

THE SUITABILITY OF THE SPATIAL PATTERN OF NORTH ACEH DISTRICT TO THE LEVEL OF EARTHQUAKE DISASTER RISK

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ABSTRACT

An earthquake is a shaking phenomenon that occurs on the surface of the earth, which is a type of natural disaster that is very close to the lives of the people of Indonesia and Aceh. This writing focuses on the suitability of spatial patterns in earthquake disaster management in North Aceh Regency through Pre-Disaster, Emergency Response and Post-Disaster measurement indicators. The purpose of writing is to find out and analyze the supporting and inhibiting factors in managing the earthquake disaster in North Aceh Regency. This writing method is qualitative writing with a descriptive approach. The results of this writing show that the role of the Regional Disaster Management Agency (BPBD) through spatial suitability patterns in dealing with the earthquake disaster in North Aceh Regency is through 3 measurement indicators, namely the first pre-disaster stage by providing training about disasters to the community, second the emergency response stage in dealing with floods in connection with carrying out steps ranging from disaster anticipation to disaster evacuation, and finally the post-disaster stage by building flood management facilities but it is still in the construction process due to the large coverage of flood-prone areas and limited budget. The North Aceh Regency Regional Disaster Management Agency should continue to improve the capabilities of human resources, organizational capacity, availability of infrastructure and collaboration. Communities around disaster locations must be protected to reduce casualties and material losses.

Keywords: Earthquakes, Spatial Patterns, North Aceh, Disasters

1. Introduction

Indonesia is a disaster-prone area because it is located in the ring of fire so it has a high vulnerability to the dangers of geological disasters which include earthquakes, volcanic eruptions, land movements/landslides and tsunamis¹. Based on data from BMKG, Aceh and the surrounding area are part of Indonesia's seismotectonics². This area is traversed by the Mediterranean Mountains and the subduction zone caused by the meeting of the Indo-Australian Plate and the Eurasian Plate. With these conditions, North Aceh and Lhokseumawe City have quite high levels of disaster vulnerability.

Geographically, Indonesia is located at the meeting point of four tectonic plates: the Asian continental plate, the Australian continental plate, the Indian Ocean plate, and the Pacific Ocean plate. Geographically, Indonesia is located at the meeting point of four tectonic plates: the Asian continental plate, the Australian continental plate, the Indian Ocean plate, and the Pacific Ocean plate. Data shows that Indonesia is one of the countries with the highest level of seismicity in the world³.

Law Number 26 of 2007 concerning Spatial Planning (UUPR) mandates spatial planning based on disaster mitigation to create areas that are safe, comfortable, productive, and sustainable. Law Number 24 of 2007 concerning the Implementation of Disaster Management (UUPPB) also regulates that mitigation is a series of efforts to reduce disaster risk. By reviewing the mandate of the two laws, it shows that spatial planning based on

¹ BMKG. (2018). Catatan Sejarah Gempa di Aceh. BMKG.

² Soemabrata, J., Zubair, A., Sondang, I., & Suyanti, E. (2018). Risk mapping studies of Hydro-Meteorological Hazard in Depok Middle City. International Journal of GEOMATE, 14 (44)

³ Badan Nasional Penanggulangan Bencana. 2017. Buku Pedoman Kesiapsiagaan Bencana. Jakarta: BNPB.

disaster mitigation is one of the efforts or Disaster Risk Reduction (DRR). The response to disasters is in the form of disaster mitigation which is in line with their efforts to stabilize and improve living standards⁴. The implementation of disaster management consists of pre-disaster, during-disaster and post-disaster stages. Spatial planning is included in the pre-disaster stage. So that spatial planning plans are more effective as disaster mitigation/DRR. The aim of spatial planning based on disaster mitigation/DRR is to realize regional resilience from disasters⁵. Spatial planning can minimize disaster risk in the pre-disaster stage which will be more effective, including savings in terms of financing compared to the rehabilitation and reconstruction stages.

Considering the characteristics of disasters in North Aceh Regency, referring to spatial planning policies and the implementation of disaster management, disaster mitigation-based KRB spatial planning is needed in North Aceh Regency.

