

# The Impact of the Enactment of the Wosi Rendani Forest Zone Status on the Condition of the Rendani River Catchment Area in Manokwari Regency

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## ABSTRACT

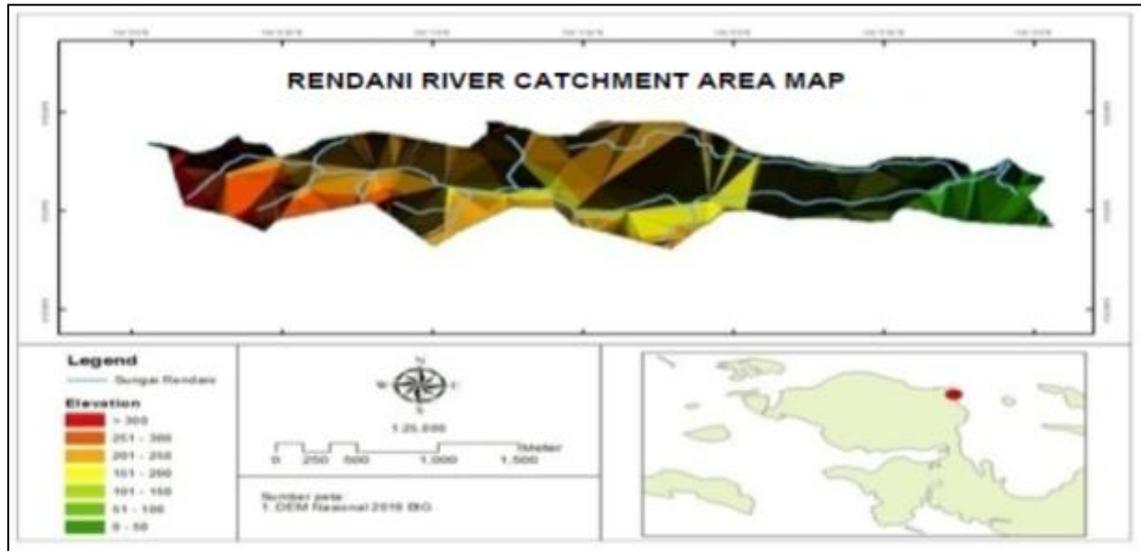
The impact of changing the status of forest zone in Wosi Rendani to become a non-forest zone also causes changes in a forest coverage zone, forest conversion, and its subsequent consequences. This was marked by the rapid housing development in the zone, which impacted water function changes in the Rendani River Catchment. This study aims to determine the consequences of determining the status of the Wosi Rendani forest zone in which there is Rendani River as one of the water sources used by the Regional Drinking Water Company (PDAM) in Manokwari city. Changes in forest coverage were reviewed for several years after determining the status of zones that switched from Protected Forests to Other Use Zones. The results showed that there has been a change in land cover by 7.38% from Primary Dry Land Forest to Secondary Dry Land Forest and increased the zone of Mixed Dry Land Agriculture by 6.97%. In addition to changes in a forest coverage zone, it also resulted in a land conversion, most of which were dominated by settlements. A further result of the change in the forest coverage.

**Keywords:** Forest zone status, Land coverage, Forest conversion, River catchment area

## 1. INTRODUCTION

A Forest zone is a particular zone determined by the government to be maintained as a permanent forest. Forests have three functions, namely the role of conservation, production and protection, including as a water regulator, oxygen provider, soil retainer, provider of community's basic need; furthermore, the crucial role of forests is as a medium for absorbing rainwater and storing it as a potential natural water supply. Under its primary function, a protected forest is a forest zone with the primary role of protecting life support systems to regulate water systems, prevent flooding, control erosion, prevent seawater intrusion and maintain soil fertility. In the development and dynamics growth, a forest zone designation and function of forest zone can be changed to meet the demands of the dynamics of national development as well as the aspirations of the

community while remaining based on optimizing the distribution of functions and benefits of forest zones in a sustainable manner and the existence of forest zones with sufficient size and distribution, that is proportional. The Presidential Decree Number 41 of 1999 on Forestry states that change of forest zone designation is an activity to change the function of a forest zone into another function which is carried out based on a request and stipulated by the Minister based on the results of integrated research, while the provisions on procedures for changing forest zone designation changes in forest zone function are regulated by government regulation, namely Government Regulation Number 104 of 2015 concerning Procedures for Changing the Designation and Function of Forest Zones. The total forest zone in West Papua is 9.713.137 hectares, of which protected forests cover a zone of 1,631,589 hectares.



