Permaculture Technology in Tropical Freshwater Swamp

IOP Conf. Series: Earth and Environmental Science **499** (2020) 012018 doi:10.1088/1755-1315/499/1/012018

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Abstract. Tropical freshwater swampy in Barito River Basin has not been often for study, mainly due to inaccessibility and the insect-borne diseases. Nevertheless, the swamp has been for living areas Banjarese for many centuries. The swampy not just for agriculture plantation or animal cultivation areas, but also for living areas. This research from 2017 – 2019 aims to collect information about local people use green natural resources for sustainable uses and fluctuation of physical and chemical factors. Data was collected from eleven villages within six regencies by interviewing about 600 people who work directlyfor using natural resources in agriculture, farming or plantation. Physico-chemical factors information is gathered by directly measuring or collecting from government agents. In conclusion, more than 70% of interviewees inform that their knowledge decent from their parents or grandparent who educate them and they also develop their skills practical by learning by doing and developing green natural technology for daily life and earn their income in extreme wetland environments both in monsoon.

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1. Introduction

Banjarese has live in the southern part of Kalimantan island, Indonesian Borneo. They mostly live adjacent rivers, some of them occupied estuarine, as traders. Others live in along and upper rivers as farmers or fishermen. Almost all of them occupied huge wetlands in the central south of the island. Wetland for Banjarese is habitat, cultivating areas, inheritance, cultural media. Interaction people to their nature was expressed in their culture and arts. Following Indonesia's development, which accelerated based on natural resource advantages, Banjarese face the negative excessive impact of natural resource exploitation, such as extensive forest degradation, coal mining, and huge oil-palm plantation.

Exported timber and the need for foreign exchange collected using wood-based products need a lot of forest woods. Indonesia exploits its forest for financing in the early development era, leading by the new order generation (Orba). Forest and land degradation sent bulk solid matter into the river development program, Indonesia in the Reformation Era uses coal as a foreign exchange source. Many companies and multi-national corporations build as operators. In the last two decades, there is land conversion for oil palm plantation.

Excessive natural exploitation has shown as environmental degradation, such as reduce river water quality, increase in land erosion, flooding, lake or pond dystrophic, reducing number and diversity of water productivity, increase land conversion, and lower local income, finally tend to increase the number of local poor people. To respond to this situation, the locals adapt and increase resilience by creating or applying conditional technology, low input technology. These technologies were local creativity, simply made models, multifunctional, degradable and naturally friendly. Their local technology elucidates their ideas for conserving nature and sustainable use for their future.

This research aims to find out the explanation about local environmentally sound technologies, which were developed and used in tropical freshwater swamp or wetland, such as tools for fishing, farming, or ranching.

2. Material and Methods

We provide equipment for measuring water quality, such as pH meter, Conductivity meter, thermometer, for conforming to the locals' explanation about their environment. We bring a Canon digital camera, voice recorder and GPS, and worksheet for taking notes on quantitative data. We hire a motorized canoe, "ketinting" and speedboat, and also using public boat, "kelotok" to meet and visit people in their daily activities such as fishing, shepherd the buffalo, mowing the grass, work in the plantation.

Our field survey in 2018 involved participatory observation and intensive discussions with 30 farmers. Observation to local daily activities has been conducted by visiting them in their villages, workplace, and also their working groups, personal and group interview, and also made for forum group discussion, which involves several experts from different disciplines of knowledge and it has been started from 2017 to 2019, collecting data by evidence-based approach [1]. The utility and value of systematic review and the evidence-based approach is well established in the medical and public health sectors [2]; [3] and is now widely recognized in other research disciplines, including conservation and environmental management [4]; [5]; [6]. Interview data were collected, grouped and analyzed quantitatively and qualitatively with several times reconfirmation for validity and value of the benefit for local people. Discussion and questioning group members, and visiting workshop, confirmation to stakeholders about what they have been done. We expect that the result shows the local use traditional approaches and based on adaptive learning strategy, and being able to handle natural and technological management for increasing benefits, such as explained by [7].

