

Sustainable Aquaculture:

an integrated approach to coastal planning

The tsunami of December 26th greatly impacted the coastal communities of Sumatra. Government agencies are currently discussing plans to “repair” the shoreline in Aceh with large swaths of mangroves to act as a buffer against future tsunami events or storms. These mangroves will replace the many acres of shrimp farms that once dominated the coastal landscape. Actions such as this must be implemented with caution. Community involvement is integral to the success of such a proposal. This project explores an alternative framework integrating shrimp farms within the mangrove plantations to sustain the livelihood of families who depend upon this industry. A foundation of ideas for a sustainable shoreline are provided that could afford economic opportunity, habitat rehabilitation, and protection against natural disaster events.

**economic diversity +
community benefit +
mangrove conservation +**

financial

Traditional Aquaculture Methods

Empang parit is the traditional application of integrated aquaculture in the mangrove area. It usually consists of an unexcavated central platform that alternates between being flooded and exposed and a canal that runs along the pond dikes where fish, shrimp, and crabs are cultured. Tides are used to carry seed stock into the system and to exchange water. The forests are locally run and operated and self-managed by the community.



previous shoreline treatment: short-term large scale shrimp farms that caused the destruction of mangroves

+



current plans to create a protective shoreline buffer with mangrove plantations

=



sustainable aquaculture incorporates economic opportunity within the mangroves

human

Growth Process



promote small scale incremental change
encourage empang parit methods

becomes a source of income for the community
support system for small scale farmers
gradual adoption of sustainable techniques

large/medium scale farms launch tourism, education, and research programs

social

Action

- +Inform and educate shrimp farmers, local government, and the community.
- +Formation of community groups separated by special interests and skill sets (such as farmers, fishermen, craftspeople and outreach).
- +Training on integrated coastal management for government staff, community members, and shrimp farmers.
- +Partner with and train local NGOs.
- +Establish a demonstration pond as a catalyst and create a learning facility.

Desired Impact

- +Increased shrimp farmer and community knowledge and understanding of the importance of coastal resource conservation to their own well being.
- +Increase participation, awareness, and community empowerment to influence resource use decisions, and ability for self management.
- +Increase understanding of integrated coastal resource management processes and methods.
- +Increase local capacity for coastal resource management and sustainable shrimp culture practice.
- +Experiment with and promote small and incremental changes to traditional practices that are more sustainable. By offering a successful example it is the expectation that this will build trust among shrimp farmers and willingness to adopt new practices.

physical

natural

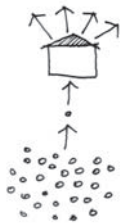
Resource: Good Practices for Community-based Planning and Management of Shrimp Aquaculture in Sumatra, Indonesia
http://www.crc.uri.edu/download/Good_Practices_Aquaculture-Sumatra.pdf

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Social Implications of Sustainable Aquaculture

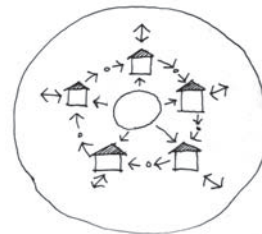
Previous approaches to aquaculture have not only dominated the landscape of the shoreline of Aceh, but have ignored the local community. The following diagrams illustrate current and possible structures within communities.



current social structure: products exported on a worldwide scale, no profits to community, work through a middleman.



the backyard structure: allows a family or individual to gain control of income return and marketing of products.



the community framework: provides local ownership and management. community profits from harvested goods.

financial

Backyard: Family

The Wai'anae Backyard Aquaculture Project in Hawaii supports families interested in small-scale production.

- + financial assistance is provided to families for initial capitol and 1st year operating fees.
- + family-run associations are created to establish a support network.
- + families are trained and provided technical assistance while coordinating a common marketing system.
- + once families complete training program and construct backyard system, they help other families do the same.

resource: Wai'anae Backyard Aquaculture Project. http://www.sustainable.org/casestudies/SIA_PDFs/SIA_hawaii.pdf



woman processing in backyard

human

Market: Family + Community

This idea stems from community forest practices. In Southwestern Thailand, a grassroots organization called Yad fon (Raindrop) Association follows this type of system.