**Figure 1** Map of the Rendani Manokwari River Catchment Area

This study looked at the land coverage condition in the Rendani River catchment area, which is included in the Wosi Rendani forest zone in the Manokwari Regency after its status was determined to be a Zone for Other Use (APL) which was formerly a protected forest. The total forest zone in Manokwari Regency in 2017 was 1,054,267.73 hectares. It is essential to know about forest cover changes in the Rendani River Catchment Area because of the Rendani River's presence as a water supply source for the people in Manokwari City. The water potential (total discharge) of four springs in the Wosi Rendani zone is  $701 \text{ l}\cdot\text{sec}^{-1}$ , where the water potential is still not fully utilized [1]. On the other hand, the rapid regional development due to changes in the zone's function causes the possibility of disruption of the hydrological system, resulting in a drastic reduction in water potential. It is hoped that this study will identify the changes that have occurred in the watershed zone after the change and determination of the status of the Wosi Rendani forest zone.

## 2. METHODS

The research was conducted in the Rendani River catchment area, which is included in the Wosi watershed in West Manokwari District, Manokwari Regency. This study's research tools are the Land Cover Map in the Rendani River catchment area, the Indonesian Ministry of Environment and Forestry (Ministry of Environment and Forestry) and DEM (Digital Elevation Model) 2018 with a scale of 1:25,000. Land cover changes can be detected using spatial analysis by comparing the land types zone in existing spatial data, while attribute data analysis uses Microsoft Office Excel 2007 software. Supporting data is secondary data in previous research results in research

locations or similar studies in another place. The final data analysis was carried out descriptively.

## 3. RESULTS AND DISCUSSION

### 3.1. Overview of The Rendani River Catchment Area

The Rendani River Catchment Area (DTA) is included in the Wosi Rendani zone, which was formerly a protected forest in the Manokwari Regency zone, located at  $134^{\circ}0'8.2''$ -  $134^{\circ}3'47''$ LS and  $0^{\circ}52'26.9''$ -  $0^{\circ}53'14.2''$  East Longitude with a zone of 383.31 hectares. Situated at an altitude between 10 to 320 meters above sea level (m asl). Rendani River has seven tributaries, and the length of the main river is 6,263 m. The Rendani River is one of the four rivers, the source of water used by the Manokwari Regional Drinking Water Company (PDAM) to meet people's raw water needs in Manokwari. The water that comes from the Rendani River is stored in a PDAM reservoir placed at the mouth of the cave in the Rendani River catchment area. The water discharge used for PDAM is only ten  $\text{l}\cdot\text{sec}^{-1}$  from the available water discharge, reaching  $448 \text{ l}\cdot\text{sec}^{-1}$  [2]. The map of the Rendani River catchment is presented in Figure 1.

### 3.2. Enactment of the Status of the Wosi Rendani Forest Zone

The Wosi Rendani forest area of 300.85 hectares is designated as a hydrological protected forest because of its natural characteristics and existence, which forms the basis for land protection, water management, and drinking water for the people of Manokwari and its surroundings. The legal basis for the determination was the Decree of the Governor of West Irian Province

Number 118/GIB/1969 dated 5 August 1969 concerning the Designation of the Wosi Rendani Manokwari Forest as a Hydrological Protected Forest. Matters related to the status of protected forest zones are as follows [3]:

