The Loss of Ecosystem Services in Women’s Forest at Youtefa Bay, Jayapura, Papua, Indonesia

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Abstract. The uniqueness of mangrove protection in Papua is found in the Enggros Tribe, Youtefa Bay, Jayapura, Indonesia, a Women’s Forest. Women’s Forest is a mangrove forest managed under the Tonotwiyat customary law of Enggros Tribe, where men are prohibited from entering and foraging in this forest. However, the function of women’s forest ecosystem services began to decline by decreasing water quality, waste accumulation, and land conversion. The loss of ecosystem services must be analyzed to identify and quantify the loss of indigenous peoples. Based on the four frameworks of ecosystem service functions of TEEB (2011), the provisioning services, regulating services, habitat services, and cultural services, then carried out by desk study and in-depth interviews, it is shown that the most perceived loss by the community was the reduction in provisioning services by the declining the number of fish and bia noor. There is also a decline in cultural services satisfaction from women’s forests, where it is a place to talk and tell stories for Enggros Women. Further research in economic losses is needed. Local management by the Enggros Tribe itself must be increased, followed by the support from external stakeholders for the sustainability of women’s forests.

1. Introduction

Papuan indigenous women feel the high value from mangrove ecosystem services where the mangrove ecosystem is a food source and a place for socio-cultural interaction for Papuan indigenous women when looking for shells, shrimp, and firewood around the mangrove ecosystem [1]. Indigenous Papuan women have a role in resource management in coastal areas through mangroves in coastal areas not far from the center of the capital city of Papua Province, Jayapura, namely in Youtefa Bay [2]. The customary law of Enggros Tribe protects the uniqueness of this mangrove forest through the ‘Ton or Tonotwiyat’ or “Women’s Forest” tradition [2][3][4]. Tonotwiyat is a mangrove forest conservation system that has existed for many years for women from the Enggros Tribes and regulates the dividing of foraging areas between men and women[2][3][4]. The entire mangrove forest area is only for women. Men are looking for fish in the sea area. If men enter this Women’s Forest area, they will be given customary sanctions by the tribal chief. In other words, men are prohibited from entering the mangrove forest area [2].

However, in recent years, the mangrove forest ecosystem in Youtefa Bay, where Women’s Forest is located, is currently starting to experiences changes in environmental quality [5][6][7][8][9][10][11][16]. Youtefa Bay is in the mild and moderately polluted category due to environmental parameters that exceed quality standards such as Acidity (pH), Total Suspended Solids
(TSS), Biochemical Oxygen (BOD), Nitrate (NO3-N), Phosphate (P-PO4), and Ammonia (NH3-N) [5]. Moreover, the condition of the Women’s Forest began to deteriorate with much-used waste flowing from the upstream of the Capital City of Jayapura, Papua, such as refrigerators, mattresses, and wardrobes into the Women’s Forest area [4]. The mangroves area also continue to decrease in some area due to land conversion [12]. If environmental degradation occurs, environmental services will also decrease and cause losses to the community. Lost or damaged ecosystem services must be known so that later the losses suffered by the community, in this case, the Enggros Tribes Papuan indigenous women, can be identified and quantified. Women’s forests began to be known due to the emergence of environmental pollution issues. Various studies have been performed. However, research that explicitly addresses and analyzes women’s forests damages from the experiences of indigenous peoples has never been carried out. Women’s forests are essential because it is the livelihood of indigenous peoples that needs to be maintained. Research that analyzes the ecosystem services lost must be done to support the sustainability of women’s forests.

2. Method

Millennium Ecosystem Assessment Board (MEA) 2005 classifies ecosystem service functions [13], then developed by The Economics of Ecosystems and Biodiversity (TEEB) in 2011. The ecosystem services functions framework used in this study is TEEB (2011) which qualified as Provisioning Services, Regulating Services, Habitat Services, and Cultural Services. The details of the framework are shown in Table 1. This study was undertaken in Enggros Village Jayapura City, Papua Province, Indonesia. The average distance from the capital city of Papua was ±5 km and had an area of 4.7 km². Data collection was conducted in July-Augustus 2021. This study uses primary and secondary data. In-depth interviews with several stages carried out primary data collection, first determining the key persons, then making questionnaires, and finally do the interview. Determination of key person is done purposively but in stages. The intention is to start from the highest caste of key persons or traditional leaders in the Enggros Tribe. They are the Tribal Chief, Village Head, and Elders of Indigenous Women. The method used is using qualitative methods. Then, data analysis using descriptive analysis. The framework which used to analyze ecosystem services by TEEB (2011) are stated in Table 1.