3. Result

There are three kind of river fishes, common carp (*Cyprinus carpio*), knife fish (*Notopterus chitala*), Mango fish, Nile Tilapia (*Oreochromis niloticus*) and three swampy fishes, such as Climbing perch *(Anabas testudineus*), snakehead murrel fish (*Channa striata*) and toman (*Channa micropeltes*) with different size. These fishes are very famous for commercial consumption and fat dietary. People booth catching directly from nature and also growing the seeds in the aquaculture system for economic reasons. Production from nature is not less dan 20 – 50 tons per season and selling price about US $ 5 – 10 per kilogram.

Picture 1: Aquaculture, using net for catching and growing local fish.

Local farmers use an efficient technique for aquaculture, they set up the cube nylon net, then they invited juvenile fishes by giving them attractants. Juvenis fish can go in and out from the square net, but when they are bigger, Actually the farmers saving a lot of money by delaying commercial foods for their fishes. As far as the fish can go and out through the net, fishes can boost they are growing when the farmers give additional bigger foods. Farmers just spend approximately 50% to 60 % of total food for growing, the rest of the food can be shaken by the fishes from around. When the fishes are bigger than the juvenile, the net's mesh eyes 1.0 inch will trap the fish inside. That is the time the farmers just exactly provides food for their fishes. Additional food will be taken from other sources that flow into the cube net.

It is very difficult to have valid data of the buffalo population, due to the spread in some places where they are wildly grazing. Counting the population may possible when they are come back to the byre, however a member of groups several times experienced split from the main groups. Almost impossible to gather them closely in the water at the same time and in the same places. During the dry season, water level significant drops, grass cannot grow well, water more polluted, insufficient food, some of the buffalo are dying and death. The only data is provided by owners or and their shepherds. So, population data about 4000 buffaloes is just low accuracy.

Early rainy season is the proper time for grazing, new growth of grass provides plenty of carbohydrates and fiber for food and fiber. Grasses grow both in shallow wetlands and floating in the water surface. In this season, farmers gain in buffalo weight, economically brings profit for farmers in the sale buffalo market.

Picture 2: Ranching water buffalo, and docking in the byre during the evening rest.

Planting rice in the dry season, when no more rainy or lake water, left muddy landscape, people provide land for planting. They cut and clear grass or macrophyte plants, by chopping into smaller pieces. The rest of water may contain allelopathic compound, a secondary chemical compound of a plant which can kill other plants, which released by the chopped grass.

Farmers leave that chopped plants for about month for fermentation to create compost. This field will become places for planting rice. To increase alkali conditions, farmers spread lime and fertilizer the soil by adding synthetic fertilizer. Usually about 1 ton lime for a hectare rice field, it will be possible to increase pH 3.5 to be pH 6. Manure also usually added to the rice field. As long as the nutrient loading of these wetlands does not surpass critical limits, plant and animal diversity is not threatened by the effects of the nutrient inputs. As long as the nutrient loading of these wetlands does not surpass critical limits, plant and animal diversity is not threatened by the effects of the nutrient inputs.

Farmer cannot plant the rice during the rainy season, due to flooding, but they must be able to provide water for watering a muddy rice field during the dry season. They also must able to plant between April to August to have appropriate periodicity, otherwise, padi will grow with empty rice. After monsoon bringing rainy, thunder, and sometimes storm seasons, the water level gradually drops into shallow lakes or rivers. It is the right time for planting any kinds of horticulture, nuts, fruit, vegetables. Farmers provide techniques for managing soil.

By managing the water level, a farmer can set elevation of soil surface for planting any kind of vegetables, such as spinach, nuts, celery, onion, eggplant, tomatoes, chili, cassava, pumpkin and corn, watermelon. Commonly, farmers are step by seedling, growing seeds in different places for selecting better young plants. At the same time they providing planting fields with different treatments based on the soil conditions, which is directly influenced by water level. For example, some people use black soil (an artificial terra preta) for enriching original soil. The farmer hopes water is available to the next monsoon, without any interruption by flooding, especially in early planting season.

