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Preface

The Transdisciplinary Research on Environmental Problem in Southeastern Asia (TREPSEA) international conference was started in 2011 by the 1st International Seminar of Environmental Geoscience (ISEGA) to provide a forum for its members to discuss and share their latest research. In 2014, the conference name was changed to 1st TREPSEA and it took place in Swiss Belinn Hotel, Makassar, Indonesia on 4-5 September 2014. The last but not the least conference is the current 2nd TREPSEA, which was held in the Papandayan Hotel Bandung, West Java with the great theme of “Disaster and Environmental”. Our community is leading the way in studies to understand how to solve the environmental problems in Southeast Asia using Transdisciplinary approaches.

The 2nd TREPSEA collected 63 papers handed by colleagues from university, researcher and professional. All papers are divided into 4 main themes: Disaster mitigation, Measure and Improvement to Urban Environmental problem, Sustainable development and Environmental Preservation, and General. From 63 abstracts the committee selected 34 manuscripts to handle as Post Proceeding TREPSEA.

The chairman would like to express deep appreciation to the 3 universities, Bandung Government city for support to this event, and 2 conference sponsor companies. The 3 universities are Bandung Institute of Technology (ITB), Ehime University (EU), and State of Gorontalo University (UNG). The 2 companies include Medco Energy and PT. LAPI ITB.

The transdisciplinary research is defined as research efforts conducted by researchers from different disciplines and non-academic stakeholders working jointly to create new conceptual, theoretical, methodological, and translational innovations. The stakeholders are funder, government and development organizations, businesses and industries, civil societies (inhabitants, NGO's etc), and media for completion of the environmental problems. We look forward to cooperate with all of you to produce a deep, thoughtful set of works that can guide our activities in the future.

Chairman
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Acknowledgement to Sponsor of TREPSEA 2016

On behalf of committee members and participant, the chairman would like to express deep appreciation to the sponsor companies that have helped us to keep down the cost of TREPSEA 2016 for all participants.

1. Medco Energy
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Investigation about Creation Possibility of Pearl Farming in North Gorontalo, Indonesia for the Solution to Economical Poverty and Environmental Problem

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IOP Conference Series: Earth and Environmental Science, Volume 71, conference 1

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Abstract

As a solution to economic poverty, we investigated pearl farming in Kabupaten Gorontalo Utara region. The average income of farmers is 15 – 28 million rupiah/year, and their incomes are low and unreliable, it is important to be developed and that agriculture and fisheries are under environmental load. The coastal environment is degraded. From 2001 till 2013, pearl farming was used in Kabupaten Gorontalo Utara, but the operation caused environmental issues with the actions of manager. To establish a sustainable pearl farming, it is important to address social issues than environmental issues.

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Investigation about Creation Possibility of Pearl Farming in North Gorontalo, Indonesia for the Solution to Economical Poverty and Environmental Problem

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Abstract. As a solution to economic poverty, we investigated the possibility of developing pearl farming in Kabupaten Gorontalo Utara region of Indonesia. The approximate income of farmers is 15 – 28 million rupiah/year, and that of fishers is 51 million rupiah/year. As these incomes are low and unreliable, it is important that food processing and other industries are developed and that agriculture and fisheries are promoted. Pearl farming minimize environmental load. The coastal environmental conditions are good for pearl shell growth. From 2001 till 2013, pearl farming was undertaken by a Japanese company in Kabupaten Gorontalo Utara, but the operation caused because of conflict with local people and issues with the actions of manager. To establish successful pearl farming businesses it is more important to address social issues than environmental factors.

Keywords: .poverty situation, farmer, fisher, pearl farming, Gorontalo Utara Regency

1. Introduction

Many rural areas in South Asia are dominated by economic poverty. There is an urgent need for the development of new businesses, but it is difficult for local populations to change their situation. Business opportunities appropriate to rural area are being sought to address economic poverty and develop the potential of environmental resources. Because of economic situation are undeveloped urban and industry facilities, the area retains a sustainable ecological system.

To address economic poverty we are investigating the possibility of developing pearl farming, which has much potential, and we are developing clear proposals to achieve this.

As pearl farming requires maintenance of clean water, large-scale engineering innovations are undesirable. In addition, unsustainable agricultural practices erode soils to rivers and the sea, and this could detrimentally affect the marine environment.

High quality products can generally be traded for good economic returns. Consequently, if local communities and associations are provided with appropriate technical support and management systems, good economic outcomes are possible.

We have an established relationship with pearl farmers because a pearl production facility is located in Ehime prefecture, where our university located. Technical advice is available through this relationship, making it is possible to initiate our proposal if possible results are obtained.