| Provisioning | Regulating | Habitat | Cultural |
|--------------|------------|---------|----------|
| Food         | Air Purification | Lifecycle Maintenance | Aesthetic Information |
| Water        | Climate Regulation (Including C-sequestration) | Gene pool protection | Recreation and tourism |
| Raw Materials| Disturbance prevention or moderation | | |
| Genetic Resource | Regulation of water flows | | Spiritual experiences |
| Ornamental Resource | Waste Treatment (esp water purification) | | Information for cognitive development |
|              | Erosion prevention | | |
|              | Maintaining soil fertility | | |
|              | Pollination | | |
|              | Biological Control | | |

3. Results and discussion

3.1. Desk Study Result

A Desk study was conducted to obtain secondary data from previous research. The research analyzed starts from 2013 until the latest research in 2021. Youtefa Bay has been damage also affects the abundance of mollusk species (shellfish), mollusk resources decrease, the economic value of mollusk
species decreases, and affects the level of consumption of the surrounding community [6]. Paulangan in 2014 calculated the economic loss of the community due to the conversion of the mangrove ecosystem in Youtefa Bay for the construction of transportation facilities (overpass); there—was a decrease in community income from Rp5.65 billion to Rp3.61 billion per year, resulting in a decrease of 2.05 billion [7]. Moreover, the Papuan Maritime Affairs and Fisheries Service reports indicate that community catches, especially fish, have declined from year to year [7].

The research in 2018 calculated the condition of mangroves from changes in the coverage area. The condition of mangroves in the Youtefa Bay area in 2017 was mostly in good condition covering an area of 211.36 Ha (90.67%) and damaged conditions covering an area of 41.76 Ha (9.33%) [9]. The following year’s research result showed that communities living around Youtefa Bay utilize the mangrove forest as a source to find food by catching crabs or shellfish, then use mangroves for firewood, building materials, medicines, net preservatives, as well as putty and boat paint materials [15]. Nevertheless, the decline in environmental quality impacts on the indigenous peoples of the Youtefa Bay area, especially the indigenous women of the Enggros Tribe. Indigenous women from the Enggros Tribe are starting to find it challenging to find bia noor, a type of shellfish that is their daily food and source of income [2].

In 2020, sari et al. analyzed that the mangrove forest in Youtefa Bay has 53 species that came from 26 families and seven orders, then the forest has ecosystem services from nursery ground, feeding ground to the shelter of predators[10]. The Econusa’s research team found that the damage to the Women's Forest was complained of by indigenous people, especially the indigenous women of the Enggros tribes, because of the reduced income which caused economic losses [4]. The recent research in 2021 stated that the mangrove ecosystem in Youtefa Bay is currently in a critical condition which has caused a decrease in the number of mangrove crabs as one of the typical biotas of the mangrove ecosystem due to the entry of domestic waste into water bodies from upstream, exploitation by the community and development with large land clearing magnitude. It is supposed that the finer the mangrove ecosystem and the water conditions, the higher the growth rate of mangrove crabs [11]. In addition, the damage of mangrove forests caused the decrease of spiritual experiences. The Enggros woman can no longer maximize their satisfaction to gather and tell stories in the women’s mangrove forest even though the forest is their traditional territory express opinions because they do not have rights [4]. The result of our research based on a desk study are stated in Table 2.