Farmers in shallow lakes build fruit gardens, create soil dome on top of water level, easier and low cost, planting and producing lime, citrus, and chili, see Picture 2. It is similar to the agriculture model in Bangladesh (Khondoker, et.l, 2014). Indonesian keen of chili and the selling price is expensive USD 1 - 2 per kg and the locals also sell seeds and sapling of them in huge parties. It is easy for the locals to earn US$ 1000 to 2000 per year. However, production can dramatically drop due to lack of water, in the long dry season.

Seasonally horticulture and fruit gardens set up and harvest respectively. Horticulture is planted in after rainy season, after growing well in early dry season, it is continuing with pollination. Then at the end of the dry season, harvest time will be expected. However, in the case of rainy comes at the beginning of the dry season, perhaps no success in pollination can be expected. Then the farmer my lost their harvest at that season.

Picture 3: Horticulture and fruit garden in and moda transportation in the dry season. (Top leaf, Tomatoes, right Manggo, below left: water melon) in harvest time.

Swift barn has been erected for the last ten years, previously wetland in the Barito basin just shows simple and low building. Today it is very easy to see about twenty to thirty-meter wooden building, composite by asbes or zink wall and roof. These buildings have some small windows and easy to see from outside, it is an entry point for swiftlet, and the artificial bird sounds are noisy for attracting the flying bird for entry and making a nest inside the building. This one is costly about US$ 10,000 to 25,000, which depends on the height and the quality of the building, see Picture 3.

The population of the bird seems to increase gradually in the last ten years, they migrate from the east coast to the midwest, Barito river basin. Perhaps due to collapse some of karst caves for cement industry and forest clearing for oil-palm plantation, they refuge to the habitat, where the place enriches with many kinds of insects and large areas of freshwater.

There are more than a hundred swiftlet barn around the Barito river basin, where it is just in Hulu Sungai Utara residents. it is a new income generator for locals. Those barns have been set around the local single or communal house. So far, there are not mentioned diseases that influence people.

Single house with single barn, usually belong to rich men, who has a wide land area. Most of the locals joint with investors. Local inhabitants create barns in their villages, very close to their communal house. People in the communal village have their own house, but they are connected with one wooden road, no cars but motorcycles. They use ironwood for bridging to each other, sometimes in rainy, the bridge sink underwater surface, see Picture 3.

Picture 4: Single and communal swiflet barn

Water fluctuation will drive all aspects of local life, in the rainy season, the house's floor looks as though uplift, because of water surface drops till 5 meters. Instead of surface water touch to the floor or even people bed in the flood season, and all mode transportation is change by canoe "Jukung or Kelotok (Motorized canoe}. Therefore, locals set their activities in different places based on the water depth in flood seasons, see Table 1.

Deepth (m)	Buffalo rancing	Swiflet barn	Horticulture garden	Aquaculture	Settlement
0					
-1					
-2					
-3					
-4					
-5					

Table 1: Area distribution of Permaculture activities based on the depth of water

Buffalo byre sets up in more sallow areas with depth of flooding just about two meters. Byre will be placed by about 20 to 50 buffaloes, its dock is made of big ironwood pillars to overcome about a ton weight of buffalo per meter square. Those pillars must be able to overcome corrosive water with a pH of 3.5. Therefore, pillars are made of ironwood, which only grown in Kalimantan and Sumatera.

During the day buffaloes are going out of the byre, swimming on the lake, grazing to the grassland adjacent. The hot day time, they are soaking in mud or river, resting. When flooding with fast current of water, sometimes a buffalo split from their gang, especially young buffalo, calf. When buffalo gets sick during grazing on the swampy grassland, it is very easily split from the gang. Perhaps, several days after that time it will be found as a floating buffalo carcass. For that reason, people build a byre in a shallow area, about 2 meters from the surface of water to the ground.

Shifted barn, a hilly wooden building with a size of 5 meters wide, 10 meters long and 15-meter height is built on the land which is soaking about 1 or 1.5-meter depth from the

water surface during flooding season. Those buildings seem like a tower on the sea with a fleet of swiftlet flying together at certain times.