- + local support and direct involvement of residents.
- + through learning techniques, small villages can ensure livelihoods gain or re-gain autonomy.
- + a group savings program provides loans for communities in need.
- + persuade a first step with initial communal projects such as digging a well to allow leaders and skills to come forward and set up a community driven program. community gains more control and incentive to protect resources. farmers can resell products at market.
- + word spreads to other communities as practices are adapted.
- + local knowledge can be applied as investment in natural systems is restored.

resource: Mangrove Action Project. <http://www.earthisland.org/map/index.htm>



selling fish at the cooperative market

social

Education: Community

- + educate children through school programs.
- + educate local community through training programs initiated by grassroots organizations.
- + provide education as research destination.
- + provide education to tourists as tourist destination (opportunity for tourism volunteer activities: help restore mangroves and re-build ponds).
- + create outreach programs with local universities.
- + promote education at a global and local level.



school children replanting mangroves

physical

natural

Sustainable Aquaculture:

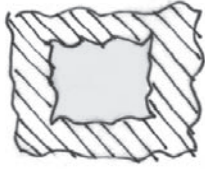
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Pond Layout

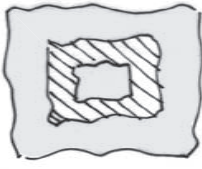
Tidal wetlands are formed by a system of ponds which retain mangroves on dikes as strips between ponds or in remnant patches inside ponds. The pond forms depend on the species for culture and on the size and shape of the area, which in turn determines the number and sizes of ponds and the position of water canals and gates. These forms can be combined to meet the needs of production and the site. The layout forms can be reconfigured and combined to create a small backyard or larger scaled community operation. These forms are not meant to be isolated but linked together resulting in a system that supports production diversity. Production diversity allows for options within the community, providing a variety of income opportunities, rooted within the community's knowledge and skills.



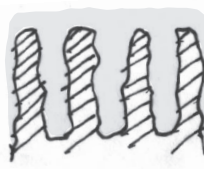
+mangroves as island



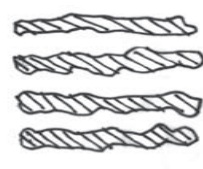
+mangroves as edge



+integrated mudcrab island



+vegetation on dikes in comb form

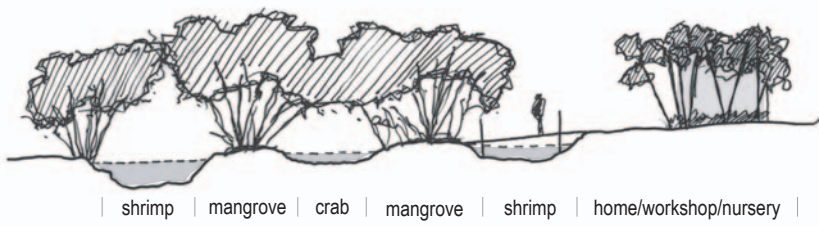
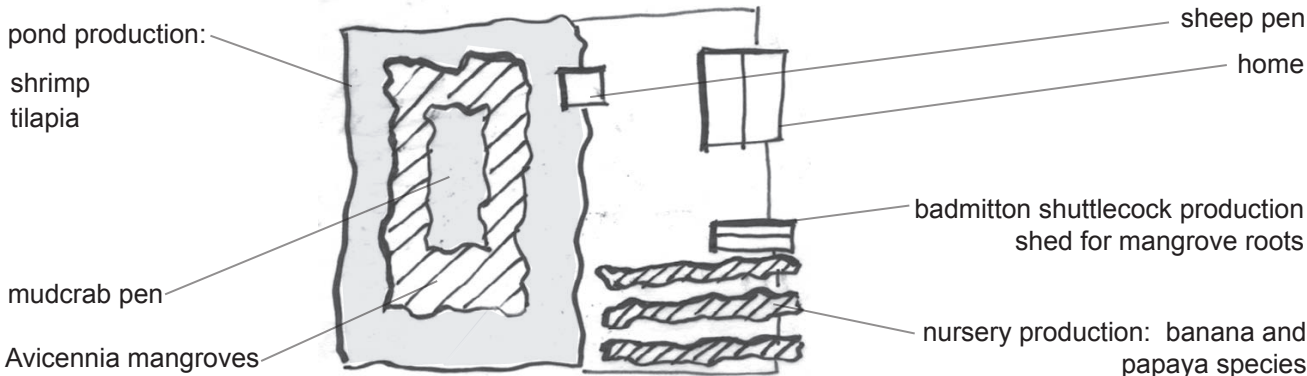