2. Literature Review

Aceh Province is a province is highly susceptible to disasters. This is caused by geology and geography. Aceh Province is located in the ring of fire, which has resulted in several volcanoes and will make the subduction zone the center of earthquake and tsunami disasters.

North Aceh Regency has many factors that can cause disasters, including geography, climate, social, cultural, economic, and technical factors. From natural disasters to non-natural disasters, and social disasters that result in death, environmental damage, loss of property, and even psychological effects on victims regularly, quickly and precisely. Human factors are also very important in this case, such as inaccurate land use, dumping waste into rivers, living in flood areas, and land construction.

Disaster management includes all efforts that involve policy determination to development recovery programs resulting in disasters, emergency response, rehabilitation and restoration, and in this case, is guided by Law Number 24 of 2007 concerning Disaster Management. Based on this, each community group must fulfill the abilities and skills to face their environment when adversity occurs. This hazard resolution aims to provide protection to the population from the threat of disaster hazards, implementing existing laws and regulations, ensuring that the handling of these hazards is carried out in a coordinated, comprehensive, planned and integrated manner. In this case, regional governments have a duty to fulfill, prosper and protect the people in their working areas in a democratic manner.

Thus, the government has the right in the process of implementing disaster management, including establishing disaster management policies, determining national and regional disaster status, establishing regulations regarding the application of technology for notification of sources of danger, distribution of logistics needs on a national scale to disaster victims. This has also been explained in Presidential Regulation Number 21 of 2008 concerning the Implementation of Disaster Management. Presidential Regulation Number 8 of 2008 concerning the Establishment of the National Disaster Management Agency. Aceh Qanun Number 5 of 2010 concerning Disaster Management and Aceh Qanun Number 6 of 2010 concerning the Establishment of the Organizational Structure and Work Procedures of Aceh Disaster Management Agency 6. As well as North Aceh Regent Regulation Number 31 of 2017 Article 6 has explained the functions of the Regional Disaster Management Agency.

2.1 Regional and Spatial Planning

Spatial planning involves the structural form and pattern of space utilization, whether planned or not. Based on Law no. 26 of 2007 concerning Spatial Planning, the definition of spatial planning does not only have the dimension of space utilization planning, but also

⁴ Wisner, Ben; Piers Blaikie; Terry Cannon and Ian Davis. *At Risk: Natural Hazards, People's Vulnerability and Disasters*. New York: Routledge

⁵ Sutanta, H. (2012). *Spatial planning support system for an integrated approach to disaster risk reduction*. PhD thesis, Centre for Spatial Data Infrastructures & Land Administration,

includes the dimension of utilization and control of space utilization. Meanwhile, regional spatial planning is a process that involves many parties with the aim that the use of space provides maximum prosperity to the community and ensures sustainable living. Spatial planning is carried out through processes and procedures for preparing and determining spatial plans based on applicable laws and regulations, and is binding on all parties⁶.

According to Sucahyo (2016: 104), Spatial planning functions as space allocation for various socio-economic activities of the community and environmental conservation activities in the city area, regulates the balance and harmony of space allocation, serves as a basis for preparing indications for the five-year medium-term main program for 20 years, and as a basis for granting permission to use space in the area. Then the role of spatial planning is essentially intended to achieve optimal resource utilization by avoiding resource utilization conflicts wherever possible, preventing environmental damage and increasing harmony. Spatial and regional planning based on disaster mitigation is expected to help reduce the impact of natural disaster risks, such as earthquakes, tsunamis, floods, volcanic eruptions and other natural disasters. Planning, utilization and control of regional and city or regional spatial planning should take into account natural disaster factors, especially in cities and regions located in areas prone to natural disasters, this aims to minimize the negative impacts of disasters. The 2005 Hyogo Framework for Action (HFA) and UNISDR also mandate the role of land use planning in reducing disaster risk, including limiting development in disaster-prone areas.