Indonesia and Japan differ in culture and social habits, so to initiate this new development there is a need to establish good relationship among local communities, organizations and government.



In this report, we describe the economic poverty of the study area, and we overview difficulties that overseas company face in establishing new business in this area. In particular, we describe the pearl farming that operated in Kabupaten Gorontalo Utara in the past. We outline necessity future research and multi-disciplinary approaches to establishing new business in the region.

2. General condition in the study area and method of investigation

2.1. The Gorontalo Utara Regency

We chose Kabupaten Gorontalo Utara (Propinsi Gorontalo Indonesia) as our study area (Figure 1). Kabupaten Gorontalo Utara is located in north Sulawesi, between $00^{\circ}41'23''$ and $1^{\circ}07'55''$ north latitude and $121^{\circ}58'59''$ and $123^{\circ}16'29''$ east longitude. The rainfall recorded in 2014 was approximately 6 – 321 mm/day, and the highest number of rainy days (20) occurred in November 2014. In 2014, the monthly maximum temperature ranged from 32.0 to 40.3°C and the minimum temperature ranged from 21.2 to 24.2°C . Kabupaten Gorontalo Utara has 11 districts (kecamatan), which in total cover an area of $1,777.022\text{ km}^2$ [1]. The capital of kabupaten is Kwandang, which is 49 km and approximately 2 hours by car from central Kota Gorontalo.

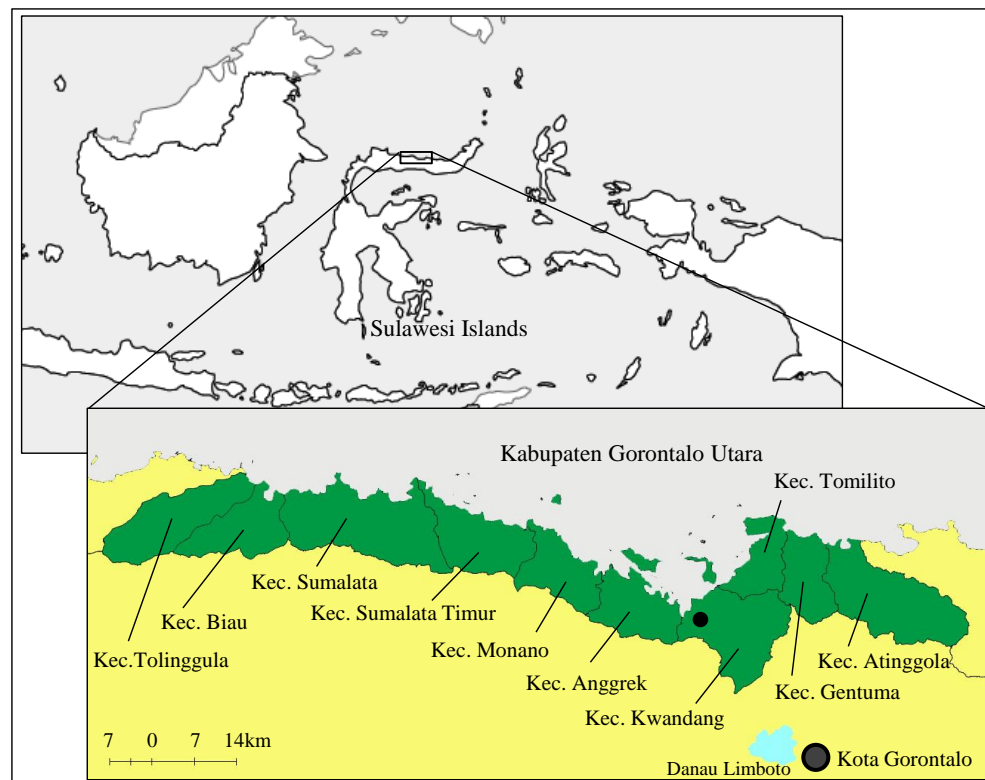


Figure 1. Map of Kabupaten Gorontalo Utara

The population in 2014 is 109,502, and the average kabupaten population growth rate from 2000 to 2010 was 1.84%. The number of household in 2010 is 24,888. As the population was 104,133 in 2010, the average of household size in this year was 4.18 [2]. The family size in this area is large compared with the average household size for Indonesia generally (3.81 in 2010) [3].

The gross regional domestic product (GRDP) from industrial activities in Kabupaten Gorontalo Utara in 2014 was 1,989,795.43 million rupiah. The agriculture, forestry, and fishery category contributed most (951,676.84 million rupiah; 47.8% of GRDP), while the other important category was construction (213,074.79 million rupiah; 10.7% of GRDP) [4].

