Eight natural treasures of Aceh Jaya, Province of Aceh

Y Christian¹*, A Afandy¹ and Desmiwati²

¹Center for Coastal and Marine Resources Studies (CCMRS) Bogor Agricultural University, Jl. Raya Pajajaran No. 1, Baranangsiang Bogor 16127, Indonesia
²Forest Tree Seed Technology Research & Development Center (BPPTPTH), Ministry of Environment and Forestry of Indonesia, Jl. Pakuan Ciheuleut, Bogor 16129, Indonesia

*Corresponding author: lakulintang@gmail.com

Abstract. The coastal regency of Aceh Jaya has great potential resources in marine and fisheries, agriculture-plantation-animal farming, forestry, minerals-mining, tourism, processing industry, and renewable energy. However, significant challenges arise regarding selecting these potentials with the principle of sustainability: encouraging economic development, being accountable and socially accepted, and having an ecological perspective as a short to medium plan to accelerate economic growth. This study has identified the leading sectors with the most potential resources for the basis of development priority of Aceh Jaya nearly two decades after the 2004’s tsunami. The research was conducted in nine districts in Aceh Jaya Regency. Data is processed through Market Analysis, Gap Analysis, Stakeholder and Institutional Analysis, and Sectoral Analysis. These analyses identified eight sectors with each superior product for the development acceleration of Aceh Jaya. Those sectors and the products are agriculture (rice), capture fisheries (tuna, skipjack, mackerel tuna, and crustacean), aquaculture (giant-tiger prawn, tilapia, and lobster), animal farming (cattle, buffalo, goat, duck), forestry (agarwood, dragonblood, and rattan), tourism (Geureutee, Reusam Island), mineral (coal), industry (prawn cracker, shredded catfish, soybean, patchouli oil, and biogas).

Keywords: Aceh Jaya; coastal development; economic acceleration; natural resources

1. Introduction
Aceh Jaya Regency facing the Hindian Ocean and its west coast experienced massive earthquake and tsunami affecting various aspects in 2004 [1]. Nearly two decades after Aceh Jaya still struggle to find the best strategy to build their economy without reducing the capacity to face the potential future disaster [2]. Coastal livelihoods from marine and terrestrial were not designed for a long-term plan [3], while not all agriculture and aquaculture were able to be recovered after a decade [4]. However, along with the coastal rehabilitation the coast of Aceh has been indicating in a positive development either on mangroves [5], fish [6], shellfish [7], and on the institutional aspect of coastal co-management [8].

Aceh Jaya Regency has nine districts, 172 villages, and 34 small islands [9]. Out of the nine districts, eight have coastlinesthat are prone to tsunami and abrasion, strong winds, and tidal waves [10]. Aside from direct risk from the sea, the large river near the estuary also affects the river by sea dynamics. A flood occurs almost every year where the Krueng Raya river overflows, including on Pasie Raya, the only district without a coastline. In 2016, 130 villages were identified prone to flood, 172 villages prone to earthquakes, 66 villages prone to tsunamis, 64 villages prone to landslides, 28 villages prone to strong winds, and 22 villages prone to fire [11, 12].

Geographically, the Aceh Jaya coastline is 156 km, where many residential areas are built. The coast is also the primary access to the Banda Aceh-Meulaboh, as well as the economic and governmental activity centers. Thus almost all essential activities are in disaster-prone areas. In addition to low coastal topography, Aceh Jaya varied with hills, river basins, and mountains. The altitude variations are in the 0-2000 meters above sea level (masl), but the dominant area is 0-100 masl [13].
The population of Aceh Jaya until 2016 was 87,622, composed of 51.90% male and 48.10% female. The age distribution is dominated by young as much as 47.71% aged between 25 and 29. It indicates the enormous potential of human resources as productive labor in various sectors. But in reality, the poverty data in Aceh Jaya in 2016 was recorded at 15.01% or around 13,100 persons below the per capita poverty line per month of IDR 331,940.00 [14], which means that the significant potential of human resources did not get the adequate work field or excluded from the regional development.

The Aceh Jaya Gross Regional Domestic Product (GRDP) 2012-2016 by business field showed an upward trend. The agricultural sector (agriculture, animal farming, estate, and fisheries) was the most significant contributor to 31.65%. The procurement sector, such as accommodation, electricity, gas, water, services, waste management, were the minor contributors, only 0% - 0.8%. However, the agricultural sector’s contribution from fisheries is only 2.37%, despite Aceh Jaya having a long coastline and vast waters. Mining was relatively declining, and the sectors that also contributed to GRDP were the construction sector (15.02%), government administration (12.10%), trade (10.57%), and transportation (9.5%) [14]. Compared to other regions in Sumatra Island in 2016, Aceh Jaya was slow despite experiencing positive growth since 2013 (3.2 in 2013, 3.69 in 2014, 3.89 in 2015). In 2016 the growth rate of Aceh Jaya reached 4.06%. This position was relatively low as the growth of Aceh Province, which was only 4.3%.

The product or commodity management has not been optimized to finance regional development. Aceh Jaya’s economic growth rate is still low, the poverty is statistically still dominant, and the Human Development Index (HDI) is categorized as Medium despite tending to increase (67.70 in 2016 and 68.97 in 2017). It has not been changed from the conditions in 2013, where the average HDI of the western Aceh region was 68.71 [15]. The correct action is still needed to accelerate economic development, improve welfare, reduce poverty, and increase the human development index.

The study came with two questions: 1) What are the leading commodities as a development priority based on the existing conditions and supporting facilities? 2) What are the challenges to accelerate
commodities production? The answer to these questions shall be the input for the policymaker of the Aceh Jaya Regency to accelerate economic development and any actors concerned with regional development and natural resource management.