+nursery production

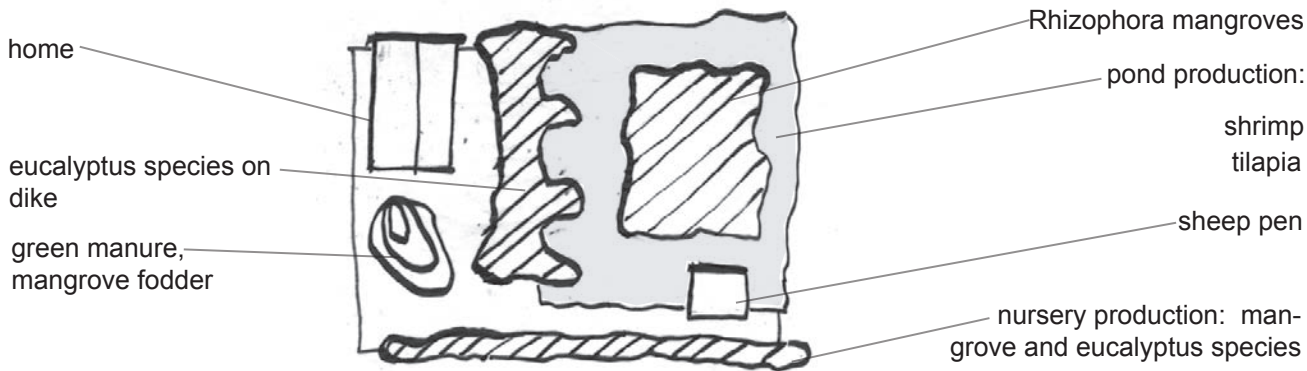
Backyard Prototypes

Backyard operations are run by an owner/operator or a family, and consist of both a home and working space. These farms have less variety than the larger scale operations, typically ranging from two to four product types per lot. Goods are sold from the home or at the local market, consumed by the owner and/or exported for profit.

Backyard Production: shrimp, tilapia, bananas, papayas and shuttlecocks



Backyard Production: shrimp, tilapia, mudcrabs, tea tree oil, green manure



financial

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social

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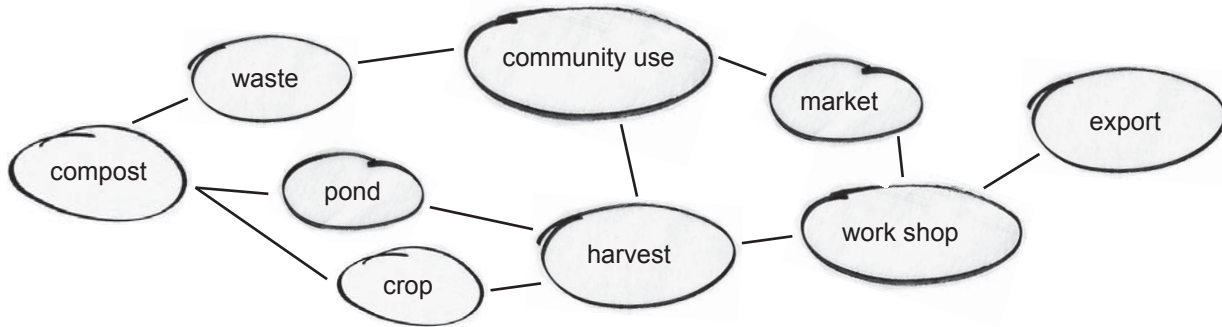
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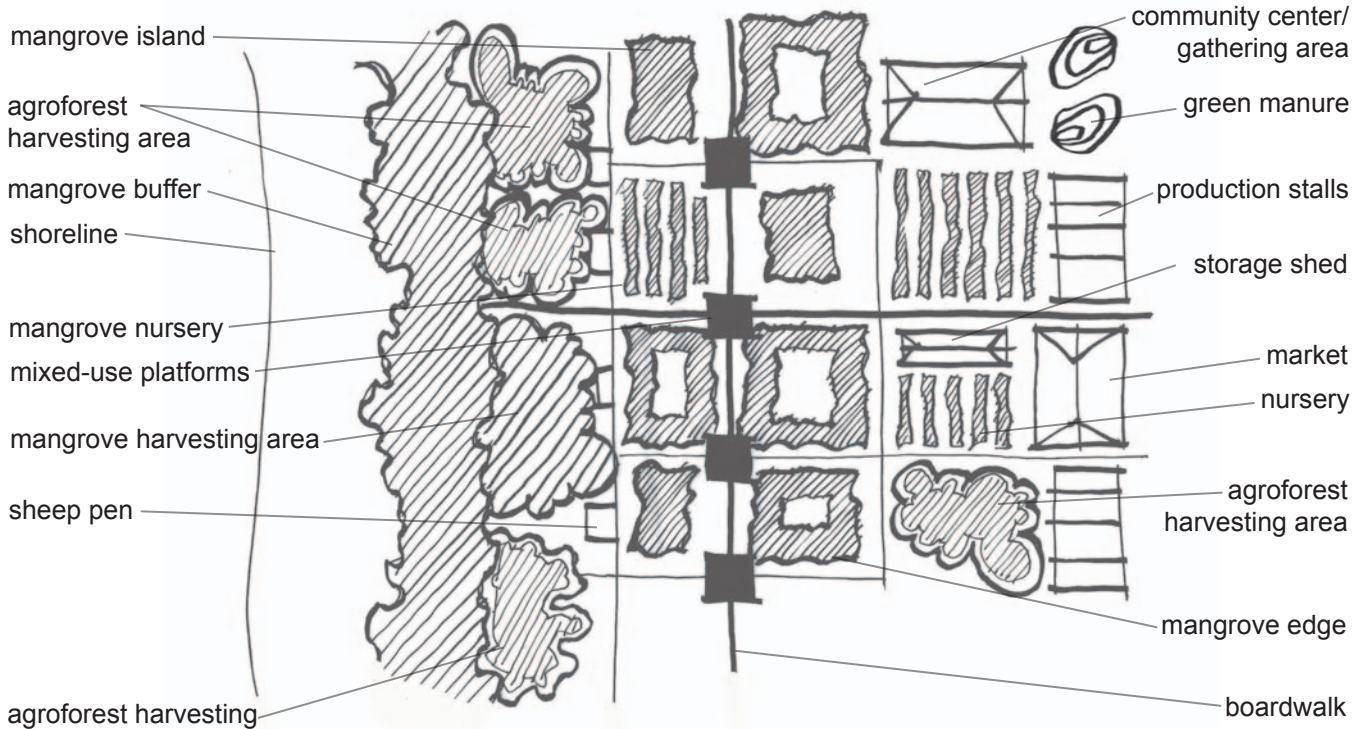
Community Scale Prototypes

