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Geoecology Identification Using Landsat 8 for Spatial Planning in North Sulawesi Coastal

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Abstract Geoecology is a landscape study combined with the social and environmental aspect. The study aims to identify Geoecology of coastal Manado, North Sulawesi. Identification of coastal Geoecology using Landsat 8 supported by SRTM. Data was collected by field survey and taking aerial photo using UAVs. The field survey was conducted to capture the documentation and in-depth interviews. The research method is the interpretation of remote sensing imagery. Data from image interpretation collaborated with field survey data. The results showed that there are three types of coastal that is sandy, rocky and muddy. The sandy comes from karst hills and volcanoes. The rocky and karst hills come from volcanic material that has the character of a big wave. The muddy affected by the presence of the river that carries materials from structural hills. Geoecology based coastal area management is expected to be instrumental in structuring regional integrated and planned.

Key words: Geoecology, Landsat, Coastal, North Sulawesi

Abstrak *Geoekologi merupakan kajian bentanglahan yang dipersepsikan terkait dengan aspek lingkungan dan sosial. Penelitian bertujuan untuk mengidentifikasi geoekologi pesisir di Kota Manado, Provinsi Sulawesi Utara. Identifikasi geoekologi pesisir menggunakan Citra Landsat 8 didukung oleh Citra SRTM. Pengumpulan data dilakukan dengan survei lapangan dan pemotretan menggunakan UAV. Survei lapangan yang dilakukan adalah untuk pengambilan dokumentasi kenampakan di lapangan dan wawancara mendalam. Metode penelitian yang dilakukan adalah interpretasi citra penginderaan jauh. Data hasil interpretasi citra dikolaborasikan dengan data hasil survei di lapangan. Hasil penelitian menunjukkan bahwa terdapat tiga jenis geoekologi pesisir yakni pesisir berpasir, berbatu, dan berlumpur. Pesisir berpasir berasal dari perbukitan karst dan gunung berapi. Pesisir berbatu berasal dari material vulkanik dan perbukitan karst yang memiliki karakter ombak besar. Pesisir berlumpur dipengaruhi oleh adanya sungai yang membawa material yang berasal dari perbukitan struktural. Pengelolaan kawasan pesisir berbasis geoekologi diharapkan dapat menjadi sarana dalam penataan kawasan yang terpadu dan terencana.*

Kata kunci *: Geoekologi, Landsat, Pesisir, Sulawesi Utara*

1. Introduction

The term "Landscape Ecology" has been introduced by Carl Troll [1939] mated geography (landscape) with ecology. Geoecology explains the structure and function geo-ecosystem. Study peeling Geoecology more dominant landscape components consisting of the biosphere, geosphere (lithosphere, hydrosphere, and atmosphere), pedosphere, geo-ecosphere. Utilization Geoecology studies more widely adopted in the countries of Eastern Europe by the experts in geography for spatial planning, land use planning, and natural resource management. Referring to this understanding, Geoecology perceived as landscape ecology related to social aspects [Hugget, 1995].

Earth is often described as a constituent of the four environment, the atmosphere, hydrosphere, lithosphere, and biosphere. Geo-system shows the flow of matter between the environment as a system of interacting. Each constituent environment interaction will occur with humans as part of the Earth system to complete the interaction. Geo-system regulates the flow of natural energy, materials, and information, [Christopherson and Birkeland, 2015].

Coastal area development in a holistic manner would be more useful if the approach used by influential

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in the coastal region. Environmental factors include the biosphere, troposphere, atmosphere, pedosphere, and hydrosphere. One approach that can integrate these environmental factors is the Geoecology approach [Mardiatno, 2002].

The study ever conducted on Geoecology is Geoecology change analysis. Analysis of Geoecology change is a major step that must be done. The landscape is always changing because of the power of nature, human activities, and time. The occurrence of a change in a component can affect other components, so it requires an understanding of the characteristics of the landscape changes. Some parameters required in order to predict the changes of landforms, as well as the basis for hazard mitigation [Nico, 2014].