2. Material and method

The study area covered nine districts and 172 villages (see figure 1) in field surveys using rapid assessment. Retrieval of data and information during research was using four ways. First, focused group discussions in nine districts by inviting formal and religious institutions. The second method was observation and in-depth interviews. In this second method, the sampling unit used the stratified random sampling method based on three types of area: coastal village, lowland village, and highland village. The total sampled village were: 3 type x 2 villages x 9 districts, so that a total of 54 villages out of 172 villages in Aceh Jaya; The third method was extracting secondary data from statistics, official/agency/unit documents, and administration of Aceh Jaya. The last process was by conducting discussions with the local government of Aceh Jaya Regency. The event aimed to verify, correct and add information relevant to the completion of this study. These findings were then analyzed using six analysis tools: market chain analysis, gap analysis, project planning analysis, stakeholder analysis, sectoral analysis, and environmental carrying capacity analysis.

3. Result and discussion

The nine sectors related to the utilization and natural resources management of coastal area of Aceh Jaya Regency are agriculture, capture fisheries, aquaculture, animal farming, forestry, tourism, mineral resources, renewable energy, and natural resource-based industries. These nine sectors are potential resources that may be developed sustainably and based on local resources.

3.1. Agriculture sector

Agriculture was contributing 31.65% of Aceh Jaya’s GRDP in 2016. This contribution was the largest compared to other sectors. This situation was relatively not changed in the last five years. The most potential commodities from the agricultural sector are divided into three categories: 1) Food crops such as rice and secondary food crops (corn, cassava, sweet potato, soybean, groundnut); 2) Horticultural plants such as fruits, vegetables, ornamental plants and phytopharmaca plants; and 3) Industrial estates crops such as rubber, oil palm, coconut, cocoa, coffee, and patchouli.

The list above arises from various variables either land suitability, existing planting area, productivity, relative resistance to pests and diseases, production percentage of GRDP, favorable for the farmers and the community, storability or ease of distribution, the ease of market, the unit price per

| No. | District    | Area (hectares) | Production (tons) | Average Production (tons/hectares) |
|-----|-------------|-----------------|-------------------|------------------------------------|
|     |             | Planted Yield   |                   |                                    |
| 1   | Teunom      | 558 1,544       | 633               | 4.1                                |
| 2   | Panga       | 1,019 1,248     | 649               | 5.2                                |
| 3   | Krueng Sabe | 1,045 687       | 2,611             | 3.8                                |
| 4   | Setia Bakti | 1,229 841       | 3,532             | 4.2                                |
| 5   | Sampoiniet  | 413 439         | 18                | 4.1                                |
| 6   | Jaya        | 2,312 2,561     | 16,134            | 6.3                                |
| 7   | Pasie Raya  | 1,118 794       | 3,097             | 3.9                                |
| 8   | Darul Hikmah| 1,102 1,015     | 406               | 4                                  |
| 9   | Indra Jaya  | 718 705         | 4,301             | 6.1                                |
|     | Total       | 9,514 9,834     | 48,354            | 4.9                                |

Source: Aceh Jaya in Figure, 2014 [16]
weight, and compliance with central government programs. The average rice production in each district was still at 4.9 tons/hectare, but it can increase productivity. The detail of productivity of agriculture is presented on table 1 above.

Apart from rice, Aceh Jaya also has another agricultural commodity. Secondary food crops is a commodity that has excellent potential as leading commodities for economic acceleration. Judging from the five variables, in table 2 is a list of potential secondary crops commodities in Aceh Jaya Regency.

Based on five indicators: existing planted area, total production, price, government support, and storability, soybeans (Glycine max) are a commodity that has the most significant supporting variable along with corn (Zea mays) as a food commodity to drive the economy. Other commodities have relatively more minor supporting variables as accelerating commodities.

The most potential horticulture crops to be developed as an acceleration of the local economy are pomelo (Citrus grandis), tangor (Citrus nobilis), and watermelon (Citrullus lanatus). The selection was based on consideration of the variables of farmer cultivation capacity, market capacity, storability, durability during distribution, and profit levels. Use the same reference above, the leading commodities from the vegetable crops category are red chili (Capsicum annum) and cayenne pepper (Capsicum frutescens).

In the category of estate crops, oil palm, coffee, and patchouli are the three most leading commodities for accelerating economic growth because of price stability, market capacity, farmers’ readiness, and the level of profitability of these three commodities shows the highest level. These three commodities are not susceptible to disease compared to other entities such as cocoa.

3.2. Capture Fisheries

The number of fishers registered in Aceh Jaya Regency was 2,342 individuals, while the number of fishers business association were 78 groups in all district except Pasie Raya. Sampoiniet and Setia Bakti districts have the highest number of fishers and the number of fishers associations. The detail number of fishers in Aceh Jaya can be seen in figure 2.
There are two facilities for capture fisheries in Aceh Jaya Regency: One Fish Landing Base in Krueng Sabee District and Fish Auctions Site in seven districts. The auction site is distributed into one unit in Jaya, two units in Indrajaya, four units in Sampoiniet, one unit in Darul Hikmah, two units in Setia Bakti, one unit in Panga, and one unit in Teunom.

Aceh Jaya’s capture fisheries production in 2014 was 4,590 tons with a production value of IDR 584.8 billion. The fisheries commodities consisted of 69.9 tons of tuna, Spanish mackerel 132.5 tons, mackerel tuna 929.07 tons, trevally 398.05 tons, grouper 356.5 tons, snapper 444 tons, pomfret 225 tons, 61.4 tons of rays, 77 tons of sharks, 16.03 tons of squid and 397 tons of other fishes. The shrimp category consists of 118.2 tons of banana shrimp, 327 tons of giant-tiger prawn, and 969.5 tons of lobster.

Several types of fisheries commodities in Aceh Jaya Regency have high economic value and are internationally traded: tuna, mackerel tuna, grouper, snapper, pomfret, banana shrimp, giant-tiger prawn, and lobster.

