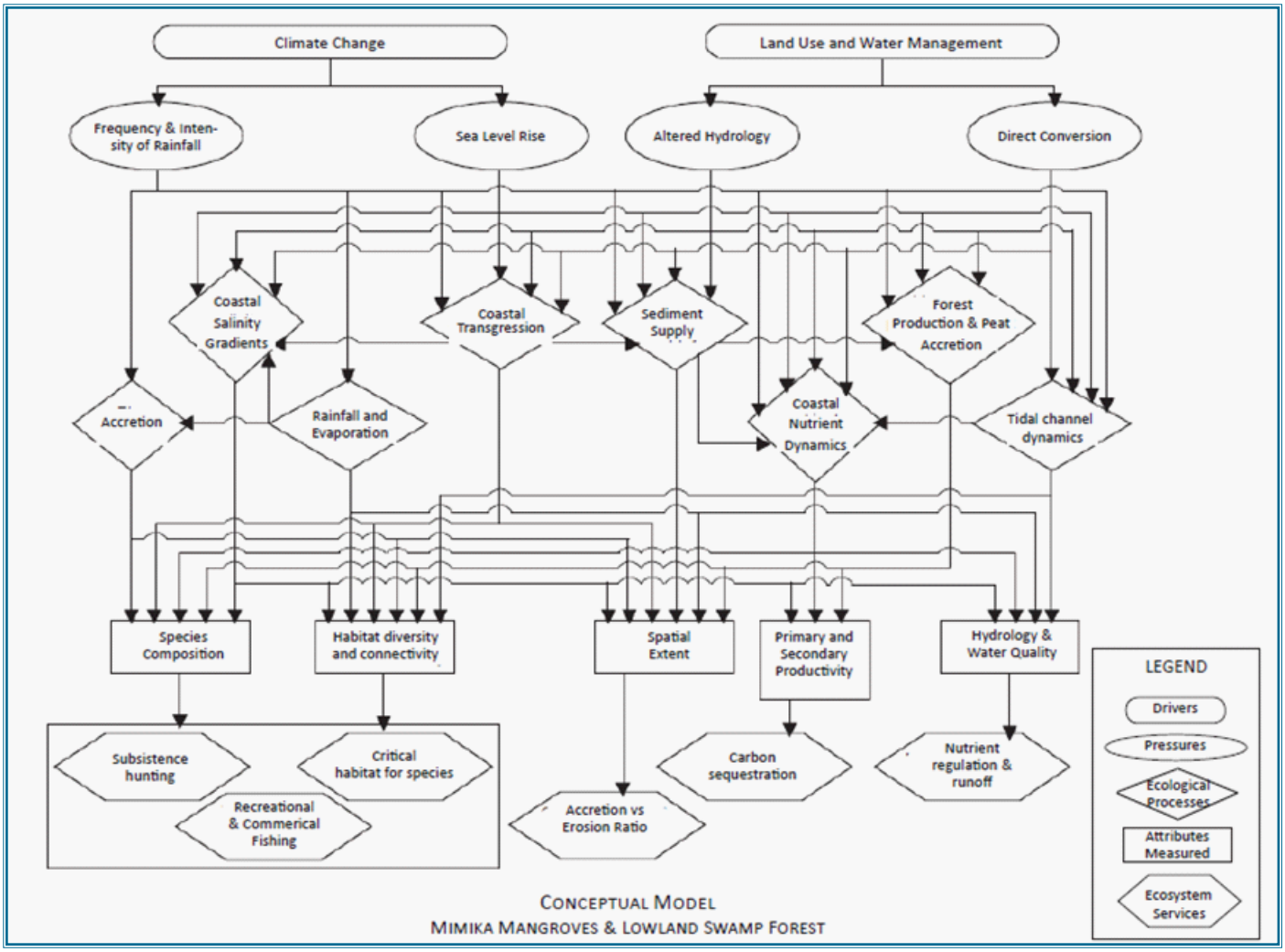


Fig. 11.4: A conceptual model for Mimika's mangroves and lowland swamp system, the main drivers of which are climate change, land use and water management.