These larger scale operations are run by a mixture of foresters, aquaculture farmers, crop harvesters, artisans and merchants. The traditional methods of Empang Parit farming are supplemented with a diversity of small cottage industries. These farms can be located along mangrove buffer zones along the coast, creating an opportunity for livelihoods in addition to security of mind. They are operated by the community, with each farmer operating a plot. The variety of products stemming from this organization is broad, determined by the choices made by each plot owner. Goods harvested are processed in on-site production shops and filter out to the market area or are utilized for wider export. This arrangement of forms also lends itself to programs catering to education, tourism, and research.

Functional Diagram: process of community economy



Local Community Production: pond products, forest products, processed goods, community economy



| shoreline | mangrove buffer | agroforest harvesting area | pond and mangrove production: dikes, channels and boardwalks | nursery | market area |

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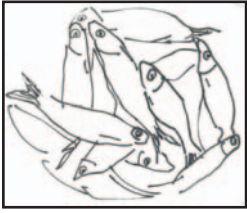
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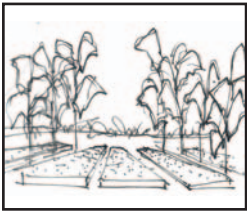
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Processes and Techniques

These are examples of small scale measures implemented by the community within the aquaculture systems. These processes and techniques supplement the overall framework of an operation.



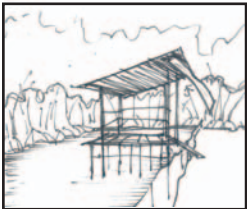
Pond Crop Rotation: Use a single pond space for a diversity of marketable products. Species stocked depend on the season, young tilapia are stocked in the ponds in January and grow out from February to May. In May the fish are harvested and the young shrimp are added to the ponds. As shrimp grow out from June to September, mudcrabs are raised/fattened in pens within mangroves. In October ponds can be drained, dried and prepared for next culture cycle. Larvae are collected naturally from tidal flow.



Nursery: Raise mangrove propagules to supplement community harvesting or use as potential stock to sell to government for shoreline treatment. Because *Rhizophora*, *Avicennia* and *Sonneratia* are fast growing and flower within their first year, they are among the few mangrove families best suited for replanting. Food crops such as bananas or papayas can be raised to reestablish agroforest harvesting areas. These nurseries can be managed at a family level in a backyard, or at a community level, reusing filled-in abandoned shrimp farms.