3.3. Aquaculture

Aceh Jaya’s aquaculture consists of three types: freshwater, brackish water, and marine. In 2014, freshwater aquaculture was 259 hectares, 672 hectares of brackish water, and 48 units of marine culture with floating cages. The number was the end of the shrinking number of cultures in previous years. Districts that have ponds are Jaya, Indra Jaya, Sampoiniet, Darul Hikmah, and Setia Bakti. Generally, ponds were used to cultivate giant-tiger prawn and vannamee shrimp, milkfish, and mangrove-crabs. However, many ponds were abandoned and became marsh and bushes despite the vast open development opportunities.

From measurements based on indicators of resource availability and regional superiority, suitability of the location and environmental support, the ability and willingness of local communities, as well as market absorption opportunities and the compliance with national programs, there are three most potential aquaculture opportunities for Aceh Jaya, namely tilapia, giant-tiger prawn, and lobster enlargement. Tilapia (Oreochromis niloticus) is the most dominant product for freshwater aquaculture, relatively easy to care for and broad market-oriented compared to catfish or carp. Up to 2014, the production value reached 21.7 tons with a value of IDR 241,000,000.

The giant-tiger prawn (Penaeus monodon) commodity in Aceh Jaya shows a difference to national production. If nationally, production of giant-tiger prawn decreases, but in Aceh Jaya, on the contrary, increased from 45 tons in 2012 to 54 tons in 2014. Aceh is a natural habitat of giant-tiger prawn, thus becoming a national supplier of giant-tiger prawn’s broodstock. In addition, because giant-tiger prawn broodstock used are endemic species, the endurance and adaptation to the environment are outstanding. The contribution of giant-tiger prawn was quite significant in national shrimp exports [17].

![Figure 2. Number of capture fishers in Aceh Jaya regency by 2014 [19] (BPS 2015).](image-url)
There are four types of lobster (*Panulirus spp.*) in Aceh Jaya waters: green lobster (*Panulirus versicolor*), scalloped spiny lobster (*Panulirus homarus*), ornate spiny lobster (*Panulirus ornatus*), and pronghorn spiny lobster (*Panulirus penicillatus*). Some of the existing locations for lobster enlargement

| No. | District        | Paddyfield (Ha) | Community estate (Ha) | Grazing area (Ha) | MPLA (AU) | MPHH (AU) | Real Ruminant Population (LU) | Capacity for increasing the ruminant population (HH) |
|-----|----------------|-----------------|----------------------|------------------|-----------|-----------|-------------------------------|-----------------------------------------------|
| 1   | Jaya           | 2,287           | 4,669.5              | 215              | 6,673     | 10,495    | 1,374                         | 4,299                                         |
| 2   | Indra Jaya     | 770             | 3,285.5              | 575              | 3,532     | 5,273     | 511                           | 3,021                                         |
| 3   | Sampoiniet     | 1,183           | 5,253.5              | 280              | 5,289     | 5,090     | 760                           | 4,530                                         |
| 4   | Darul Hikmah   | 1,310           | 5,825                | 134              | 5,775     | 4,398     | 514                           | 5,261                                         |
| 5   | Setia Bakti    | 1,544           | 7,431                | 820              | 7,590     | 5,915     | 857                           | 6,733                                         |
| 6   | Krueng Sabe    | 1,677           | 7,245                | 212              | 7,244     | 11,750    | 689                           | 6,554                                         |
| 7   | Panga          | 1,605           | 6,823.5              | 380              | 6,933     | 5,808     | 1,151                         | 5,781                                         |
| 8   | Teunom         | 1,773           | 6,346                | 375              | 6,683     | 10,100    | 1,254                         | 5,429                                         |
| 9   | Pasie Raya     | 1,375           | 4,779                | 310              | 5,094     | 4,718     | 404                           | 4,691                                         |

**Note:**
- **MPLA:** Maximum production based on Land Availability
- **MPHH:** Maximum Production based on Farmer Household
- **A.U.:** Animal Unit
- **L.U.:** Land Unit
- **Ha:** Hectares

Source: Aceh Jaya in Figure 2014, Agriculture and Animal Husbandry Office 2014

**Table 5.** Leading non-timber forest product of Aceh Jaya Regency.

| No. | Commodity                  | Description                                                                 |
|-----|----------------------------|----------------------------------------------------------------------------|
| 1   | Agarwood resin (*Aquilaria malaccanensis*) | Agarwood is a type of wood containing resins with various shapes, colors, and distinctive aromas produced by trees or parts. It grows naturally or cultivated generally produced by *Aquilaria* spp. trees (Dephut 2003). Agarwood is formed from the infection process by pathogens or fungi into the trunks, whether by human intervention or naturally, so plants take defense mechanism by releasing phytoalexin. The most microbes or fungi that infect the trees for producing agarwood is *Fusarium* sp. The price of agarwood resin in Aceh Jaya Regency is IDR 53 million/kg (primary data 2017) |
| 2   | Dragonblood (*Daemonops draco*) | Dragonblood or locally called *Jernang*, is a resin that covers the fruit of *Daemonorops draco* species. The resin is bright red, covering the surface of the immature rattan fruit. Dragonblood is widely used for pharmaceutical and cosmetics raw materials, and the most used is for dyes. The availability of raw materials of rattan plants is wide in Aceh Jaya, spread in 12 villages and three districts, both growing naturally or from cultivation. Rattan that produces dragonblood fruit can be harvested from more than three years old trees and can be continued to 30-50 years later. |
| 3   | Rattan (*Calamus manau*) craft/furniture | Rattan raw material used for handicraft production in Aceh Jaya comes from the forest in the regency. There are seven rattan industries in the regency, with one of them having a production capacity ranging from 5-25 tons/week. The industry’s potential market is broad due to continuous demand from provinces in Aceh, Medan of North Sumatera, and Cirebon of West Java. The Rattan handicraft industry in Aceh Jaya is only found in Mon Mata Village, Krueng Sabe District. The industry is one of the most significant production in Aceh Jaya Regency. |