The most important initial step undertaken in the development of the region is planning development. Development planning is intended to make changes toward a better development for a community, the government, and the environment in certain regions. [Muta'ali, 2014].

North Sulawesi province with the capital city of Manado is located between 00°15'-05°34 'north latitude and between 123°07'-127°10' east longitude. Geographically, north of North Sulawesi province bordering the Sulawesi Sea, the Republic of the Philippines, and the Pacific Ocean. East with Maluku Sea. Boundary south and west respectively Tomini and Gorontalo province. The area of North Sulawesi recorded 15.273 km^2, divided into 11 districts and 4 cities. Bolaang Mongodow an extensive area, which is 3,022 km^2 or 19.78 percent of the North Sulawesi region (BPS, 2014).

2. The Methods

The method used in the study is the interpretation of remote sensing imagery. Landsat 8 is used is supported by the image of the SRTM (Shuttle Radar Topography Mission). Coastal analysis performed using pan sharpening techniques. Pan sharpening is the process of combining multispectral and panchromatic imagery which has a spectral and high spatial resolution to produce a new image colored with a spectral resolution and high spatial [Siwi and Hendayani, 2014]. Landsat 8 that has been processed by the pan sharpen method has a resolution of 15 meters. Data from image interpretation collaborated with survey data in the field. The field survey was conducted to obtain documentation, sampling, and in-depth interviews. The documentation is intended to take on the appearance of the objects that represent the coastal typology. Sampling was conducted to obtain information sand composing materials in coastal areas. In-depth interviews to residents in coastal areas. The method used is descriptive exploratory with collecting data that has been collected, then analyze it.

3. Result and Discussion

Geoecology is a combination of constituent material that comes from the atmosphere, hydrosphere, lithosphere, and biosphere, in which each constituent material interaction between each constituent. The interaction that occurs in some constituent components also comes to human interaction. The mention of the word Geoecology itself has components of a complex between abiotic and biotic elements. Abiotic elements related to coastal typology coastal areas. Typology of coastal landforms associated with constituent coastal areas. Based on the results of interpretation and analysis has been done, the North Sulawesi province has three types of coastal typology which consists of sandy coastal typology, typology coastal rocky and muddy coastal typology. Coastal typology found in North Sulawesi can be seen in Figure 1.

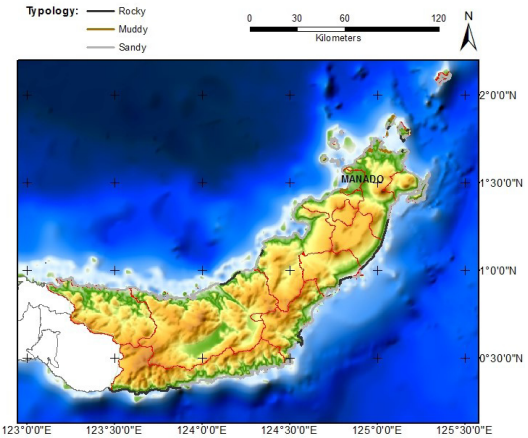

Figure 1. Typology of North Sulawesi Coastal. Source: Alanysis, [2016]

Biotic element that became constituent Sulawesi Geoecology associated with living creatures therein. Interactions between humans and biota be a focus of study. Each coastal typology would represent Geoecology contained in an area. The coastal typology contained in the North Suawesi province include Geoecology of sandy, rocky and muddy coastal. Explanation of the elements contained Geoecology in North Sulawesi province is as follows.