Space Utilization and Control

According to (Hadi, MA 2013)⁷ Space utilization is a series of development implementation activity programs that utilize space according to the time period specified in the spatial planning plan. Space utilization is carried out through the implementation of the spatial planning program. What is meant by financing the space utilization program is the mobilization, prioritization and allocation of funding required for the implementation of development.

According to Lutfi Muta'ali (2013:32), controlling the use of space in disaster-prone areas that have been determined as an effort to direct the use of space so that it remains in accordance with the spatial plan that has been determined. Control of space use is implemented through zoning regulations, permits, monitoring, evaluation and control of space use. Controlling space utilization is an inseparable part of the spatial planning process. According to Kartika (2011:123) The use of space in its implementation is not always in line with the spatial plan that has been determined. These discrepancies or violations are caused by several factors, including market development pressure on space, unclear control mechanisms, and weak law enforcement⁸. This condition suggests that to create orderly development in space, measures to control space utilization are needed. This tendency for deviation can occur because spatial planning products do not pay enough attention to implementation aspects or conversely, space utilization does not pay enough attention to spatial planning. Spatial planning utilization control is carried out so that spatial planning utilization can proceed in accordance with the spatial planning plan.

2.2 Disasters

Understanding Disaster

According to BNPB head regulation no. 4 of 2008 concerning Guidelines for Preparing Disaster Management Plans, a disaster is an event or series of events that threatens and disrupts people's lives and livelihoods caused by both natural/non-natural factors and human factors which result in human casualties, environmental damage, property loss, objects and psychological impact. Definitions of disasters vary, according to Ongkosongo in (Liesnoor 2010:8) disaster is an impact of activities or risks that have a negative effect on

6 Gammara Gumayani. 2004. Pengaruh Kebijakan Politik Pembangunan Terhadap Tata. Ruang Kota (Studi Kasus: Kota Jakarta). Jurnal NALARs Volume 3 Nomor 2 Juli 2004: 46-59.

7 Hadi, M. A. (2013). Urban sprawl di kota Semarang: Karakteristik dan evaluasinya terhadap rencana detail tata ruang kota. Jurnal Bumi Indonesia, 2(4).

8 Kartika, I. M. (2011). Pengendalian pemanfaatan ruang. GaneC, 5(2), 123-130.

humans⁹. Stefan and Unesco generally explain disasters as influences received by humans that cause humans to lose and suffer losses. Disasters are a limitation of human ability to minimize risks. If the risks that occur can be minimized then disasters are said to be reduced.

2.3 Earthquake & Tsunami

Damage mechanism from earthquakes, vibration energy sent through the earth's surface from depth. Vibrations cause damage and destroy buildings, which in turn can kill and injure the people who live there. The cause of earthquakes is the release of energy by geophysical adjustments deep in the depths of the earth along areas of cracks that form in the earth. Tectonic processes resulting from the slow movement of continents over the earth's surface. Local geomorphological shifts, volcanic activity. A tsunami is a series of sea waves that can travel at speeds of up to 900 km per hour, mainly caused by earthquakes that occur on the seabed.

3. Research Methods

Research methods are the workflow of research activities in general. The stages of the state of the art description and road map are:

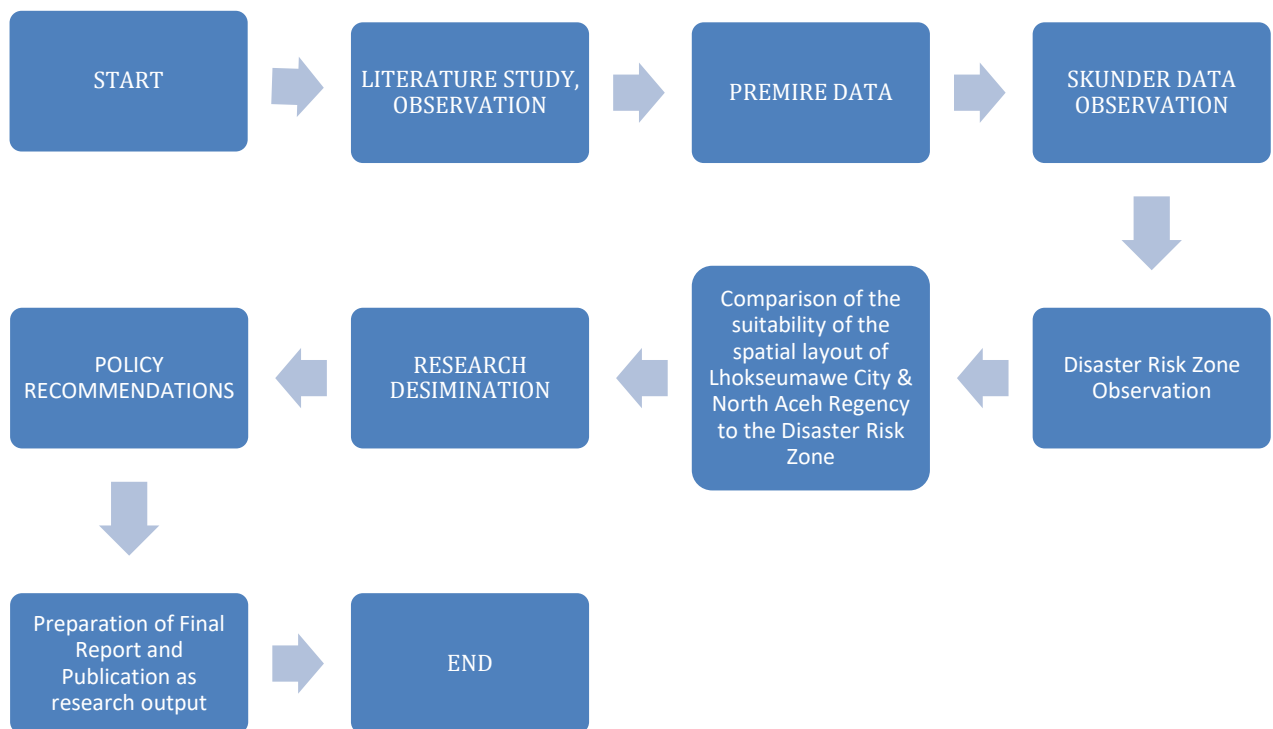


Figure 1. Research Methodology

3.1 Research Variables

Research variables are anything in any form that is determined by the researcher to be studied so that information about it is obtained, then conclusions are drawn [12]. The variables used are divided into several groups, namely: 1) Disaster risk level variable consisting of threat/danger (hazard) and vulnerability, and 2) Variable suitability of spatial patterns to earthquake and tsunami disasters.

3.2 Methods and Data Collection

The unit of analysis used in this research is all sub-districts in North Aceh Regency. Data collection was carried out by means of a secondary survey. A secondary survey was carried out to obtain data in the form of earthquake and tsunami threat maps, spatial pattern maps, and thematic maps related to existing conditions in North Aceh Regency. Analysis Method Disaster Risk Analysis Disaster risk is a combination of the characteristics and frequency of danger in a particular place or potential losses due to disasters in a certain area and time period which can be in the form of death, injury, illness, life at risk, loss of security, displacement, damage or loss of property. and community disturbances. Disaster risk aspects consist of threats, vulnerabilities and capacity. The level of disaster risk can be determined using the equation:

$$R = Hx \frac{v}{c} \dots\dots\dots \text{(equation 1)}$$

Information:

- R: Disaster Risk (Risk)
- H: Danger (Hazard)
- V: Vulnerability
- C : Capacity (Capacity)

In this research, the plan is to only use threat variables and vulnerability variables. So to determine the level of disaster risk only comes down to the threat stage multiplied by vulnerability.

3.3 Data Types and Sources

Primary Data The primary data source in this research was obtained through accurate data sourced from the North Aceh Regency Regional Disaster Management Agency (BPBD) Office and residents affected by the earthquake. The secondary data in this research was obtained from the law that regulates regional disaster management, namely Law Number 24 of 2007 concerning Disaster Management and Regulation of the Regent of North Aceh No. 31 of 2017 in North Aceh Regency and books about earthquake disasters. Research informants are desired subjects for researchers to analyze. Research informants were chosen deliberately and played a role in providing the information needed during the research period. Research subjects in qualitative research are called informants.