2.2. Method of investigation

The above shows that most people are engaged in agriculture, forestry and fisheries. Many families are supported on single incomes, but there are not always reliable. We have considered alternative options for income generation based on knowledge of the economic situation, and have identified pearl farming as one possible solution, particularly as a Japanese pearl farm operated in Kabupaten Gorontalo Utara in the past. To obtain historical details, from 12 to 16 August 2016 we undertook interviews in three kecamatan (Kwandang, Angrek and Tomilito) involving 10 farmers and fishers, 7 desa chiefs (Tolango, Danbaro, Jembatan Merah, Bubode, Leawo, Bolango and Mutiara Laut) and government officers from Kabupaten Gorontalo Utara (Figure 2).

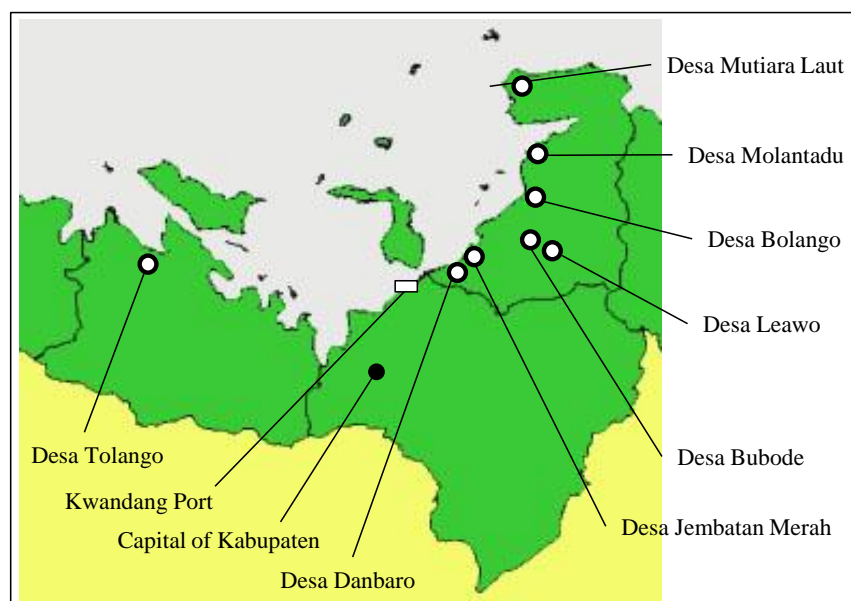


Figure 2. Research Point in Kabupaten Gorontalo Utara

To assess the best areas for pearl farming, we undertook basic investigations of environmental conditions. We obtained many details from fishers, including on wind direction and intensity, ocean currents, and the condition of fishery resources.

Pearl farming commenced in the area in 2001, but ceased in 2013 because of controversy. Understanding the issues involved is essential to the possibility of reintroducing pearl farming operations. Prior to our investigations there were many unsubstantiated rumours, so we interviewed a number of people who provided diverse opinions.

3. Rural Working Conditions

Most people are engaged in agriculture or fisheries in Kabupaten Gorontalo Utara, but there is variability in the details among locations and seasons.

3.1. General information about farmers and fishers

The population number of households, and ratio of farmer and fisher in each desa are listed in Table 1, based on interviews with desa chiefs and local people. Fishers are common in coastal area but not in the mountainous areas. The populations of fishers and farmers varies among desa, depending on the size of the paddy fields and farms. Desa Morantabu and Desa Mutiara Laut are small so the ratio of fishers is higher than for other desas. Conversely, for desas where paddy fields and farming are possible, the number of farmers increases and the ratio of fishers is lower. Areas having a low ratio of fishers tend to have land available for cultivation, so the proportion of farmers increases.

Fishers cannot work full time in the fishery during any year. In the rainy season, many fisheries do not operate because of the strong west wind and heavy rain. During this season, fishers are engaged in agriculture.

Table 1. Basic Data of Sub Districts; Population, Household and Ratio of Farmer and Fisher (2016)

Name of Desa	Location	Population	Household	Farmer families	Fisher families
Tolango	coast, mountain	1,987	507	80%	13%
Danbaro ^a	coast, mountain	900	240	80%	20%
Jembatan Merah	coast, mountain	1,013	297	60%	40%
Bubode	mountain	1,006	294	100%	0%
Leawo ^b	mountain	600	160	90%	0%
Bolango	coast, mountain	787	205	60%	30%
Molantadu ^c	coast, mountain	1,000	300	30%	70%
Mutiara Laut	coast, mountain	500	139	10%	90%

^{a, b, c} Estimation by chiefs of sub districts

3.2. Agricultural and fishery activities

3.2.1. Agriculture.

Farmers cultivate two corn crops and one rice crop each year, and all crops are cultivated on the same farm or paddy field. The cultivation period for each crop is 4 months. During the rainy season (January to April) water is available for irrigation, so rice is cultivated in the paddy fields. In the dry season, when less rainwater is available, corn crops are cultivated from May to August and from September to December.