There are four types of lobster (*Panulirus spp.*) in Aceh Jaya waters: green lobster (*Panulirus versicolor*), scalloped spiny lobster (*Panulirus homarus*), ornate spiny lobster (*Panulirus ornatus*), and pronghorn spiny lobster (*Panulirus penicillatus*). Some of the existing locations for lobster enlargement
in sea waters using the floating cages in Aceh Jaya are Ujung Sudheng and Lhok Timon. Technically, in addition to the enlargement activity using the floating net media at sea, the enlargement cultivation activity can also be carried out inland using a cemented tank or fiber tub with mechanical circulation support [18].
However, some obstacles remained for lobster’s aquaculture: lobster commodities still rely on nature’s catches, the potential of juveniles in the wild is enormous but not yet utilized, lack of the technical abilities of aquaculture, there is no active and sustainable technical and financial assistance, and even if there is assistance, it is sporadic and not in a structured manner. If adequately managed, 3,872.70 km² terrestrial area and 104,527.74 hectares marine area along the 156 km coastline provide the large potential for aquaculture development, either freshwater, brackish water, or marine. The table 3 shows the total potential areas for Aceh Jaya’s aquaculture.

Freshwater has enormous potential for aquaculture with 7,211.7 hectares, followed by brackish water (4,158.8 hectares) and mariculture (170.7 hectares). Development of freshwater aquaculture may be based on wetland areas (freshwater swamps, lakes, rivers, springs, and land with high groundwater levels) and paddy fields. These areas are generally starting from 3 meters above sea level to the hills area.

3.4. Animal farming
In general, Aceh Jaya Regency has the potential to develop ruminants, namely cows, buffaloes, and goats. The districts of Sampoiniet, Setia Bakti, Krueng Sabee, Panga, and Teunom have massive potential for animal farming development. The extent of un-utilized land as a foraging area is essential in its development. The livestock raising system in Aceh Jaya uses an extensive system with a limited level of animal husbandry knowledge. Time allocation and attention to livestock are low, and farmers perceive livestock only as a tertiary livelihood and savings. As a result, the performance of livestock did not result in the best conditions. Livestock appears to experience emaciation, even though they appear healthy and have a good reproduction cycle. It indicates a lack of feed, but the nutritional balance seems quite good, as seen in cattle and buffalo.

For better performance of goats, this was likely due to the availability of adequate feed. The type of goat feed is more varied and does not depend on grass. In addition, the number of goats was less than cattle and buffalo in the same grazing area, so the competition for food was low.

Table 4 shows that Aceh Jaya Regency can develop a population of ruminant animals as many as 46,298 A.U. (animal units; one large adult ruminant). The increasing ruminant population per district is around 3,021 - 6,733 A.U. The highest capacity is Setia Bakti District, and the lowest is Indra Jaya District. The potential of existing land is relatively high. It is possible for the development of cattle, buffaloes, and goats. Land productivity is estimated to accommodate 1.5-2 A.U./hectare or 3-4 adult cattle using a grazing system. It will be even higher if intensive care applied with cattle is kept in cages and the making of introduced grass fields such as king grass (Pennisetum purpupoides) or nappier grass (Pennisetum purpureum) whose productivity is very high.

Most poultry in Aceh Jaya Regency were not well managed as a commercial sector, but ducks have opportunities as a leading commodity. Ducks are easier to maintain than other poultry and are supported by vast agricultural areas and high grain production. Duck rearing systems are usually semi-intensive. Starting from morning to afternoon, duck is traditionally released and herded in groups to the rice fields. Their presence will not interfere with the plants in the areas. Bran mixtures are often used as the main feed for the duck. Rice bran production in Aceh Jaya Regency ranges from 217 - 1,943 tons per year. The figure is obtained from the conversion of 12.04% of grain production.

3.5. Forestry
The forest area in Aceh Jaya Regency reaches 251,894 hectares consisting of 86,023 hectares of production forests and 165,871 hectares of protected forests. Forms of utilization consist of timber products (TFPs), non-timber forest products (NTFPs), and environmental services. The utilization of TFPs and NTFPs can be applied in production forest, while in protected forests, only NTFPs is allowed to use(Law No. 41 of 1999). However, since June 6, 2007, all forest areas in Aceh experienced a logging moratorium enacted under Governor Instruction Number 05/INSTR/2007. This instruction suspends logging activities throughout Aceh to restructure the Aceh Forest Management Strategy through reorganization, reforestation, and reducing deforestation. Forests in Aceh Province must be maintained.
at a minimum of 50 percent of the total area of Aceh as permanent forests both in side the (state) forest area and outside (state) forest area based on the Environment and Forestry Ministerial Decree.

The utilization of non-timber forest resources as a leading commodity is a consequence of the Aceh logging moratorium. The performance indicators are compiled, including land suitability, availability of raw materials and sustainability of products, market potential, mastery of technology and social capital, and production. These indicators indicate that the leading commodity is ecologically, technically, economically, and socially feasible. The leading three non-timber forest products of Aceh Jaya is presented in table 5. These three commodities meet development indicators and do not violate government forestry policies.

3.6. Tourism

There are three types of natural resource-based tourism in Aceh Jaya: marine tourism, mountain/hill tourism, and cultural/religious tourism. Based on the “5A” principle indicators, namely Activities, Acceptability, Accessibility, Amenity, and Area Developing Plan [19]. The two types of tourism can be developed as a stimulus for development and benefiting people of Aceh Jaya are marine/beach tourism and religious-based tourism. The potentials object is describer at table 6.

Out of six areas, two places are most superior for accelerating natural resource-based development, namely the Geurutee Beach, which can accommodate 910 people per day, and Reusam Island, which can accommodate 217 people per day. The picture and location can be seen in figure 3. Activities in both locations are pretty diverse, either in nature, beach sports, underwater, or lake tourism.