4. Results

North Aceh Regency has 852 gampongs and 27 sub-districts and is included in areas potentially prone to earthquakes. In North Aceh Regency there are 19 sub-districts, namely Matangkuli, Lhoksukon, Pirak Timu, Samudera, Tanah Luas, Tanah Pasir, Tangaan, Tanah Jambo Aye, Baktiya, Baktiya Districts. Barat, Seunuddon, Cot Girek, Syamtalira Aron, Paya Bakong, Geureudong Pase, Simpang Kramat, Sawang, Muara Batu, and Kuta Makmur.

North Aceh Regency is located in the northern part of Aceh Province, according to the Bakosurtanal Map. Geographically, the borders of North Aceh Regency with other areas have changed. There are several regional expansions, as shown by Republic of Indonesia Law Number 48 of 1999 concerning the Establishment of Bireuen Regency and Simeulue Regency, Republic of Indonesia Law Number 2 of 2001 concerning the Establishment of Lhokseumawe City, and Republic of Indonesia Government Regulation Number 18 of 2003 concerning the Relocation of the Capital of North Aceh Regency from the Lhokseumawe City Area to Lhoksukon.

The topography of North Aceh is very diverse, ranging from extensive lowlands in the north stretching from west to east to mountainous areas in the south. Because the eastern Sumatra route crosses the lowlands of North Aceh, these lowlands are more economically developed than the southern interior. In lowland areas, rice fields and residential areas consist of agricultural land; on the coast, salt water fisheries ponds. In the highland areas,

plantation land began to be widely cultivated by the community. Because the irrigation system for rice fields in North Aceh still relies on traditional irrigation, and most of the rice fields there are still rain-fed, the agricultural potential in the region cannot yet be relied upon to improve the standard of living of its people. North Aceh Regency has an area of 3,296.86 km², or 329,689 ha, and consists of 27 sub-districts, 70 settlements and 852 gampongs administratively.