However, the growing periods are variable. If farmers can get water in the dry season they cultivate rice paddies year round (Figure 3). In areas where upland rice grows well, such as Desa Jembatan Merah, cultivation commences in October or November, because upland rice needs a growth period exceeding 5 months. The farms are mostly small (less than 1 ha), and typically 1 – 3 km or more distant from the farmer's house.



Figure 3. Even if dry season, if farmer can draw enough water to paddy, they can cultivate paddy every season. Because sell price of rice is more expensive than maize, farmers want to cultivate paddy. This picture is paddy and irrigation at Desa Bubode in Dry Season, August 2016.

Farmers save rice and corn seed from their own crops, or they buy seed from neighboring farmers. Therefore, all seeds are native species, first filial generation seeds have not introduced. Farmers apply 300 kg/ha of chemical fertilizer for rice paddy cultivation and 225 kg/ha for corn cultivation. Some years ago fertilizers was provided by the kabupaten, but now farmers buy fertilizer from retail stores. The fertilizer price ranges from 200 to 300 rupiah/kg. Farmers also apply insecticides three times prior to harvest.

Each desa has a tractor provided by the kabupaten. And all farmers in the desa share its use. The desas operate on a mutual aid system for planting and harvesting of rice. Among collaborating groups of farmers, all members of the group helping in the cutting of grass.

The rice production is typically 2,000 kg/ha and for corn is 3,000 – 7,000 kg/ha. Farmers sell the crop production to brokers at a price of 8,000 – 10,000 rupiah/kg for rice and 2,000 – 3,150 rupiah/kg for corn. These prices are 200 rupiah/kg lower than the market price. Because brokers contract with farmers, farmers have to sell to brokers.

3.2.2. Fisheries.

Most fishers use traditional fishing boats (Figure 4). In Kabupaten Gorontalo Utara there are only three vessels equipped to wrap nets; these vessels are based at Kecamatan Kwandang. Traditional style boat can carry a maximum of three persons, but generally carry only two fishers. They leave from a bay or port late in the day or in the evening, and go offshore approximate 5 km, returning in the early morning. Fishing by hand only, nets are not used. Caught fish are stored on ice on a small boat until they return to the bay/port. From December to January there are strong westerly winds and fishing is not possible. During this period the fishers are usually engaged in irrigated agriculture based on rainfall.



Figure 4. Fishers use traditional small boat with 2 outriggers and outboard motor. They leave from bay or sandy port at evening and come back early morning. They fish only hands with fish line. This picture is fisher's boat leaving from Kwandang bay, August 2016.

Fishers catch approximately 10 kg/boat of fish on each fishing trip. The fish are sold to brokers at 30,000 rupiah/kg, which is 20,000 rupiah/kg less than the market price. Fishers need 100,000 rupiah for each fishing trip to cover the costs of fuel (6 L), food, drink, and cigarettes. As an initial investment, 7 million rupiah is needed for the purchase of a boat, and 5 million rupiah for a 9 horsepower engine or 3.6 million rupiah for a 5 horsepower engine.

In Desa Tolango, fishers harvest and sell seaweed, which is cultivated at sea on long ropes supported by floats. After 2 weeks the seaweed is harvested, dried on nets on the coast, then sold to brokers for 12,000 rupiah/kg. The brokers sell the dried seaweed for export to Hong Kong.

In the past, fishers used dynamite fishing based on bombs made from car parts; the explosions kill the fish, which rise to surface. Some fishers from another area were killed, so it is now prohibited by government.

3.3. Economic situation of farmers and fishers

3.3.1. Income and costs.

From the above it is possible to estimate the economic situation of farmers and fishers (Tables 2 and 3). The approximate farmer income is 15 – 28 million rupiah/year. Because the price of their produce varies each year and farm size differ, farmer incomes differ. The yield is different year by year, the income of farmers is hard to be stable.

The approximate fisher income is 51 million rupiah/year. Fishers have higher incomes than farmers, but have to pay for the initial investment in boats and engines, and ongoing maintenance.

Forestry is not undertaken because the forests do not have roads, so transporting the cut timber is not possible. Consequently, most workers are farmers and or fishers, and depend on these activities for income to support their families.