Sandy Coast

Most areas of North Sulawesi has a sandy coastal typology. Sandy coastal typology found in some landforms origin of volcanic processes and landforms origin solutional process. Landform origin of volcanic processes affecting material intake in coastal areas. Sand originating from volcanoes cause dark-colored material and tend to be black. Black sand transported by the river to the sea through transport and sedimentation processes in the areas in its path. Some of the material that is traversed by the river, experiencing an erosion process, causing the mixing of the material. Sand

material which is influenced by the origin of solutional landforms process tends to white. Sand is formed from coral fragments that undergo physical and chemical weathering processes. Physical weathering caused by the pounding waves of the sea, wind, and sun exposure. Chemical weathering is caused by the presence of salt is capable of breaking material into smaller sizes. The appearance of the sandy coast can be seen in Figure 2. Based on the analysis that has been done, the existence of sandy coastal typology almost contained in most areas of North Sulawesi. The dominance of volcanic landforms caused because there are many volcanoes in North Sulawesi region. But some still active volcanoes such as Lokon Mount (Tomohon), Soputan Mount (Southeast Minahasa Regency/South Minahasa), Karangetang Mount (Sitaro Islands District) and Awu Mount (Regency of Sangihe Islands) [Kompas, 2015].

Figure 2. Sandy Beach in Mokupa, Minahasa
Source: Field survey, [2016]

Sandy coastal ecosystems such as mangroves. Some mangrove plants are cultivated and some of which grow naturally in coastal areas. The presence of mangrove areas also indicates that the conditions of the calm waters. Abrasion that may occur can be minimized their losses by mangroves along the coast of North Sulawesi. Some of the marine life living in harmony in the sandy coastal areas with mangrove ecosystems. Mangroves are found in coastal areas of North Sulawesi can be seen in Figure 3.

Figure 3. Mangrove and Coastal Life in Mokupa, Minahasa. Source: Field survey, [2016]

The immediate benefits of mangrove forests in the village communities experience Tiwoho, Wori District, North Minahasa Regency is through the use of arrest, fishing, crab and utilization of palm leaves. The utilization of mangrove forest is done in or around the area of mangrove forests. The value of the indirect benefits of the mangrove forests is as anchoring abrasion, sea waves, and seawater intrusion barrier [Kalitouw, 2015]. The amount of the gains the society makes the mangrove forests should be preserved its existence.

Habits utilization of mangrove has lasted for generations until sometime in late 1989, a company that carries the banner of "Wori Mas" come. The company makes an effort in the field of fisheries, namely shrimp and fish farms. There are approximately 25 hectares of mangrove forests converted into pools of shrimp and fish farming. Most people support the cultivation of shrimp and fish, but some are denying the existence of the pond [Sonjaya, 2007].

Rocky Coast

The existence of a rocky coastal typology is closely related to the volcanic and solutional landforms. A striking difference between the rocky and sandy coast is distinguished by agents of material. Rocky coast with volcanic landforms have characteristics closer to the source of the discharge. Based on the observations made, the size of the stones found in coastal areas is of 5-10 cm. Materials such as stone can be produced from ancient or active volcanoes. Rocky coast on solutional landforms characterized by the sea that has waves big enough.

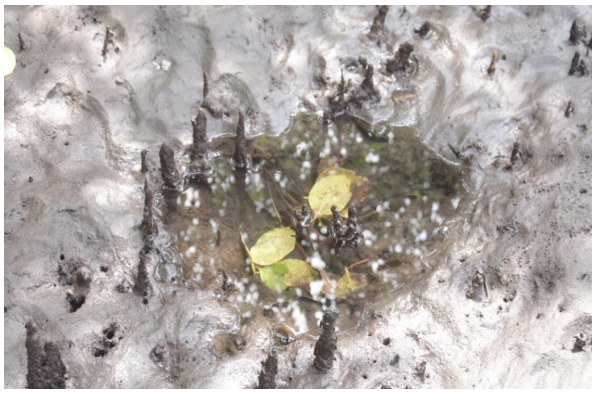

Figure 4. Rocky Beach in Mokupa.
Source: Field survey, [2016]

Rocky material seemed to be along the coast Malalayang. Interactions between humans and the area looks of the opening of tourism in Malalayang Beach. Many visitors who were on the beach to enjoy the beautiful scenery at sunset. Panorama of mountain, sea, sand and rocky complements the beauty of the beach.