Uplifting soil, beside ditches ("bedeng"), can be used for growing vegetables. The ditch itself can be used for aquaculture. Farmer also uplift bulk of soil is like dome ("Tukungan") for planting fruit trees, like citrus and hairy fruits. Trees need more space for their roots and it cannot be soaked underwater. Therefore, farmers must construct a tukungan look like a soil dome on top of the water surface. Tukungan is a unique indigenous invention agriculture of the wetland society, easily maintained, environmentally friendly. This agricultural system does not really depend on flooding. Maintaining the dome by adding mud from around can fertilize plants because mud contains compost and fertilizer.

Almost three-quarters of the years, wetland soaking underwater. Farmers use water for aquaculture, any kind of aquaculture models depend on water level, such as hapa, rengge, beje, ancau. Hapa uses when water level is high, while rengge can be used for when water level about 1 to 2 meters. A Beje used for aquaculture when the water level drops below the land surface, Locals create ponds and use water from the wheel.

Activities	Production time											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Buffalo ranching												
Saliva Swiflet barn												
Horticulture garden												
Aquculture												
Handycrafts												

Table 2: Seasonal Activity along the year

Locals live in wetlands, build high wooden buildings. Some of them, build a single house, while others build in a communal village. One and another build houses side by side, share wooden road and yard. Their home build with wooden pillars, about 5 meters from the ground. Because in the dry season, the water level will decrease very significantly, see Picture 5.

Picture 5: Single and communal settlement in the village during dry season.

January to March, sometimes to April rainy dominates daily time. Flooding is almost everywhere, plenty of grass for buffalo food. Buffaloes grow well and some of them will be sold by the owners. People buy buffalos here for meat like inland people inland consume cow meat. Therefore, locals here use cows as sources of proteins. April to September is the time of no more or very rare rainy, dry session. In October, a new monsoon session commences. If the climate is normal, usually, rain comes again in September or October. However, for the last five years, the local climate has changed, it is a very long dry season about 8 months in 2019. So, October to December becomes a peak of dry season, which is always followed by bush or forest fire. This condition is responded by the reduction of the swiftlet population.

Horticulture and aquaculture will be started in early monsoon and harvest during the dry season. When the water level drops, farmers prepare soil beds for growing vegetables and fruits. If the climate is good in that year, a farmer can harvest twice a year in the dry season. Farmer giving more lime than fertilizer, almost every time planting season, farmer giving lime for soil. Fertilizing usually use previous mud and compost which collected from around planting areas, probably they use the rest of fertilizer which washed out by water to adjacent plants.

Handy crafts which were use local bio-material, can be planted and harvest almost along the year. *Purun* is spesific local plant, grows well in wetland a long year too. This wild plants grow very fast, if this macrophyte grown in the water, they can grow up to 2 meter height. This renewable resource is naturally available in wetland, see Table 2.

Technology	Product (Average)	Unit	Margin (US $)	Saving (US $)
Buffalo ranching	8	head	2500	2000
Saliva Swiflet barn	4	kg	4000	2500
Horticulture garden	3	tonne	600	500
Aquculture	2	tonne	3500	2000
Handycrafts	100	piece	150	50

Table 3: Production, Margin, and Saving of Permaculture activities (farmer-family^{-1} year^{-1}).

Farmer develop Permaculture to have food dan the rest of yield for income-generating. Previously, agriculture means growing rice and some local vegetables, such as cucumber, eggplant, cassava. Following the increase in population and migration of different people's origin, there is an increase in different kinds of foods. Migrant from Java, Javanese consume more vegetables than fishes. Chili is also needed by industry, making Chili sauces ("sambal"). Fruits reach to restaurants. So, locals participate to increase wetland services. They sell those with a comparable price. Their benefit can also increase the Government's local income. Then, the government increases local facilitation, such as health service, technology, public facilitation, transportation, etc. The most important locals get benefits, profit and have saved. Table 3 shows farmer's production, margin and their saving in a year on average in different activities.

4. Discussion

Monsoon cycle is regulating tropical wetland, in some places, water cover the land more than eight months, in certain area just about a half year and in high plain area is just about three months. Water is also limited plant growth and distribution, kinds of plants, so the success of harvesting is also determined by a monsoon.