Table 2. Basic Data to Calculate farmer's Economy

Statistic data of Kabupaten Gorontalo Utara ^a		Agricultural basic units ^e	
population	109,502	amount of rice production	2,000kg/ha
average of household size ^b	4.18	amount of maize production	3,000 - 7,000kg/ha
number of household ^c	26,197	sell price of rice	8,000 - 10,000rupiah/kg
percentage of farmer	57.2%	sell price of corn	2,000 - 3,150rupiah/kg
number of farmers ^d	14,984	fertilizer (rice)	300kg/ha
rice field area	8,930ha	fertilizer (maize)	225kg/ha
farm paddy area	2,247ha	price of fertilizer	20 - 30rupiah/kg
corn area	9,054ha		

^a Data of 2014 from "Badan Pusat Statistik Kabupaten Gorontalo Utara, 2015"[5], except average of household size.

^b Data of 2010.

^c Estimation by population and average of household size.

^d Estimation by household and percentration of farmer.

^e Data based on interview of 2016.

Table 3. Estimation of the Income and Outcome of Farmer and Fisher

Farmer	
(1) Income	
management area of rice	0.75ha
management area of maize	0.60ha
amount of rice products	1,500kg/year
amount of maize products	1,800-4,200kg/year
income of rice (minimum - maximum)	11,936,000 - 14,920,000rupiah/year
income of maize (minimum - maximum)	3,600,000 - 13,230,000rupiah/year
total income(minimum - maximum)	15,536,000 - 28,150,000rupiah/year
(2) Outcome (fertilizer)	
consumption to rice	300kg/ha
consumption to maize	225kg/ha
buy price of fertilizer	200 - 300rupiah/kg
total outcome(minimum - maximum)	72,000 - 108,000rupiah/year
(3) Deduction (minimum - maximum)	15,464,000 - 28,042,000rupiah/year
Fisher	
(1) Income	
fish catches	10kg/day
fishing days	270days/year
sell price of fish	30,000rupiah/kg
total income	81,000,000rupiah/year
(2) Outcome	
fuel, meal, drink and cigarette	100,000rupiah/day
total outcome	30,000,000rupiah/year
(3) Deduction(minimum - maximum)	about 51,000,000rupiah/year

Data from Table 3 and based on interview of 2016.

3.3.2. *Support Systems.*

Increasing crop harvests and fish catches, and stabilizing incomes, are the major issues for farmers and fishers. Even minor improvements are beneficial, and some have already been introduced.

Support for agricultural activities has sometimes been provided by the kabupaten. For example, Kabupaten Gorontalo Utara built irrigation systems at Desa Bubode in 1974 and 1990. The system built in 1974 is near the center of desa, and **that** built in 1990 gets water from 1 km further up the catchment. These systems supply water to the rice paddies throughout the year, and are managed by the kabupaten.

Kabupaten Gorontalo Utara also provides tractors to the desas. Kecamatan Tomilito has approximately 100 desa and each desa has a tractor. Until these were provided, farmers used cows for cultivation, but this process process has become markedly easier with the availability of machinery.

Furthermore, the supply of fertilizer in the past was a kabupaten policy. The size of agricultural harvests and fish catches depends on the weather. The kabupaten also runs technical improvement programs to help stabilize incomes. Support by the kabupaten is important for farmers and for agricultural development.

Although support from the kabupaten is necessary and provided, farmer incomes vary each year. In 2015, the income situation for farmers was the worst in recent years because of a slump in the corn price; e.g., in that year a farmer could receive 500,000 rupiah for a corn harvest of 30,000 kg, corresponding to a unit sale price of only 17 rupiah/kg, or 1/120th of that expected in an average year. Because of this crisis the local government assisted farmers to buy fertilizer in 2015, and undertook to support the purchase of corn and rice seed in 2016.

3.3.3. *Other approaches.*

Under conditions of income instability, the absence of support from the kabupaten, and or if an unpredicted crisis occurs, farmers and fishers face difficulties. If a bank finances 5 million rupiah over 6 months, the amount to be repaid is 5.2 million rupiah. For a farmer who makes 1.3 million rupiah/month income, repayment at this rate is not possible. Other income sources include factory work for 20,000 rupiah/day, expatriate labor to Kota Gorontalo, and load progressing duties in the large port at Kecamatan Angrrek for 70,000 rupiah/day. People can obtain employment planting and treating trees, but the income is less than that for other jobs. If a farmer's income was insufficient and he sold his 3 ha corn farm for 50 million rupiah, even if his economic situation stabilized, the price of the farm would have increased, making it is very difficult to buy back. If he wanted to work in agriculture again he would need to clear the forest and make a new farm.

The income of farmers and fishers is low and unstable, so to escape economic poverty they must break out of this situation.

3.4. Opportunities to increase incomes

To improve income it is necessary to adopt technical innovations, particularly those not requiring major environmental change.