1. Protected forest zone boundaries were implemented for the first time by the Irian Jaya Region X Forest Inventory and Mapping Center in 1976 by making a 7,745 km boundary with 108 palms. Within the zone, there is an enclaved community plantation.
2. In 1981, a forest treatise was compiled containing the forest conditions needed as material to prepare protected forest management.
3. In 1983, the boundary reconstruction was carried out by the Regional Forestry Planning Agency for Region VI Maluku Irian Jaya
4. In 1990, reconstruction of boundaries by the Sub-Center for Inventory and Mapping of Forest in the Manokwari zone. The zone boundary length is 7.73 km for a definitive zone of 300.65 ha with 118 stakes consisting of reinforced concrete stakes.
5. In 1999, the zone's status changed to another use zone as shown on the map based on the Minister of Forestry Decree Number: 891/KPTS-II/1999 concerning the Designation of Forest Zones in the Provinces of Irian Jaya, covering a zone of 42,224,800 Ha
6. From 1999 to 2012, there was no return of the zone's status to protected forest
7. The year 2013 follows the Regional Regulation of West Papua Province Number 04 of 2013 concerning the Spatial Plan of West Papua Province, which states that this zone is a zone for other uses.
8. The Year 2014 is following the Map of Forest and Water Conservation Zones for West Papua Province (Attachment to the Decree of the Minister of Forestry Number 710 of 2014) and Decree of the Minister of Forestry Number 783 of 2014 concerning West Papua Forest and Marine Conservation Zones which state this zone is included in other zones of use.
9. From 2014 to 2017, the zone's status is permanent, and there is no proposal for this zone's status.

### ***3.3. Impact of the Enactment of the Status of Wosi Rendani Forest Zone***

A forest zone change changes a particular forest zone into a non-forest zone or a forest zone with other forest functions. The purpose of changing the forest zone's role is to realize the optimization and benefits of forest zone function sustainably and continuously. Changes in forest zones occur as a result of changes in forest zone functions to other functions, or changes in

functions within the essential function of the forest zone, and changes in forest zone allocation from forest zones to non-forest zones as well as a partial designation of other zones of use into forest zones. The scope of forest zone change includes (a) changes in forest zone function, (b) Changes in forest zone allocation, (c) Partial designation of other zones of use into forest zones [4].

#### ***3.3.1. Changes in Land Cover and Land Use in DTA Rendani River***

Land Cover Map from KLHK RI (Ministry of Environment and Forestry of the Republic of Indonesia) and DEM (Digital Elevation Model) 2018 shows five land cover types in the DTA Sungai Rendani zone for the period 2009, 2014, 2016, and 2017. This series delivers the changes that took place at the research site included in the Wosi Rendani forest zone. The reason for showing land cover after 2014 is that there has been a change in the status of new forest zones that began to spread in 2014 until the Decree of Forestry No. 783 was issued. The map of 2009 was selected to show the condition of the T-5 cover before 2014, while the map of 2016 and 2017 was selected to illustrate the conditions of the post-2014 cover. Land cover type and land use are presented sequentially in Figure 2-5.

Figures 2 to 5 show changes in land cover and land use from 2009 to 2016 concerning the catchment zone. The data shows that there was no change in zone per land cover type from 2009 to 2014. Changes began to occur from 2014 to 2016. Based on these data, it can be concluded that the changes that occurred are as follows:

1. From 2014 to 2016, there was a decrease in the zone of HLKP by 7.38% to become HLKS. As a result of these changes, there was an increase in the zone HLKS with the same percentage. In addition, there was an increase in a residential zone by 7.10%, which came from the change in the zone PLKC and a decrease in the zone PLKC with the same percentage.
2. In the 2016-2017 period, there was an increase in the zone of (26.72 ha) or 6.97% in the PLKC, resulting from a decrease in the zone HLKS. During this period, there was no change in PEM.
3. During the period 2014 to 2017, there was a change in the zone at 28.31 ha or 7.38%, HLKS of 1.58 ha or 0.41%, PEM of 7.10 ha or 1.85%, PLKC of 19.62 ha or 5.12%, while the zone of open land (airport) remains 3.22 ha.

The data also shows that from 2014 to 2016, there was a change (decrease) of 100%, causing an increase in the zone of 11.21%. In the same period, there was a decrease in the zone of 10.04% of the total PLKC to PEM, or there was an increase in the zone by 24.91%.