Rice field in wetland is just only possible in the last monsoon, in early dry season. When the rain comes just before plating the rice, the farmers must hold the rice while waiting for the lower water level. If rainy days come early before harvesting, the farmers must let their harvest collected before mature, otherwise, the yield will wash away by flooding. The local grow rice without irrigation system, due to unavailable facilities. If the farmers have not planted in May, their harvesting may be a failure in August, due to the periodicity of sun for rice has been changed. Some farmers modified their rice fields by creating a level to avoid flooding. In some places, the success the harvesting rice due to able to avoid flooding in the rainy season. Maybe they must adopt a model of Dhaps and Kandis, which are made available by the ingenuity and entrepreneurship of Bangladeshi people [7].

After long dry season, mature fishes are limited. River fishes migrate to the upper river to get flowing water with high oxygen content waters. Some of them are limited distribution due to a reduction in water level. Swampy fishes dive into the mud maintain their respiration activities, hibernating and return to normal life when the rain comes and supplying water. Each fish naturally has it's mating and hatching season, some of them use the early rainy season. At the early monsoon, it is time to have new fingerling of river fishes. However, if the rainy discontinue and disturbs hydro cycling, the breeding season may be delayed or even failure, the regeneration process fail for this season. Local people know well this situation and they will change their hope to get other benefits at that time. For the locals, they know well condition in the swamp.

People used to be fishermen who catch the fishes to earn income. They collect the fishes using traditionally hand-made traps made by bamboo, or plastic nets, or just a fishing line. Some of them create a fish trap made of bamboo. This equipment traps a school of fish (Rasbora sp.) or for growing juvenile. Fishermen put certain homemade bio-attractants, which is made of insect-carbohydrate mixed larvae to invite certain fish. For carnivorous fish, they give an amount of trash fish that contain more proteins. It is a similar use of wetland in Kenya, farmers manage the land for agriculture based on water level fluctuation [8].

After following more practice and technical training farmers and fishermen can work together to create an integrated model. This model developed based on broadening knowledge and skills which is combine and blending more green technology, such as Permaculture, a permanent culture. Permaculture needs the skill that farmers already have so far, and need more integrity to the sustainability perspective. In this case, farmers aid indirectly catching the fish, instead the catching fish, they are breeding and growing the fingerling, then selling products at the right price. all local activity should be apart of rural development activities that must maximize production, income, and sustainable development. Their techniques a part of the biocultural heritage, that has been descended by their great grandparent. Their views on natural resource management draw about sustainable use of wetland resources.

Recently farmers collaborate with the investor to grow swiftlet, they produce swiftlet saliva. Farmers provide lands and investor constructs building nests. Success farmers can harvest about one or two kgs per two months, with a selling price of USD 1000 – 1500. Bird

live and look for insects for food in wetland, therefore swiftlet saliva is a prospective business for locals and the production can be expected throughout the year.

5. Conclusion

They learn and experiment in daily life, and creating environmentally friendly technologies, for surviving and reviving life in extreme ecosystem. Their technologies have been proven can be used for a long time, especially in the equilibrium of resource exploitation and recovery, Permaculture. Local people also, open-minded and brave to correct regarding to over-exploitation and misuse of natural services, required mental sustainability. Local people's attitudes are likely promising in building resilience and creating sustainability of natural, personal, social and community capital, Permaculture. Being able to handle the integration of natural and social science methods can be supported by the use of macroecology, land-use planning land-use planning land-use planning, human geography, comparative politics and regional studies for sustainable growth in the future. In conclusion, willingness to succeed, earn money and have social credibility based on the sustainability of natural resources, grow well on ordinary local mindset, as a character of local Permaculture technology. So, we are called to search for practical tools that can deepen our understanding of the rapidly changing and intertwined social-ecological dynamics of the Anthropocene.

Acknowledgment

The government of Kabupaten Hulu Sungai Tengah, South Kalimantan and Peat Restoration Agency (BRG) of The Ministry of Environment and Forestry of the Republic of Indonesia for supporting the finance of action-research.

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