With respect to a agriculture, it is necessary to diversify crops production beyond just rice and maize. At present If the one or both crops fail there is no alternative crop or jobs to supplement the family budget. This problem is weather-dependent, and not a major issue in the rainy season. However, if water is not available in the dry season, which occupies half of the year, crops resistant to drying are needed. In the dry season the kabupaten supplies water for household use every 3 days, but there is not enough to supply water for agriculture.

With respect to fisheries, the current methods, boats, and materials are traditional, thus limiting fish catches to approximately 10 kg per fishing event. If fishery resources are abundant, the introduction of fish traps or seining will effectively increase fish catches. This may necessitate building ports, using larger boats or ships, introducing traps or nets, and learning associated techniques. How such changes could be progressed is a future problem. However, traditional methods have only small environmental impacts, so introducing new methods will require careful assessment to ensure their introduction does

not lead to overfishing. It is essential that consensus on such changes is reached among fishers and local people. Whatever innovations are proposed, it is essential to remember that the traditional method has maintained the environment in good condition. These considerations are necessary in deciding whether or not to introduce innovations or change methods.

A common issue in agriculture and fisheries is the need to strengthen food processing capacities. The food processing industry is adequate but local communities do not have a custom of food processing. There is little preserved food used in everyday meals. Rice with grilled or fried fish, chicken, egg, and vegetables is the staple food, and is available year-round because of climatic consistency. Unlike cold countries, where crop cultivation may not be possible for more than half the year, food preservation in this area is not necessary, and it is unlikely that the population of Kabupaten Gorontalo Utara has knowledge of preserving products and techniques.

It may be possible in rural areas to develop alternative industrial economic subsystems other than agriculture and fisheries. For example, Kerawang, the traditional embroidery in North Sulawesi, is produced by female workers, usually in the houses of farmers and fishers. It is currently made and distributed locally, but there is possibility of developing a souvenir market by developing the skills associated with producing Kerawang. In Kabupaten Gorontalo Utara in 2014, the percentage of males involved in economic activities was 74.8%, but for females was only 46.8% [6]. It may be possible to promote manual industries more extensively.

The above highlights the importance of introducing innovations in food processing and other industries, in addition to improving the conditions for farmers and fishers. The activities of women should also be promoted, as they have important potential roles in rural development.

4. Possibility of pearl farming

4.1. Environmental conditions

One potential industry to develop while minimizing environmental impacts is pearl farming. Assessing the best locations for pearl farming requires considerations of the marine environment, climatic and geographic conditions, the effects of soil erosion (especially from agriculture), and the connections among mountainous areas, farms, paddy fields, rivers, and the sea.

A pearl farming company operated over a 12-year period at Kecamatan Anggrek and Kecamatan Tomilito (Kabupaten Gorontalo Utara), demonstrating the potential for pearl farming in this area. Interviews with fishers indicate that red tides of harmful phytoplankton, which can cause pearl shells mortality, have not been occurred in the sea, suggesting it is a suitable environment for the growth of pearl shells. The water depth for pearl farming must be less than 50 m because at greater depth it is difficult to anchor the ropes and nets to the bottom. Figure 5 indicates that most of the sea area within 3 km from coast (to the red line) has appropriate topography.

Wind has the biggest influence on pearl farming. From May to October weak winds blow from the south, and the wave height is approximately 1 m. From November to April, strong winds, sometimes with rain, blow from the west and the wave height is usually 3 – 4 m, which can impact 20 m inland from the shoreline. Fishers cannot work in December and January, when the waves are particularly high and offshore waves are higher than on the coast. The waves near the coast are not usually high, but soil erosion and transport by rivers to the coast be significant.

As much pearl farming occurs at sea it is important to select places where the effect of west winds is least, including areas in the lee of mountains or islands. However, the direction and force of winds can vary from place to place, so each potential site must be individually assessed.

Although little soil erosion occurs during the dry season, erosion is likely to increase during the rainy season. It is thought that there is little erosion from flat rice paddies and small areas cultivated using traditional methods, but erosion from farms on sloping land is potentially more serious. Upland rice and corn crops are commonly planted in these areas, so detailed investigations are necessary if new technical innovations are introduced in those areas.