### Table 2. Loss of services in women forest from desk study.

| No | Services Typology | Loss of Services |
|----|-------------------|-----------------|
| 1. | Provisioning      | Food; loss of mollusk species (shellfish and bia noor); fish and crab. Raw materials: the decrease of firewood |
| 2. | Regulating        | The decrease of biological control; the decrease of water quality |
| 3. | Habitat           | The accumulation of garbage in mangrove forest. |
| 4. | Cultural          | Spiritual experiences; Enggros Papuan indigenous women have lost their place to gather and talk. |

### 3.2. Primary Data Result

Primary data was obtained from in-depth interviews-with key persons determined purposively to support the needs of research data. The critical person was the head of the Enggros village, the chief of the Enggros tribe, an Enggros female elder who has been looking for food in the Women's Forest for more than 30 years. The result of the research interview is mention in Table 3. Primary data from interviews using questionnaires were tabulated and then analyzed using the TEEB (2011) Framework. The results of the interviews were analyzed and described based on the type of ecosystem lost by four categories of TEEB (2011) Frameworks. The results show that provisioning services are more known and felt by the
Enggros indigenous people. Indigenous people also complain about the large piles of garbage entering the women's forest area, making it difficult to find fish or shellfish. Furthermore, the construction of the Youtefa Bridge near the forest has caused the Enggros village area to be noisier due to the sound of motorized vehicles added by the construction of a rowing venue for national sporting events causes a reduction in the catchment area. According to indigenous peoples, both of these things have caused a decrease in the number of fish. It is analyze based on the TEEB (2011) frameworks, the result shown and stated in Table 3 as follows:

| No | Services Typology | Loss of Services                                                                 |
|----|-------------------|----------------------------------------------------------------------------------|
| 1. | Provisioning      | Food; loss of fish and bia noor                                                  |
|    |                   | Raw materials: the decrease of firewood                                           |
| 2. | Regulating        | The decrease of biological control; the decrease of water quality                |
| 3. | Habitat           | The loss of lifecycle maintenance; nursery habitat for fish and bia noor         |
| 4. | Cultural          | Spiritual experiences; Enggros Papuan indigenous women could not stay in the forest for long because the water quality and the condition of the forest had decreased causing itching in the body. |

3.3. Discussion
The results are based on a desk study and primary data collection, four typologies of TEEB (2011) Frameworks; the provisioning services, regulating services, habitat services, and cultural services occur and felt by the community and indigenous women of the Enggros tribe. For provisioning services, the results of the analysis are the same which both the community and the women of the Enggros tribe feel that their food sources are reduced, namely crabs, fish, and bia noor, and the amount of firewood from mangrove forest products is reduced, and this causes economic losses and a decrease in income for them. Furthermore, the results show that water quality in mangrove forests has decreased for regulating services, causing the decline of biological control.

The different results of the analysis are in Habitat Services and Cultural Services. If we make a comparison, it is not much different. The primary data stated-the details. The secondary data show the loss of habitat services due to the accumulation of garbage, and the primary data shows the loss of spawning habitat for fish and shellfish. Furthermore, the community, especially indigenous women, feel that they have lost a place to gather and talk in the women's forest for cultural services. This is supported by a statement obtained from primary data, which states that they can no longer gather and talk in the forest because of the declining quality of the water then causing itching in their body. To this point, the four functions of ecosystem services categorized by TEEB (2011) are felt and utilized by the community and indigenous women of the Enggros Tribe, and there is a decrease or damage to the function of these ecosystems services.

4. Conclusion
Mangrove ecosystems in women's forests, the Papuan Enggros Tribe, have an ecosystem service as described based on the Ecosystem Services Framework by TEEB (2011). Frameworks are categorized into four types of services, first the provisioning services. Second, regulating services; third, habitat services, and fourth cultural services. The loss of ecosystem services from women's forests which indigenous peoples most widely perceive is the decrease in the number of fish catches and bia noor, the decrease in the amount of firewood, and most importantly, the decline in the environmental quality of women's forests both water quality and waste accumulation. This situation causes one of the essential services, the cultural services experienced by indigenous Enggros women, which indigenous women cannot fully feel. This research needs to be continued with calculating the value of the economic loss of
decreasing women's forest ecosystem services. In addition, research on the importance of women's forests must be carried out and developed because women's forests are a vital object for the Youtefa Bay area and their role for indigenous Papuan women of the Enggros tribe. Moreover, the development of women's forest local management systems originating from the indigenous Enggros Tribe itself must be improved, as well as the role of outsider’s stakeholders such as the government and communities around Jayapura, Papua, regarding the sustainability of women's forests.

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