Some types of gastropods are also found in the area known as a slug or snail. Gastropods found in intertidal (tidal area) Malalayang Beach. In the dead coral substrate thin sandy and muddy there are 15 types of gastropods with the highest density on the type *Batillaria sp* (0,2 ind/m^2) and the lowest density on the type Cypreae annulus (0,1 ind/m^2) (Roring., et al: 2013).

Figure 5. Rocky Beach in Malalayang.
Source: Field survey, [2016]

Muddy Coast

Muddy coast expanses are small compared with the sandy coast. Muddy coast associated with material carried by the river erosion process results from the hills at the top. Material brought in the form of material colluvium and alluvium. Landforms that make up the region of origin structural processes. Rivers became the dominant material transport media.

Figure 6. The Tongkaina Beach with muddy material.
Source: Field survey, [2016]

Figure 7. The mangrove area in Tongkeina Beach.
Source: Field survey, [2016]

Coastal muddy be used as a suitable medium mangrove cultivation area. Some of the marine life living in the mangrove areas such as fish, shrimp, crab, and scallops. Seagrass beds are also on Tongkaina Beach. There are two types of seagrass beds are the most dominant seagrass *E. acroides* and *T. hemprichii*. The types of fish found in coastal region Tongkeina generally inhabit seagrass beds and coral reefs. [Assa., Et al. 2015].

Coastal Management Based on Geoecology Approach

Nature has a state of dynamic and changeable. The direction of nature change, going towards the point of balanced that it will have an impact on the environment, both biotic and abiotic environment. Proper management is needed in the spatial management so that survival can be maintained. The coastal area of northern Sulawesi, Manado in particular, is dominated by a form of gentle relief, and an anthropogenic landform, namely the reclamation of land for residential and commercial

interests. Since the turn of the millennium, the coastline has changed considerably Manado [Mawike & Mowor, 2014]. Examples of reclaimed land can be observed in Figure 8.

Figure 8. Reclamation in Manado.
Source: Field survey, [2016]

Making a prolonged land reclamation in Manado, causing the fishing settlement not only shifted, but disappear by itself [Mawike & Mowor, 2014], was replaced by modern human settlements. Basically reclamation have a positive impact also negative impacts on the people residing in coastal and marine ecosystems that are short term or long term are influenced by the condition of the ecosystem and the communities around [Siregar, 2014]. The coastal area has a specific ecosystem, which must be maintained so that the potential of coastal disasters can also be addressed properly. North Sulawesi, has a tourism sector that is very potential to be developed. One of the strategies taken by the government to develop the tourism sector is to find, build, and develop ODTW (Objects and Attractions) new [Mangindaan et. Al, 2012]. Regions that have the potential to be expanded as the tourism sector is the coastal area. Coastal of Manado there are many beautiful attractions and beautiful beaches. In addition, some locations in the coastal area of the city of Manado overgrown by mangroves that is potentially as ecotourism.

Figure 9. Mangrove Region in Manado.
Source: Field survey, 2016

Mangrove systems to function as a habitat for many marine organisms, such as fish, crabs, oysters, wildlife, such as birds and reptiles, other invertebrates [Feller & Sitnik, 2016]. Given the importance of mangrove functions as buffer ecosystems in coastal areas, it is necessary zoning arrangement of the region for the development and preservation of the original area. Currently the coastal area has opportunities in the field of specialty. The impact of business opportunities in the field of tourism is doing coastal reclamation efforts for the construction of the visitor some lodging facilities. Structuring the region should pay attention to the impact of the environment and conditions Geoecology each coast. Each coast has its own characteristics and advantages that need to be pursued sustainability.

4. Conclusion

There are three types of coastal Geoecology the muddy, sandy and rocky. The sandy coastal comes from karst hills and volcanoes. The rocky coast comes from karst hills of volcanic material that has the character of a big wave. The muddy coast affected by the presence of the river that carries materials from structural hills. Geoecology based coastal area management is expected to be instrumental in structuring regional integrated and planned.