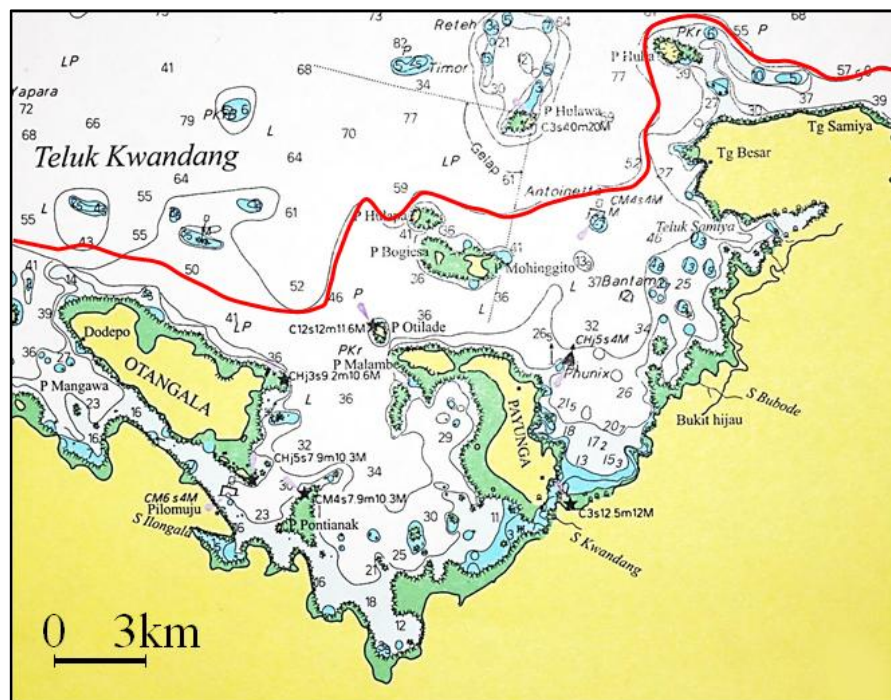


Figure 5. Depth of Sea Around Research Area [7]

4.2. History of pearl farming

Although the coastal waters of Kabupaten Gorontalo Utara are suitable for Pearl farming, the only pearl farming cased operation after 12 years. To establish the reasons, we interviewed laborers involved at that time.

4.2.1. Japanese pearl farming in Kabupaten Gorontalo Utara.

Japanese pearl farmers operated a pearl farming in Kabupaten Gorontalo Utara from 2001. They are considered the pioneers of pearl farming in this area. This case must be examined when considering the possibility of reestablishment pearl farming.

In 2001, MADOKA company established a peark farm at Desa Tolango (Kecamatan Anggrek, Kabupaten Gorontalo Utara), prior to which the company had operating at a different location. The company involved 3 Japanese people, 12 technicians from Kota Gorontalo, and 25 local fishers from Desa Tolango. The principal members were Japanese, and included the general manager, his son, and a pearl farming technician. All staff lived in a house approximately 3 m above the sea level (Figure 6). The house and workshop were built on many pillars on a very small sandy island.

From 2002 to 2003, a satellite farm knowns as MARIA at Desa Mutiara Laut. This location provided good condition for rapid shell growth. There were 15 laborers, most of whom were from Kota Gorontalo; only 3 people were locals. They floated ropes in the sea to which were tied many shell nets. Sometimes the propellers of fishers' boats cut the ropes as the boats passed the pearl farm area. Consequently, army were introduced to keep people away from the pearl farm, resulting in local fishers having to detour to reach their fishing grounds and neighboring ports. After 2 years, the guarding ceased, opposition to the activities at MARIA grew. The pearl farmers abandoned the MARIA operation; they harvested pearl products twice over 2 years, but ceased operations in 2003.



Figure 6. House and Workshop of MADOKA

The company investigated other suitable places for pearl farming prior to abandoning the MARIA operation. Farming was attempted at Kecamatan Boroko (Kabupaten Bolaang Mongondow Utara, Propinsi Sulawesi Utara), but operations were soon discontinued as dynamite fishing was still occurring there.

In 2004, the aging general manager returned to Japan, but his son continued management of MADOKA. However, in 2013 they ceased all operations in Kabupaten Gorontalo Utara, and MADOKA moved to Kecamatan Marisa (Kabupaten Pohuwato, Propinsi Gorontalo). The first general manager and his son now live in Japan, and MADOKA is operated by another Japanese group.

4.2.2. Pearl farming process.

The general manager bought shell seedlings at Kabupaten Kupang (Propinsi Nusa Tenggara Timur), and staff bred them over 3 months. The shells were then separated to achieve 16 shells in each box, and pearl core was inserted into each shell. This was done only by Japanese staff, because it is a very delicate process and requires a high level of proficiency and technique. Next, eight shells were placed into each net, and the nets were tied to branch ropes 3 m in length. A main rope floating on the sea surface had branches to which the nets were tied. A single main rope had 250 nets attached, and the main ropes were tied to a raft in the sea. Each raft had 25 main ropes and MADOKA managed 9 rafts. Based on the above, they were growing 450,000 shells in total.