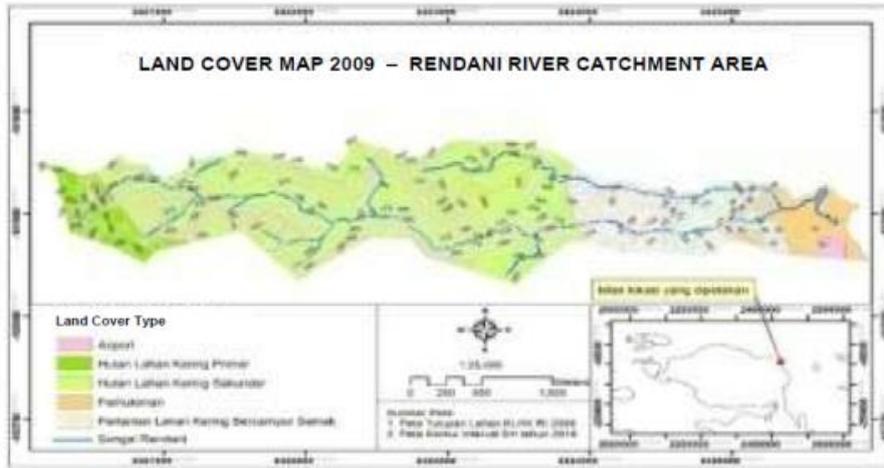


Figure 2 Land Cover Map 2009 Rendani River Catchment Area

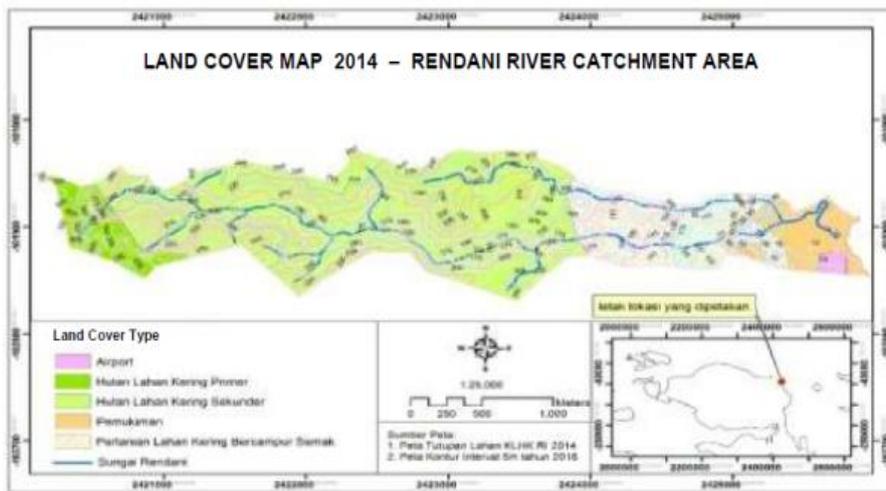


Figure 3 Land Cover Map 2014 Rendani River Catchment Area

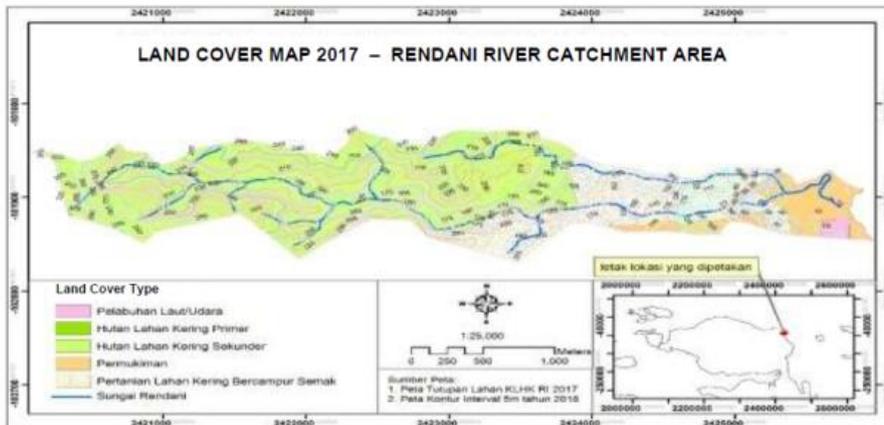
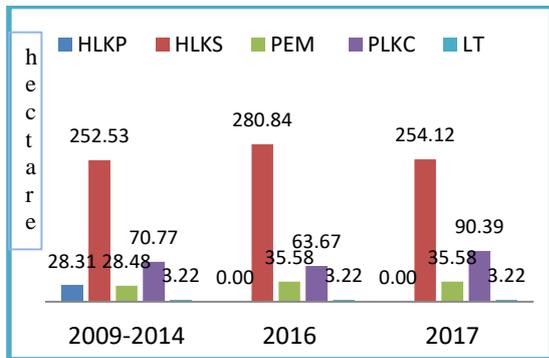