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References

Buol, Ronny Adolf. 15 Maret (2015). http://regional.kompas.com/read/2015/03/09/15282881/Menengok Tiga Gunung Api Siaga.dan.Alam.Indah.Nan.Subur.di.Sulut. (in Bahasa Indonesia).

Christopherson, Robert W dan Birkeland, Ginger H. (2015). *Geosystems an Introduction to Physical Geography*. Inggris: Pearson Education Limited.

Feller I. C., Marsha, S. (2016). *Mangrove ecology: a Manual Focused on the Biocomplexity on Mangrove Ecosystem*. Smithsonian Institution. Wahington DC: Smithsonian Institution Press.

Huggett, Richard John. (1995). *An Evolutionary Approach*. New York: Routledge.

Kalitouw, Winda Desitha. (2015). Valuasi Ekonomi Hutan Mangrove di Desa Tiwoho Kecamatan Wori Kabupaten Minahasa Utara. *Jurnal Ilmiah*

Fakultas Pertanian Universitas Sam Ratulangi. Vol 6, No 8. (in Bahasa Indonesia).

Manngindaan, P., Adnan, W., Mandagi, S. V. (2012). Analisis Potensi Sumberdaya Mangrove di Desa Sarawet, Sulawesi Utara, Sebagai Kawasan Ekowisata. *Jurnal Perikanan dan Kelautan Tropis. Vol. VIII-2, Agustus 2012.* (in Bahasa Indonesia).

Mardiatno, Djati. (2002). Kajian Geoekologi Daerah Kepesisiran Lombok Barat untuk Pengembangan Wisata Pantai. *Majalah Geografi Indonesia. Vol. 16. No. 1. Hal 57-75.* (in Bahasa Indonesia).

Mawike, F.R., Wowor, M. (2014). Kajian Historis Pemukiman di Sekitar Pantai Manado. *Jurnal LPPM Bidang EkoSosBudKum. Volume 1 Nomor 2 Tahun 2014.* (in Bahasa Indonesia).

Muta'ali, Lutfi. (2014). *Perencanaan Pengembangan Wilayah Berbasis Pengurangan Risiko Bencana*. Yogyakarta: badan Penerbit Fakultas Geografi (BPFG). (in Bahasa Indonesia).

Nico, Theresia Agustina Ana. (2014). Analisis Perubahan Geoekologi (Studi Kasus: Pengaruh Perubahan Bentanglahan Vulkanik dan Marin). *2th Assignment Paper of Environmental Geoecology. UGM.* (in Bahasa Indonesia).

Roring, Irawati., Fransine B. Manginsela., Boyke H. Toloh. (2013). Keberadaan Gastropoda Intertidal di Pantai Malalayang, Sulawesi Utara. *Jurnal Ilmiah Platax. Vol.1: (3).* (in Bahasa Indonesia).

Siwi, Sukentyas Estuti dan Hendayani Yusuf. (2014). Analisis Pansharpening Citra Spot 5. Prosiding Seminar Nasional Penginderaan Jauh, hal 480-489, Lapan, Jakarta Troll, Carl. 1971. Landscape Ecology (Geoecology) dan Biogeocoenology–a Terminological Study. *Jurnal Geoforum. Vol. 8. Hal 43-46.* (in Bahasa Indonesia).

Sonjaya, Jajang Agus. (2007). *Kebijakan untuk Mangrove Mengkaji Kasus dan Merumuskan Kebijakan*. United Kingdom: IUCN Publications Services Unit. (in Bahasa Indonesia).

Siregar, C. N. (2014). Partisipasi Masyarakat dan Nelayan dalam Mengurangi Pencemaran Air Laut di Kawasan Pantai Manado-Sulawesi Utara. *Jurnal Sosioteknologi Volume 13, Nomor 1, April 2014.*