To grow the shells, the nets were taken to MARIA at Desa Mutiara Laut, where there were 3 rafts, each of which had 10 main ropes (each 100 m long) in parallel and 10 m apart. Therefore, the pearl farming area occupied 3 ha on sea surface. Each main rope had 20 branch ropes with net which was attached to the tip of rope. The shells at MARIA were bigger than those at MADOKA, and the number of shells was different in each net. Nets were hung at various depth in the sea, including at 3, 5, and 7 m. The distance between ropes was 5 m. The distance between nets was wide because larger shells need access to more plankton.

At both MADOKA and MARIA, parasitic animals that attached to the surfaces of the shells were removed using grinding machine. This was main task, with laborers spending 20 days each month on this activity; on the other 10 days they repaired nets and ropes. One year after the core had been inserted, the shells were removed from the sea to harvest the pearls. For pearl farmers starting new operations, typically more than 1 year is required for pearls to develop, but at MADOKA pearl products were obtained in the first year, and every 3 months subsequently.

4.2.3. Situation of local laborers.

Local laborers at MADOKA were employed part-time. The wage of local laborers followed these local minimum wages. They were provided with meals and drinks in addition to wage. People from Kota Gorontalo who had training in pearl farming techniques could obtain higher wages.

The laborers at MARIA were locals from near the pearl farming area, but because the farm was some distance from their homes, they couldn't return home every day or even weekly, in addition, they were only given 3 days off every 2 months. Their wage was 400,000 rupiah/month, plus meals and drinks, which is very low. The possible reasons for the manager paying such low wage include that the work was simple and required little technique (laborers washed shells for 20 days and repaired ropes for 10 days a month), that the laborers didn't need to pay for anything when at the farm and their basic needs (shelter and foods) were supplied. However, this type of employment does not encourage development of industry because no local people learnt the techniques needed for pearl farming and pearl production, or developed management skills. In actuality, most laborers were never taught the difference between pearl products and the pearl core.

The working conditions were also very severe. Time management was strictly overseen, and laborers were not allowed to talk or smoke while working. This is very different from the customary work style of the local people.

4.2.4. Relationships with the local Communities.

Conflicts occurred between local people and MADOKA staff. Unfortunately, the MADOKA company did not provide any support for the communities or local people, and cooperated only with the desa and local government officials until the time that their operation ceased. Furthermore, the activities of fishers who made their living harvesting seaweed were disturbed by the MADOKA guards. Consequently, many local people refused to work for MADOKA.

In addition, the manager at the MARIA site did not communicate adequately with local people or members of the desa, and there was an attack on the MARIA site after the guards left the farm area, making reconciliation impossible.

Despite these problems, pearl farming has not been rejected. Local people, chiefs of the desas and mayor of the kabupaten hope that if pearl farming is re-established it may be beneficial for the local community. When MADOKA was in operation it bought 4,000 kg rice per year, and bought economic benefits to local shops, machine repairs, and schools, as well as to the laborers and their families.

While it is clear that a new pearl farming company would need to cooperate with the local people and community, the latter also benefit directly or indirectly from the activities if the company.

There are various reasons why the MADOKA and MARIA pearl farms ceased operating. Local people said that they did not get sufficient benefit, and that the new manager (the son of the first general manager) failed to cooperate with the locals, and failed to form a good relationship with local people and communities.

5. Conclusions

In Kabupaten Gorontalo Utara it is possible to develop innovate agriculture and fishery techniques or establish new business to help solve issues of economic poverty. One alternative business opportunity is pearl farming, which can provide many advantages for the area.

In tackling the problem of poverty by establishing a new industry, it is important to first address any social issues that may arise. To avoid conflicts such as those associated with the operation of the MADOKA pearl farm, a major focus must be on communication with local people, the desa, and the kecamatan and kabupaten. The company manager and community leaders are required to support the laborers, as well as the farming and fisher communities where the activities are located. This is an extremely common issue that is not restricted to pearl farming.

When we discussed with local people and government officials the possibility of reintroducing pearl farming in Kabupaten Gorontalo Utara, the reaction was generally positive; however, they do not need confliction from unilaterally way.

This study comprised only basic research. We will next need to undertake detailed investigations to establish whether pearl farming can be operated in sustainable way. To assess its potential, trans-disciplinary approach is needed to address the following issues.

Clarification of the conditions necessary for growing pearl shells, and assessment of its environmental sustainability.

Approaches to balancing pearl farming development while maintaining environment conditions.

Ensuring management of pearl farming occurs through establishment of good relationship with local people.

Ensuring laborers receive fair wages, consistent with those received by farmers and fishers.

If these issues can be resolved it may lead to the development of pearl farming as one way to address poverty problems in this area.

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