Figure 4 Land Cover Map 2017 Rendani River Catchment Area

In 2017, another change (decrease) of the HLKS zone by 9.52% to PLKC, causing an increase in the PLKC zone by 41.98%. If we calculate the change in the zone from 2009 to 2017 (effective only since 2014) based on the data on the change in the zone in point 3) above, to the initial total zone of each type of cover, it is

known that there has been a change (decrease) of 100%, the respective increases at 0.63%, 24.91% PEM and PLKC 27.72% or with the annual average change rate of total DTA are: (2.46%), HLKS (0.14%), PEM (0.62%) and PLKC (1.71%).

The land is the basic material of an environment defined by several natural characteristics: climate, soil geology, topography, hydrology, and biology [5]. Change in land cover is the state of land because humans experience changing conditions at different times [6]. In addition, land cover changes occur in the description of objects on the earth's surface obtained from selected data sources and grouped into classes of cover according to their needs [7].



**Figure 5** Changes in Land Cover Zone and Land Use

Description:

- HLKP (Primary Dryland Forest)
- HLKS (Secondary Dryland Forest)
- PEM (Settlements)
- PLKC (Mixed Dry Land Agriculture)
- LT (Open Land)

The policy to change forest zones' function that is carried out has the objective of realizing the optimization and benefits of forest zone functions sustainably. The procedures and mechanisms are carried out in stages where outreach is carried out to local governments, especially to communities around or in zones that will experience change before stipulation. Change in forest zone changes a particular forest zone to become a non-forest zone or into a forest zone with other forest functions.

In line with current developments in land use, these forest functions are disturbed. Increased forest destruction tends to occur in the future in line with evolving human needs. The cause of forest destruction is a poor forest management system such as logging, shifting cultivation, illegal grazing, forest fires, clearing forest zones for development purposes, and so on [8]. Changes in forest land use can also occur due to the development of settlements/villages in the forest. This causes people's access to take forest products, which causes changes in forest land use, leading to changes in the zone. The results of research in Donggala [9] and India [10] show that there has been a change in the function of protected forest zones where there is a change in the zone of primary forest to secondary forest and a reduction in the zone of primary forest due to the

forest being in the village administrative zone. The results of observations in the field show that there has been a change in land use function until 2017 with a total percentage decrease in the zone HLKP by 7.38% to HLKS, an increase in a residential zone by 1.85%, an increase in the zone of 6.97% in PLKC which comes from a decline HLKS zone.

Another use is for garden land carried out by community owners of customary matters and cultivators, while land use is the clearing of residential land, whether carried out collectively by housing developers or individually. The results of [11] research in 2005 show that there has been a very high conversion of land use until the 5<sup>th</sup> year; only about 2% of forest land remains in the Kali Tundo watershed. Land-use change is due to land use as a banana, coffee, clove, and mixed garden. For the downstream zone, individuals generally carry out the land because it is located along the main road. The results of observations made by the Manokwari Regency Forestry and Plantation Service showed that there had been forest clearing covering a zone of hectares [3]. One of the factors that cause forest coverage changes is the community's economy, which is related to human life needs, especially people living around forests, which is a social factor. Since 2014, land rights have been released by customary rights owners, especially for residential land. Field observations indicate that the change in the zone to HLKS and subsequently to PLKC is intended to develop residential housings in the zone. The catchment zone location, which is at an altitude with views towards the sea, has led to increased community interest in owning settlements in the zone. This has led to an increase in residential development investors who offer housing by way of soft credit through banks, resulting in the increased public interest. This is an increase in land clearing or a decrease in the zone of vegetation coverage in the DTA.