3.7. Mineral Resources

Aceh is one of the oldest locations of mineral exploration in Sumatra’s history.[20] Geologically, three types of rocks in Aceh Jaya have been identified: igneous rocks, metamorphic rocks, and sedimentary rocks.

Geologists’ exploration [21, 22] identified at least eleven economically valuable mining materials in Aceh Jaya, namely: Lead (Pb), Copper (Cu), Molybdenum (Mo), Magnetite (Fe₃O₄), Gold (Au), Pyrite (FeS₂), Manganese (Mn), Limestone (CaCO₃), Coal (CH₄), Uranium (U) and construction rocks.

Currently, thirteen companies have obtained a Mining Permit and distributed it in several areas (see figure 4). The allocated area of metal mineral mining is spread across all districts within the Aceh Jaya

Table 6. Potential tourism objects in Aceh Jaya Regency.

| No. | Type of object Nature | Common local name | Location | Facilities | Management        |
|-----|-----------------------|-------------------|----------|------------|-------------------|
| 1   | Beach landscape       | Geurutee Beach    | Babah Lee Village, Jaya District | -          | Unmanaged         |
| 2   | Beach landscape       | Lhok Geulumpang   | Lhok Geulumpang, Setia Bakti District | -          | Managed by regency’s government |
| 3   | Sea landscape         | Reusam Island     | Lhok Timon Village, Setia Bakti District | Quay and crossing boat | Managed by regency’s government |
| 4   | Beach landscape       | Pasir Saka Beach  | Jeumpheuk Village, Sampoiniet District | -          | Unmanaged         |
| 5   | Beach landscape       | Batee Tutung Beach| Panton Makmur, Krueng Sabe District | -          | Unmanaged         |
| 6   | Built Historical monument | Tomb of Teunerehom | Gle Jong Village, Jaya District | Road, mosque, gazebo | Managed by Village |

Source: Processed primary data 2017.
Regency. The 746.99 hectares mining area is located in Krueng Sabe District. Non-metal mining is spread out in all districts within the Aceh Jaya Regency. Rock exploitation areas spread on all districts (sandstones, dumping soil, river stones, and limestones). The coal mining area of 29,618.59 hectares is in Panga, Teunom, and Pasie Raya Districts. Radioactive mining areas spread in all districts as well as oil and gas.

Out of the variety of mining resources, only two are considered superior: gold and coal. It was based on four comparative parameters: the economic value in the short term, effect on regional gross domestic revenue, social impact, and impact on accelerating development. In Aceh Jaya, gold has been abundant and has long been mined. Therefore gold metal can be included as a superior mineral material while coal is very feasible to exploit as the primary commodity in Aceh Jaya. If produced on a large scale, coal can be used to supply Power Plant in Nagan Raya as the nearest location (75 km) with a total demand of 110,000 tons per month with calories ± 5000 µp calories/kg. The second potential is for exports to India because Aceh Jaya is located on the Hindian Ocean coast that can be directly connected to India, instead of further Japan and China. At the same time, the other option is for coal briquettes for household needs.

### Table 7. Indicators for the use of renewable energy.

| No. | Type                | Indicators                                                                 |
|-----|---------------------|---------------------------------------------------------------------------|
| 1   | Agricultural waste | • Location of crops cultivation (rice)                                     |
|     |                     | • Purpose of utilization: thermal or electricity                           |
|     |                     | • Type of utilization: individual or potential small industry              |
|     |                     | • Animal farming locations                                                |
| 2   | Biogas              | • Type of utilization: individual or potential small industry              |
|     |                     | • Purpose of use: electricity                                             |
| 3   | Hydro               | • Potential locations: slope, the width of the river                      |
|     |                     | • Distance from settlement                                                |
| 4   | Solar and wind      | • Availability of electricity network                                     |

Source: primary data 2017.

### Table 8. Aceh Jaya biomass potential.

| No. | Sub-sector     | Biomass source                  | Potential energy (in Mwe) |
|-----|----------------|---------------------------------|--------------------------|
| 1   | Agriculture    | cassava (liquid waste)          | 0.07                     |
| 2   | Animal farming | cows feces (biogas)             | 0.53                     |
| 3   | Estate crop    | oil palm (stem and branches)    | 38.85                    |
| 4   | Estate crop    | rubber (stem and branch)        | 0.54                     |
| 5   | Agriculture    | paddy straw husks               | 8.51                     |
| 6   | Estate crop    | coconut (fiber and shells)      | 0.09                     |
| 7   | Agriculture    | corn (stem and leaves)          | 0.22                     |
| 8   | Urban waste    | Urban waste potentials          | 0.35                     |

Source: Ministry of Energy and Mineral 2013.

3.8. New and renewable energy

Aceh Jaya’s energy supply is relatively dependent on North Sumatra’s 150 kV interconnection because 70% of the electricity supply comes from North Sumatra. The remaining 30% comes from diesel power plants in Teunom, Krueng Sabee, and Jaya Districts, although they are relatively expensive because based on fossil fuels. From the potential aspects, Aceh Jaya has alternative renewable energy from biomass, hydroelectric, solar, and wind who come with several indicators (see table 7). The biomass
potential based on The Directorate General of Renewable Energy and New Energy Conservation data (2013) shows how much potential alternative energy of Aceh Jaya [23] as shown in table 8.

Biogas, agricultural waste such as paddy straws, husks, and oil palm stem is an untapped potential in Aceh Jaya. Likewise, micro-hydro energy is from many rivers and solar and wind energy. However, it needs to be examined further regarding their economic and sustainability levels. Bio-masses from biogas, oil palm stem, or paddy’s husks remain superior for immediate development to support home or small-scale industries.