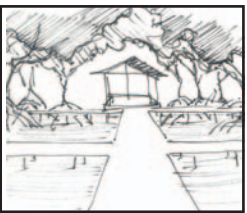
Green Manure Processing: Fodder can be collected from mangrove harvesting areas for use as fertilizer and food for livestock within the community. Tree debris is shredded and spread over crops or fed into ponds to increase production. Leaves and other trimmings can be fed to livestock such as goats, cows and sheep.



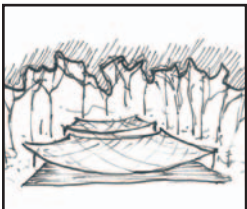
Organic Pond Fertilization: Nutrient input can be added in the form of animal manure or compost. Pen structures are built over ponds and sheep are closed in at night or during the day, manure falls through slats in the bottom of the structure to reach the pond. Household waste such as food scraps can be disposed of on compost piles placed on similar structures built over the ponds.



Debris and Re-use within the Community: Before the mangroves can be reestablished, debris from the tsunami can be used to build items such as boardwalks, oyster trays, shelters, animal pens, fencing, and compost bins. Random debris that is not useful for lumber can be used build the dikes of the ponds.



Mixed-Use Platforms and Boardwalks: Use can vary according to types of adjacent ponds. Possibilities for tool storage, pond monitoring or maintenance, as well as opportunities for education, research and tourism. Boardwalks separate pond activities and can run along canals or on the top of constructed-dikes.



Protective Nets: Structure tannin treated nets over ponds to protect from predators. Marketable fish/shrimp are collected at the end of the culture period by draining the pond and using harvesting nets.

resource: Interview with Charles Angell, local Sustainable Aquaculture expert.

financial

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social
















physical

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Product Matrix:

	source	harvest	value/uses	ecological value	challenges/notes		
pond products:							
milkfish	 high tidal range , can hold water at least one meter deep in brackishwater pond.	drain pond. fry require a separate nursing pond.	high demand, highly profitable. consumed and sold locally and nationally.	dikes reinforced with mangroves or cash crops.	can be cycled with shrimp crops, ideal for a small-scale operation.	financial	
shrimp	brackishwater pond, culture during rainy season.	varies according to species raised.	global market.		can be cycled with other crops. collect larvae naturally from tidal fluctuations.		
tilapia	freshwater to brackishwater. stock in january.	with nets from february to may.	requires few inputs and works well on subsistence farms.		able to undergo large changes in salinity. 		
oysters	pen-cultured, rafts.	reach market size in 6-9 months, feed on detritus.	large demand globally.	can be grown in old shrimp ponds.	not common in sumatra, would need to gain familiarity among locals.	human	
mudcrab	 pen-cultured, can restock with crabs from a nearby river.	fattened in may, cultured for 4-5 months. must be delivered in live condition.	alternative income for fishermen.	prefer forested areas, can recharge natural crab populations.	ensure that native crab species are used, to prevent the release of invasive species. prefers dense forest canopy.		
forest products:							
banana	plant in well-drained areas.			can be mixed with other species to create an agroforest community, fodder can be used to create fertilizer community run, provides habitat.			
papaya							
eucalyptus		harvested and distilled for scent and oil.					
mangrove							
+green manure	fodder collected from mangroves.	can use debris leftover from harvesting activities.	fertilize fish ponds and/or crops.	replaces the use of chemical based fertilizers.		social	
+lumber		harvested by community or through backyard operation.	homes, roofs, fishing poles, nets, floats, boardwalks.	community ownership, direct benefit.	will need adjacent nurseries and management plan to ensure it is not overlogged.		
+firewood	Rhizophora.		renewable fuel.				
+tannin	bark of Rhizophora.		production of leather.	artisans take value in products harvested from their forest and promote their protection, thereby reducing reforestation.	more common in india	physical	
+dye	Bruguiera gymnorrhiza seedlings. 	seedlings are peeled, chopped up, boiled and the fabric immersed in the soup, then dried in the shade.	resulting colour is a red-brown, and repeated dyeing gives black. The dye also strengthens fishing nets, grass skirts and other fibers.		in southeast asia, the tree is one of the traditional dyes used in batik-making: it produces an orange-red color.		
+medicines	Rhizophora.	varies.	varies.				
+paper and pulp			this is already a large industry in indonesia.		create a program for locally made paper products.		
+honey	bees feeding in river mangroves <i>Aegiceras corniculatum</i> . 				can this be done in indonesia?		
+shuttle cocks	roots of <i>Avicennia</i> .	roots regenerate quickly.	to construct shuttlecocks for badminton.		ideal for backyard operation.	natural	
+crafts	pneumatophores. 		baskets are woven with forest materials.				