### 3.3.2. Further Impact of Changes in Land Cover and Use

The enactment of the new status as a zone for other uses has a further impact on the Rendani River catchment zone, resulting from changes in land cover and land use functions. These changes can cause changes in the zone's biophysical conditions around the Rendani River catchment and changes in the community's socio-economic conditions. Changes in the biophysical conditions of the Rendani River Watershed, such as damage or reduction in support plants on the banks of the Rendani river due to logging in the riverbank zone, the tendency of increasing flow rates to flooding in the downstream zone, damage to the riverbank due to opening access to the river body, the entry of waste originating from the settlement around water bodies or spreading around water bodies, closure

of small rivers to the main river caused by soil material covering due to eviction from road construction to community settlements, landslides in the periphery zones resulting from road construction activities, micro-climate change, loss of community land ownership rights due to control over land rights by other parties (housing investors or land buyers for settlement development or other businesses individually). The impact of increasing community acceptance as compensation for land tenure by other parties is only felt by customary rights owners who are only temporary (once at the time of payment/settlement of compensation for land). Open access to the upper reaches of the Rendani River due to road construction.

Along with the increase in human numbers and activities, the need for land has also increased. Humans tend to use land towards higher usability and expand their land's potential to meet their needs. The efforts to improve usability have led to changes in land use, especially forests. Land use is one of the factors that affect the water management function of a watershed. River flow discharge could increase due to the degradation of the soil's physical properties due to forest functions' conversion to Other Use Zones (APL) [12,13]. With the increase in the built watershed zone coverage, surface water infiltration into groundwater will be disrupted. This triggers an increase in river discharge during the rainy season, which can cause flooding and impact the lack of river discharge in the dry season, reducing river water quality. The Rendani River, which is in the Catchment Zone (DTA), Rendani River is one of the rivers of raw water for the Manokwari Regional Water Supply Company (PDAM). This could lead to the loss of water sources needed for Manokwari City people in the future.

The critical role of forest coverage is to protect the soil surface in reducing flooding [8]. Losing or reducing land coverage will result in decreased infiltration and increased runoff. The research results [14,15] showed a significant effect of cover changes due to changes in land use on the runoff coefficient, which caused an increase in discharge in the upstream part that triggered flooding. Land cover, which is dominated by forests, will better impact the hydrological parameters of a watershed. The effect of decreasing forest cover by 20.1% led to an increase in the runoff coefficient from 0.28 to 0.41 [16]. Similar research on the impact of land cover on the infiltration rate of rainwater runoff [17] shows a decrease in the infiltration rate due to the higher level of surface compaction due to changes in cover. The research results in Subang Regency [18] showed that 75% of land-use change in conservation forest zones resulted in tidal flooding and water shortages. Changes in forest land's function into plantations indicate changes in soil chemical properties, including pH, C-organic, cation exchange capacity, total N, and organic matter. It also affects root biomass, the number

of soil microorganisms [19-21], and land cover and use changes. It also results in changes to temperature [22-25].

Apart from further impacts on biophysical conditions, other different consequences are changes in the community's socio-economic conditions. There has been a change in the communities' socio-economic needs around the forest in the Sukabumi zone of West Java due to the change in the function of the zone [26]. These changes include changes in the number and type of livelihood due to loss of arable land, changes in income, changes in consumption of energy sources in the form of wood. There is a close relationship between forest land zone changes and community economic growth, as found by [27], in their research on four major islands in Indonesia: Sumatra, Java, Kalimantan Sulawesi 2011 to 2015. The direct impact on the economy due to the change in the Wosi Rendani forest zone's status is generally felt more directly by the customary rights owner as compensation for the release of land rights. The indirect impact is in the form of changes in business opportunities and business opportunities for business actors and workers, who generally take advantage of working in residential development locations.

#### 4. CONCLUSION

- (1) The enactment of a new status for the Rendani forest zone impacts land cover changes and land use in the Rendani River catchment.
- (2) A further impact of changes in cover and other uses is the biophysical change of the Rendani River catchment.

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