3.9. Natural resource-based processing industry

The development of small and medium industries in Aceh Jaya Regency from 2007 to December 2015 was increasing. The business units increased from 165 units to 455 units or 36.2% from 2007. The increase in business units is inline with active workers. It grows from 523 to 1378 people in 2015, or a 38% increase from 2007 [24].

Economic growth acceleration can be achieved by enhancing local natural resource-based industries such as agro-industry, fisheries, and forestry [25]. These industries can add value and competitiveness to the fishery, agriculture, plantation, animal farming, and forestry products [26, 27]. These sectors in Aceh Jaya are developed mainly by small industries that are strategically able to connect the agriculture and non-agricultural sectors and bring up other services and trade businesses. In Aceh Jaya, generally, there are two types of natural resource-based industries: the agro-industry and the food industry.

**Table 9. Natural resource-based processing industry products of Aceh Jaya.**

| No | Sub-sector               | Processed products                  |
|----|-------------------------|-------------------------------------|
| 1  | Marine and fisheries   | a. Marinated fish                   |
|    |                         | b. Anchovies                        |
|    |                         | c. Dried shrimp (*ebi*)             |
|    |                         | d. Shrimp paste                      |
| 2  | Agriculture and estate | a. Coffee powder                     |
|    |                         | b. Patchouli oil                    |
| 3  | Animal farming         | a. Biogas                            |
| 4  | Forestry               | a. Rattan craft                      |
|    |                         | b. Dyer from dragon blood           |

Source: processed data 2017.

**Figure 5.** Chain of processing industry in Aceh Jaya.
### Table 10. The implication of acceleration to labor and economic growth.

| No. | Sectors | Estimated impact on labor absorption | Estimated impact on economic improvement | Assumption applied |
|-----|---------|-------------------------------------|------------------------------------------|--------------------|
| 1   | Lowland agriculture: rice | 51.5% of the workforce or 28,322 individuals per crop season | increased yield from 6.3 tons to 10 tons. Crop cycle increase from once to twice a year | Using mid-tech, superior seed and intensive irrigation |
| 2   | Capture fisheries | - demand of free labor in the development of fisheries structure is 74 individuals <br> - demand on permanent labor in development of fisheries structure is 23 individuals | Regional revenue at 2021 from capture of tuna, skipjack, mackerel tuna, crustacean and other fishes can reach IDR 13,249,846,712 | Four fish aggregating device each year, additional two purse seine vessel each year and regional retribution 1.5% |
| 3   | Aquaculture | - absorption of 2,524 fisheries household og freshwater aquaculture. <br> - absorption 1,040 fisheries households on brackishwater aquaculture. <br> - absorption 213 fisheries households on marinewater aquaculture. <br> - increase on farm business parties of 2,3% on freshwater and 0,9% on brackish. | - production of giant-tiger prawn will increase 278% by intensive system and 438% by super intensive system. <br> - production of tilapia will increase from 0.009 ton/hectare to 2.16 tons/hectare by semi-intensive system. <br> - the use of effective land of 4.3 ha with floating cage will increase production from 96 kg to 1,720 kg. | - transition from traditional shrimp culture to intensive/super-intensive. <br> - transition from traditional tilapia culture to semi-intensive (3 cycles) or intensive (4 cycles) and superior seeds. <br> - If effective 4.3 hectares land used for lobster’s floating cage than the only existing 0.04 Ha. |
| 4   | Animal farming | - on the fifth year the labor absorption from cattle farming is 3,306 ind./year <br> - on the fifth year the labor absorption from buffalo farming is 772 ind./year <br> - on the fifth year the labor absorption from goat farming is 4,433 ind./year <br> - on the fifth year the labor absorption from duck farming is 1,475 ind./year | - economic growth from cattle reachs 146% on fifth year <br> - economic growth from buffalo reaches 72% <br> - economic growth from goat reaches 5,306% <br> - economic growth from duck reaches 40,884% | - the application of centralized and controlled common farming. <br> - can be managed as secondary livelihood or primary. |
| 5   | Forestry | - potential labor absorption from agarwood is 43,153 ind./year <br> - potential labor absorption from dragonblood is 61,638 ind./year <br> - potential labor absorption from rattan is 49,761 ind./year | - potential profit from agarwood breeding is IDR 5,748,389,808,876, <br> - profit from dragonblood IDR 460,405,578,804, <br> - profit from rattan IDR 106,709, 218,405, <br> | Feasibility analysis shows the demand of 6 individuals in each hectare of land. |
**Table 11.** The implication of acceleration to labor and economic growth (*continue*).

| No. | Sectors | Estimated impact on labor absorption | - Estimated impact on economic improvement | Assumption applied |
|-----|---------|--------------------------------------|---------------------------------------------|--------------------|
| 6   | Tourism | Labor absorption is 125 individuals from main activities | - The increase of tourism economic growth up to 6.5%/year.  
- Increasing visitation from 20,000/year to 27,400/year | The location are on two superior sites: Geureutee and Reusam Island. |
| 7   | Mineral Resources: Coal | Labor absorption on five companies reach 370 individuals | - If there are 4 companies can reach capacity increasement to 1,200,000 ton/year then the annual profit will reach IDR 632,486,232,000,-  
- Royalti to state (13,5%) as much IDR 85,385,641,320,- | Monthly production on each (five) companies is 20,000 tons. |
| 8   | Natural resource -based industry | Absorption on first year is 71 individuals or 15.64% from total jobseeker in Aceh Jaya (454 individuals) | - From 5 types of processing industries, on first year the percentage of production growth as much 100-200%  
- On fifth year predictedly the growth can reach 800-1400%  
- On fifth year with the average of production capacity increasement is 2-3 times and the additional of industrial unit 3 times and 5 times for biogas installation (extention of industries location), it is predicted will increase the economy around 11 times or reach IDR 15.5 billions. | - Number economic unit in each district is 1-3 unit, so in total there are 24 economic unit spread on 7 districts.  
- Including the processing of prawn crackers, shredded catfish, soyben, paychouli and biogas |

Small industrial businesses can be the primary source of income for the community to encourage rural development. The choice of types of businesses in small rural industries should consider the following aspects: Labor-intensive based industry, prioritizing the regional core competencies/local resources, high multiplier effects, including income, labor, and technology, and bringing regional spillover to the surrounding area [28, 29, 30]. Meanwhile, the selection of industries that can be developed in the Aceh Jaya Regency was based on:1) Potential or availability of local natural resources; 2) Simple production technology; 3) Availability of facilities and supporting facilities; 4) Market availability, and 5) Business sustainability.