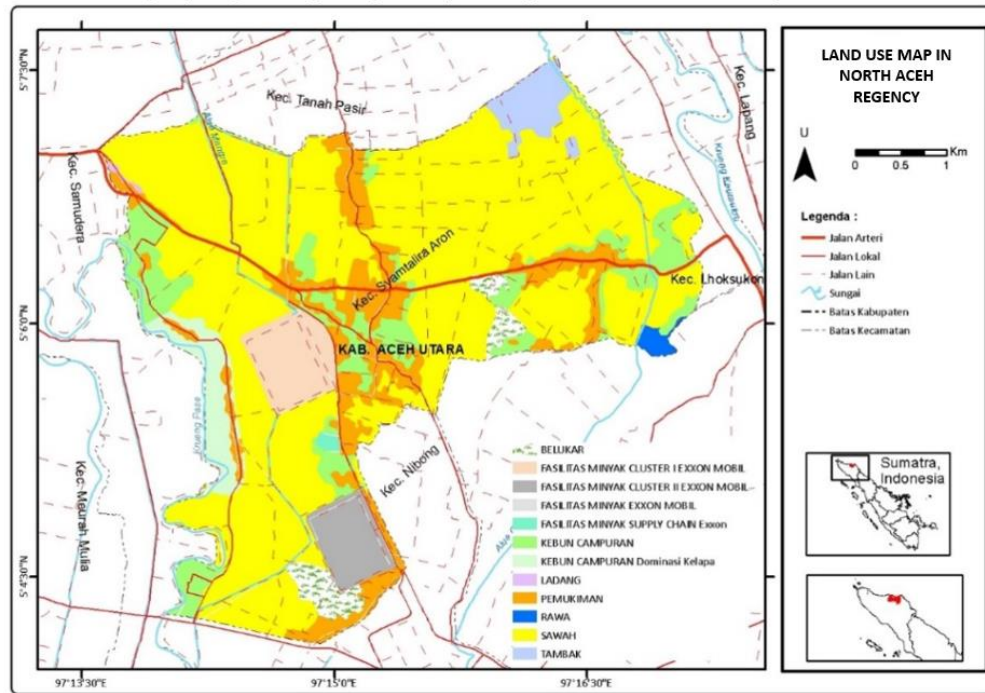


Figure 2. Land Use Map. Source: Field Survey, 2022

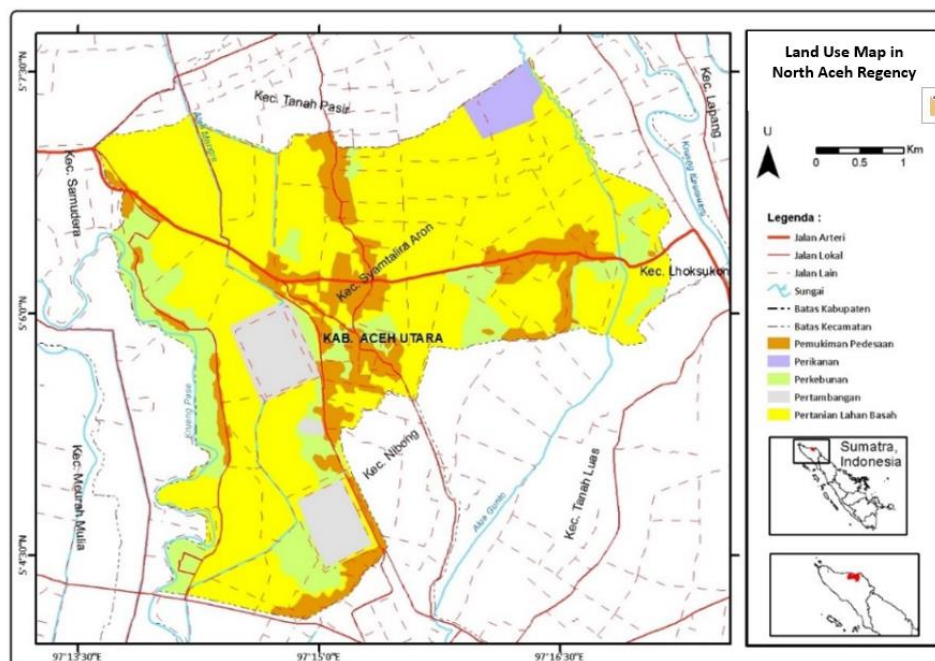


Figure 3. Map of RTRW Spatial Patterns for North Aceh Regency 2012-2032. Source: North Aceh Regency Bappeda, 2022

The land use map consists of 11 types of land use including scrub, four Exxon Mobil oil facilities, mixed plantation, mixed plantation dominated by coconut, field, swamp, settlement, swamp, paddy field and pond. While the spatial pattern defines five types, namely rural settlements, fisheries,

plantations, mining and wetland agriculture. Based on Figure 2, the types of arterial and local roads have a greater influence on the occurrence of land use mismatches with the RTRW with patterns extending along the road and converging at road intersections. The majority of unsuitable types of land use, namely shrubs and rice fields, have been intensively converted into plantations and plantations and rice fields into residential areas. This research strengthens the findings of other researchers that public facilities, roads and factories have an important role, especially regarding the realization of regional development, equal distribution of development results (Hadijah & Sadali, 2020; Martínez et al., 2020; Sebayar, 2020). Several types of land use that are in harmony and are not in harmony with other spatial patterns are tabularly presented in Tables 1 and 2.

Table 1. Suitability of land use to RTRW

Type of Land Use	RTRW Spatial Pattern	Description	Area (hectares)	
Settlement	Rural Settlement	in accordance	241,51	11,39
Fish Pond	Fishery	in accordance	41,75	1,97
mixed plantation	Plantation	in accordance	156,92	7,4
mixed plantation dominated by coconut	Plantation	in accordance	52,56	2,48
Exxon Mobil Cluster I Oil Facilities	Mining	in accordance	69,58	3,28
Exxon Mobil Cluster II Oil Facilities	Mining	in accordance	48,91	2,31
Oil Facilities Supply Chain Exxon	Mining	in accordance	4,00	0,19
Swamp	Agriculture	in accordance	10,02	0,47
Ricefield	Wetland	in accordance	1283,60	60,51
The total area of land use suitability for RTRW is				90,00