Derivation of the Conceptual Model

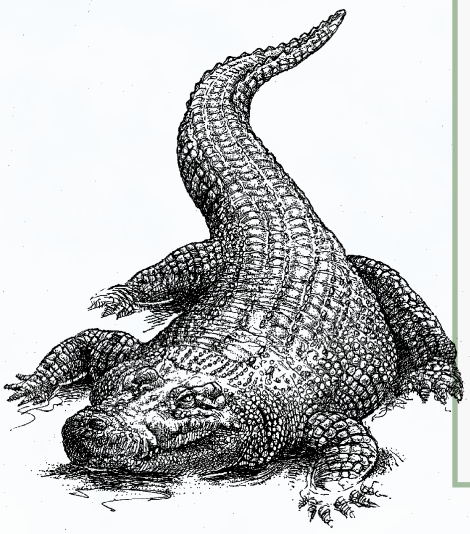
As has been described in previous chapters – the mangroves and lowland swamp forest of Mimika measures approximately 75,000 and 150,000 ha respectively. These coastal wetlands form a transition zone between the freshwater and marine environments of the Mimika District. These systems provide diverse ecosystem services that are valued by society, primarily the Kamoro people who live in harmony with them, and are important for subsistence, to local and regional economies, and local and global climate.

Several key species, such as Barramundi, Crocodiles and Mud Crabs, spend their life history moving between the various ecotones of these wetland forest systems, (closely followed by the Kamoro people) making the connections between the systems of critical importance. However, the coastal wetlands are increasingly vulnerable due to rising sea level, changes in climate, land use, and water management practices.

An integrated conceptual ecological model (ICEM) for the system that illustrates the linkages between drivers, pressures, ecological process, and ecosystem services was adapted from a similar model from the Comprehensive Everglades Restoration Plan, after a series of 8 consultations with local stakeholders from Mimika.

The conceptual model includes indicators which can be measured over time in order to monitor the health of the entire ecosystem, to inform managers when new management interventions need to be prescribed and tested.

Five ecological indicators are presented: (1) mangrove community structure and spatial extent; (2) waterbirds; (3) prey-base fish and macroinvertebrates; (4) crocodilians; and (5) periphyton. Some of these indicators are already measured by the government. (Fig 11.5) Others can be monitored in full participation by the Kamoro people.



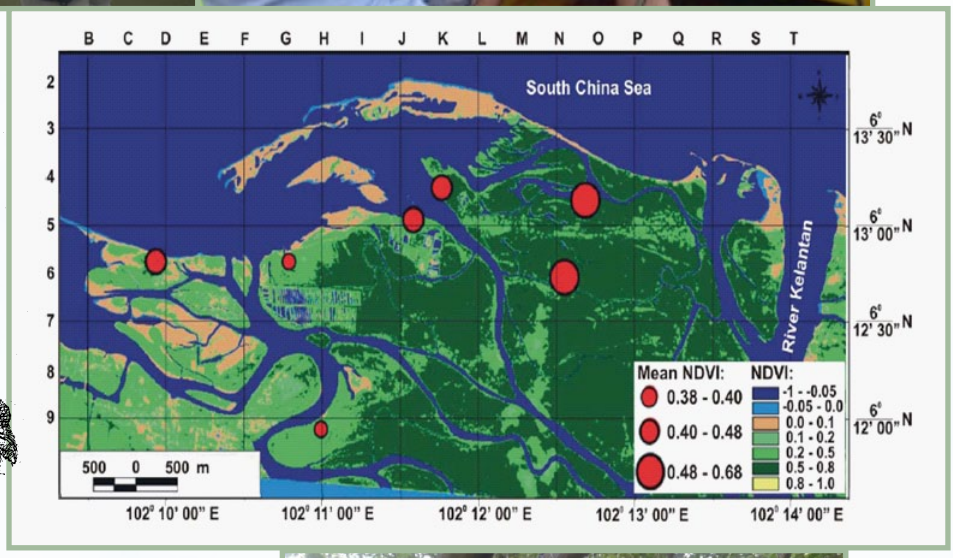
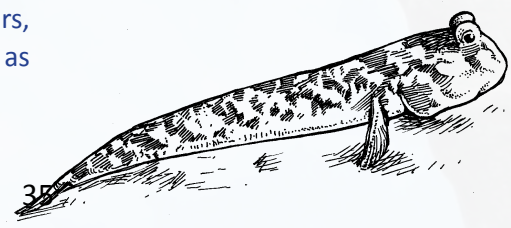


Fig 11.5 A Montage of Monitoring Techniques
Monitoring will be carried out by remote sensing and ground-truthing, in part by government and academia and in part by Kamoro communities (top left). A mixture of methods will be required. Pseudocolour image of NDVI (QuickBird 2006), and its mean value distribution help prioritize trouble spots (middle right). Leaf litter catchers indicate forest productivity (bottom right). The Shoreline Video Assessment Method was developed by Mangrove Watch out of James Cook University, who are ready to support Mimika mangrove management through periodic analysis of forest condition (top right). A variety of fauna can be measured as indicators of forest and water quality including; crocodiles, indicator fish such as mudskippers, indicator macroinvertebrates such as barnacles, as well as populations of fruit bats and king-fishers.



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