From the indicators above, the following table 9 shows the types of natural resource-based industries in Aceh Jaya and can be developed into rural and regional economy leverage and efficient use of natural resources. Based on the main problems and external constraints that can hamper the development of the processing industry, [31] in Aceh Jaya, the development strategies can be based on the existing businesses (based on strengths and weaknesses). The other approach is establishing small-based industries with simple production technology and market demand (opportunities and challenges).
As shown in figure 5 above, the processing and supporting components included raw materials, human resources, process technology, capital, markets, and the marketing strategy. Based on gap analysis, there are some challenges and procedures to address if policymakers urge to develop these natural resources-based industries: 1. Improving the quality of human resources; 2. Increasing an added value and development of product diversification; 3. Product packaging and branding development; 4. Market creation and provision of product promotion centers; and, 5. Provision of the mean of production and capital.

In addition to the economic aspects, the acceleration of natural resources-based economic development will strengthen institutional development and partnerships between institutions at the local government level up to the gampong (village) level within the framework of the special autonomy of Aceh Province. The collaboration between institutions is expected to build the social capital of the people of Aceh Jaya. According to Fukuyama, [32] quantitatively, the non-economic factors contribute 20% to growth and are qualitatively crucial because it involves the subject and the goals of economic growth: humans and society itself. [33, 34] So, the socio-cultural aspects cannot be ignored in the plans to accelerate natural resources-based economic development because it concerns the sustainability of the natural resources and human life. [35]

4. Conclusion

Considers the existing conditions and supporting facilities in Aceh Jaya Regency, the commodities that can be prioritized for natural resource-based development are in eight sectors: Agriculture with rice as its superior; Capture fisheries with tuna, skipjack, mackerel tuna, crustaceans, and other fish as superior products; Aquaculture with giant-tiger prawn, tilapia and lobster as its superior products; Animal farming with cattle, buffalo, goats and ducks as its superior products; Forestry with agarwood, dragonblood and rattan as superior products; Tourism with Geureute and Reusam Island as superior products; Mineral resources with coal as its superior product; and natural resource-based industries with prawn crackers, shredded catfish, soybeans, patchouli oil, and biogas as their superior products. Meanwhile, renewable energy still needs further studies regarding the feasibility and opportunities to be implemented in the short and medium-term.

The eight sectors with the respective products can leverage the economy and encourage sustainable management of natural resources without reducing the carrying capacity. Supporting factors as the basis of the argument for selecting products are based on a multi-tool analysis of market analysis, gap analysis, project planning analysis, stakeholder analysis, sectoral analysis, and environmental carrying capacity analysts.

To implement the scheme of acceleration of natural resource-based development in the Aceh Jaya region, the Regional Development Planning Agency may be a leading actor to integrate this acceleration plan into the short and medium-term of sectoral development planning. The role of the executives is also crucial in setting the achievement targets and development priorities of the Aceh Jaya Regency. The combination of setting political targets for regional development, strengthening technology, strengthening institutional capacity internally in planners and implementers of development is a strategic approach that becomes a means in achieving the target of accelerating natural resource-based development in Aceh Jaya Regency.

Acknowledgment

This paper is part of study conducted by CCMRS-Bogor Agricultural University from the Bogor Agricultural University in collaboration with Aceh Jaya’s Regional Development Planning Agency. Highly appreciation to Aceh Jaya Regional Development Planning Agency for its support in terms of data, operational, funding, and assistance during the implementation of the study. We would also like to thank all those who assisted in the whole process and constructive discussions on the findings of this study from the offices, agencies, district governments, villages and the entire community in the study location. Last but not least, we highly appreciate all experts involved in this research who can not be mentioned one by one.
References

[1] Ismail N, Okazaki K, Ochiai C and Fernandez G 2018 Livelihood changes in Banda Aceh, Indonesia after the 2004 Indian Ocean Tsunami *International Journal of Disaster Risk Reduction* **28** 439-449.

[2] Sieh K, Daly P, McKinnon E, Pilarczyk J, Chiang H, Horton B, Rubin C, Shen C, Ismail N, Vane C and Feener R M 2015 Penultimate predecessors of the 2004 Indian Ocean tsunami in Aceh, Sumatra: stratigraphic, archaeological, and historical evidence *J. Geophys Res. Solid Earth* **120** 308-325.

[3] Daly P, Halim A, Nizamuddin, Ardiansyah, Hundlani D, Ho E and Mahdi S 2017 Rel rehabilitating coastal agriculture and aquaculture after inundation events: Spatial analysis of livelihood recovery in post-tsunami Aceh, Indonesia *Ocean & Coastal Management* **142** 218-232.

[4] Syamsidik, Fahmi M, Fatimah E and Fitrawansyah A 2018 Coastal land-use changes around the Ulee Lheue Bay of Aceh during 10 year 2004 Indian Ocean tsunami recovery process *International Journal of Disaster Risk Reduction* **29** 24-36.

[5] Kagaratnam U, Schwarz A M, Adhuri D and Dey M M 2006 Mangrove Rehabilitation in the West Aceh - Issues and Perspectives *World Fish Center Quarterly* **29**

[6] Rizwan T, Nasution T, Dewiyati I, Elrahimi S A and Putra D F 2017 Fish diversity in the east coastal waters area of Aceh Besar District, Indonesia *AACL Bioflux* **10**

[7] Ali M 2010 Struktur Umur *Geloina erosa* di Kawasan Ekosistem Mangrove Pesisir Barat Kabupaten Aceh Besar *Omi-Akuatika* **9** 44-50.