Source: Author's primary data analysis, 2023

Table 2. Incompatibility of land use with RTRW

Type of Land Use	RTRW Spatial Pattern	Description	Area (hectares)	
Shrubs	Rural Settlement	It is not in accordance	0,425	0,02
Exxon Mobil Cluster I Oil Facilities	Rural Settlement	It is not in accordance	1,177	0,06
Exxon Mobil Cluster Ii Oil Facility	Rural Settlement	It is not in accordance	0,682	0,03
Exxon Oil Supply Chain Facility	Rural Settlement	It is not in accordance	0,197	0,01
Mixed Gardens	Rural Settlement	It is not in accordance	23,082	1,09
Coconut Domination Mix Garden	Rural Settlement	It is not in accordance	3,316	0,16
Ricefield	Rural Settlement	It is not in accordance	16,215	0,76
Ricefield	Fishery	It is not in accordance	2,684	0,13
Thicket	Plantation	It is not in accordance	45,242	2,13
The total area of land use suitability for RTRW is				210

Source: Author's primary data analysis, 2023

Based on Tables 1 and 2, the results show that the total area of the research area in Syamtalira Aron District is 2121.20 hectares. Of the total area, there are 212.36 hectares or 10 percent of which have land use that is not in accordance with the spatial pattern directions in the RTRW. However, most of the land use in Syamtalira Aron District is still in sync with the spatial use directions set out in the Regional Spatial Planning (RTRW). The area of land use that is in accordance with the RTRW is 1908.84 ha or 90% of the total area of the sub-district and that is not appropriate is 212.36 ha or 10% of the total area of the sub-district. The three types of land use that are suitable and have the largest area are rice fields, mixed gardens and residential areas with respective percentages of 60.51%, 11.39% and 7.4% of the total area of the sub-district. Meanwhile, other types of use such as Exxon Mobil oil facilities, coconut-dominated mixed plantations, swamps and ponds have a suitable area of less than 4% of the total area of the sub-district.

There are matches and discrepancies between land use and RTRW in Syamtalira Aron District. Based on spatial analysis using land use maps and RTRW maps, it was found that an area of 1908.84 ha was suitable or 90% of the total area of the sub-district and 212.36 ha was not suitable or 10% of the total area of the sub-district. The plantation area is the area with the highest incompatibility with existing land use in the form of residential areas, Exxon Mobil facilities with an area of more than 45.83 ha. Incompatibility of land use types with RTRW is a necessity, due to the high demand for land for the construction of public facilities and settlements. Therefore, local governments need to review regulations regarding RTRW in order to create quality, integrated and sustainable development. There are at least three reasons why the implementation of RTRW in Syamtalira Aron District is not 100% appropriate. These causes are the political factors of policy makers, the level of economic growth, the amount of people's income and consumption. Even though the RTRW has been ratified through North Aceh Regency Qanun Number 7 of 2013, the public does not understand the function of the spatial plan, how accurate it is, how to use it, and how it is prepared. The lack of community participation in preparing spatial plans is thought to be the cause of land use incompatibility with the RTRW. Moreover,

the public will be increasingly unfamiliar with the existence of the RTRW if the RTRW document is not published down to the site level, both online and offline. Therefore, the North Aceh regional government needs to prepare a revised RTRW by involving elements of the community to obtain effective and efficient use of space. Local regional governments need to pay attention to four conditions at the sub-district government level, namely: social, population, economic, environmental, application of the latest science and technology. The hope is that evaluation of the RTRW in each sub-district, as in this research, can become an instrument for other sub-district governments to assess the progress of all space utilization activities. Thus, optimal use of space is able to achieve the goals of a sustainable district spatial plan.

5. Acknowledgement

This research was supported and funded in part by PNPB funds from the Research and Community Service Institute of Malikussaleh University. We thank our colleagues from LPPM Malikussaleh University and the North Aceh Regional Government who provided insight and expertise that greatly helped this research.

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