[8] Kurien J 2017 Collective action and co-management initiatives in post-disaster Aceh, Indonesia *Maritime Studies* **16** 21.

[9] Badan Pusat Statistik Kabupaten Aceh Jaya 2017a *Aceh Jaya dalam Angka 2017* (Banda Aceh: Badan Pusat Statistik Kabupaten Aceh Jaya)

[10] [BNPB] Badan Nasional Penanggulangan Bencana 2013. *Indeks Risiko Bencana Indonesia Tahun 2013* (Bogor: Direktorat Pengurangan Risiko Bencana BNPB)

[11] [BPBK] Badan Penanggulangan Bencana Kabupaten Aceh Jaya 2017 Primary Data (Not published).

[12] Sariyanti L 2018 *Kerentanan Masyarakat dan Kapasitas Pemerintah Daerah dalam Penanggulangan Banjir di Kecamatan Pasie Raya Kabupaten Aceh Jaya* (Medan: Thesis Department of Sociology FISIPO University of Sumatera Utara)

[13] [Bappeda] Badan Perencanaan Pembangunan Daerah Kabupaten Aceh Jaya 2013 *Rencana Pembangunan Jangka Menengah Kabupaten Aceh Jaya 2012-2017* (Calang: Badan Perencanaan Pembangunan Daerah Kabupaten Aceh Jaya)

[14] [BPS] Badan Pusat Statistik Kabupaten Aceh Jaya. 2017b *Produk Domestik Bruto Kabupaten Aceh Jaya menurut Lapangan Usaha 2012-2016* (Calang: Badan Pusat Statistik Kabupaten Aceh Jaya)

[15] Mauriza S, Hamzah A B and Syechland M N 2013 Analisis indeks pembangunan manusia di kawasan barat dan kawasan timur Provinsi Aceh *Jurnal Ilmu Ekonomi Pascasarjana Universitas Syiah Kuala* **1**.

[16] [BPS] Badan Pusat Statistik Kabupaten Aceh Jaya 2015 *Aceh Jaya dalam Angka 2014* (Calang: Badan Pusat Statistik Kabupaten Aceh Jaya)

[17] [DJPB] Direktorat Jenderal Perikanan Budidaya Kementerian Kelautan dan Perikanan RI 2014 *Udang Vaname dan Udang Windu masih Andalan Ekspor Indonesia* Article on http://www.djpb.kkp.go.id/arsip/c/246/Udang-Vannamei-dan-Udang-Windu-Masih-AndalanEkspor-Indonesia/category_id=13

[18] Effendii I 2016 *Budidaya Intensif Udang Vaname (Litopenaeus vannamei) di Laut: Kajian Lokasi, Fisiologis dan Biokimia* Disertation (Bogor: Aquaculture Science Institut Pertanian Bogor)

[19] Dickman S 1989 *Tourism: An Introduction Text* (Riverwood: Ligare Pty)

[20] van Leeuwen T 2014 A Brief History of Mineral Exploration and Mining in Sumatera. *Proceeding of Sundaland Resources 2014 MGEI Annual Convention* Palembang
[21] van Bemmelen R 1949 The Geology of Indonesia Vol. I.A. General Geology of Indonesia and adjacent archipelagoes Government Printing Office: The Hague

[22] Young R D and Johari S 1978 The Tangse copper-molybdenum prospect, Indonesia. In: Nutralaya, P. (ed.), Proceedings of 3rd Regional Conference on Mineral Resources of SE Asia. Asian Institute of Technology, Bangkok, 377-386

[23] Kementerian Energi dan Sumberdaya Mineral (ESDM) 2013 Statistik Energi Baru, Terbarukan dan Konservasi Energi 2013 (Jakarta: Direktorat EBTKE Kementerian ESDM)

[24] [Disperindag] Dinas Perindustrian dan Perdagangan Kabupaten Aceh Jaya 2015 Primary Data (Not published)

[25] Harianto 2007 Peranan Pertanian dalam Ekonomi Perdesaan (Bogor: Pusat Studi Pembangunan Pertanian dan Perdesaan IPB)

[26] Sutawir 1994 Peranan Agro Industri dalam Pembangunan Industri Pedesaan Suplement on Bestari August -December 1994

[27] Andri K B 2006 Perspektif Pembangunan Wilayah Pedesaan Inovasi 6.

[28] Forni M S 2002 Spillovers and the Growth of Local Industries. The Journal of Industrial Economics 50 151-171.

[29] An D and Lee S 2006 The Spillover Effects of R&D Investment on the Performance of Individual in Food Manufacturing Industry Paper in American Agricultural Economics Association Annual Meeting California 23-26 July 2006

[30] Micek G 2011 Estimating Multiplier Effects on the Local Scale Acta Universitatis Lodziensis Folia Oeoconomica 252.

[31] Domanski B and Gwosdz K 2010 Multiplier Effects in Local and Regional Development. Quaestiones Geographicae 29.

[32] Murniningtyas E 2011 Industri berbasis Pertanian: Peluang dan Tantangan. Presentation on Forum Studi dan Diskusi Ekonomi 2011 "13th Year Indonesian Reform: Opportunities and Challenges of Agricultural and Industrial Development" Yogyakarta 19 November 2011

[33] Norton A 1996 Filling the 20 per cent gap: Francis Fukuyama on trust and social capital. Agenda 3 351-358.

[34] Lawang R M Z 2004 Kapital Sosial dalam Perspektif Sosiologik: suatu pengantar (Jakarta: FISIP UI Press)

[35] Redclift M 2005 Sustainable development (1987-2005) an oxymoron comes of age Sust.Dev. 13 212-227.