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Contribution of Land Use Change and Land Cover to Climate Change in Coastal Areas and Their Impacts: Evidence in Jayapura City, Papua Province, Indonesia

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Abstract: This study aims to analyze land use and land cover change (LULCC) that affects climate change, especially in the coastal areas of Jayapura City as well as disaster mitigation strategies for vulnerabilities caused in the future. The method used is descriptive quantitative by identifying land use change with the spatio-temporal remote sensing method using the gaussian mixture model in the dzetsaka plugin in QGIS 3.22.4 software and strategies for handling climate change vulnerabilities in the coastal areas of Jayapura City. The geospatial process is carried out for socio-environmental aspects that apply that in the Jayapura city area experienced a significant decrease in vegetation ranging from 67.28% or an area of 29,875,904 ha. This shows the category as a deforestation area that is prone to the impacts of coastal climate change in Jayapura City. In such vulnerabilities it is necessary to take preventive measures such as reforestation or even greening that serve for proper and continuous monitoring. As in this coastal area, it is hoped that it will always have a maintained ecosystem balance to realize local environmental sustainability in the future.

Keywords: afforestation; climate change; disaster mitigation; land use and land cover change (LULCC); reforestation; spatio-temporal

Introduction

Land use and climate change have been the two major global problems, and proper research demands finding relationships and their impact for the future. Land use land cover change and climate change are interrelated to each other. This change influences one another at various temporal and spatial scales; however, improper land uses are the primary causal factor on climate change. In recent centuries land-use change significant effects on ecological variables and climate change (Mokhena et al., 2016). Land use–land cover (LULC) alteration is primarily associated with land degradation has resulted in various harmful changes in the landscape (Majeed et al., 2021). As well as in coastal areas

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there are various ecosystems that are very important for the living things that are in them. Ecosystems consisting of certain lands that are used as habitats for animals and marine life such as shrimp, shellfish, and so on. The most basic land in coastal areas is the mangrove area (Cahyaningsih et al., 2022), where animals and marine life are in dire need and feel comfortable in it.

Climate is defined as the average measure and variability of the relevant quantity of a particular variable, such as temperature, rainfall, or wind over a given period that generally spans from monthly to annual or even millions of years (Barung et al., 2021). The climate will continuously undergo changes due to the interaction between its components and external factors, such as volcanic eruptions, variations in sunlight, and factors caused by human activities, such as changes in land use to the use of fossil fuels are some of the causes. Ecosystems that are beautiful and thriving, especially in coastal areas, have sufficient characteristics to support environmental sustainability. Beautiful and developed ecosystems, especially in coastal areas, have sufficient characteristics to support environmental sustainability. This ecosystem also helps to regulate environmental stability during climate change in the region (Arifanti, 2020). However, if there is less land as an ecosystem in the region, the carrying capacity of climate change counterweight will also be reduced due to deforestation which has more impact on environmental sustainability.

In the global era, especially regions that have diverse landscapes, there are risks to land changes (Näschen et al., 2019). This risk arises in various tropical areas, especially in the coastal areas of Jayapura City. Land change is a phenomenon that can be affected by sclimate change that has occurred in the last period. According to Santos et al. (2021) with the definition of derivatives of the impacts of climate change, one of which is deforestation of about 8%. Deforestation is also a major factor in the world's spotlight related to the reduction of green land (Giam, 2017). This has a huge impact on local climate change. Because these environmental phenomena such as changes in land use and cover, deforestation and climate change become one continuity that will have a serious impact on ecosystems. Some of the factors that cause deforestation and climate change are the first, community communities related to socio-economic needs such as tourism and infrastructure development, especially in coastal areas. Some of the factors that cause deforestation and climate change are the first, community communities related to socio-economic needs such as tourism and infrastructure development, especially in coastal areas (Triyanti et al., 2021). Jayapura City has several tourist destinations, one of which is Cibery Beach, where this beach has great infrastructure in the form of a bridge named *Jembatan Merah* which was built during the administration of President Joko Widodo and Vice President Jusuf Kalla in 2018. This bridge connects between Hamadi Beach and Holtekamp Beach. This is considered very concerning for animal life and marine life which is in a unified coastal ecosystem of Jayapura City. Second, what concerns some researchers regarding the influence of deforestation and climate change is the change in coastlines. This coastline change is caused by decades of sea level rise (Tan Phong et al., 2022).

According to the Intergovernmental Panel on Climate Change (IPCC) (2022) suggests that climate change can be linked to changes in land use and cover such as deforestation, decentralization, land degradation and so on. This affects the stability of the environment in coastal regions, especially in Jayapura City. According to Sippo et al. (2018), mangroves are spearheading as a type of plant that can regulate environmental balance, especially in coastal areas. The reduction of this area poses a threat to biodiversity along the coast of Jayapura City. These impacts are the focus of this study so that potential strategies can be formulated to prevent this type of vulnerability. Although previous studies have conveyed climate change, it has not been correlated with deforestation that is increasingly rampant. Therefore, this study contributes to resilience to the threats posed as

an implementation in the coastal area of Jayapura City, Papua Province, Indonesia. The purpose of this study is to identify threats that will arise because of land change, especially the reduction of vegetation in the last five years.

Research Method

This research study area covers all areas in Jayapura City. In Figure 1, it shows the total area of Jayapura City is 75,819,854 ha with Muara Tami District as the largest district which has a coverage of 43,351,232 ha. Because evenly The Jayapura City area can be categorized as a coastal area (Hamuna et al., 2018). So, that it can become a center for the development of ecosystems based on natural resources and the environment in a sustainable manner.

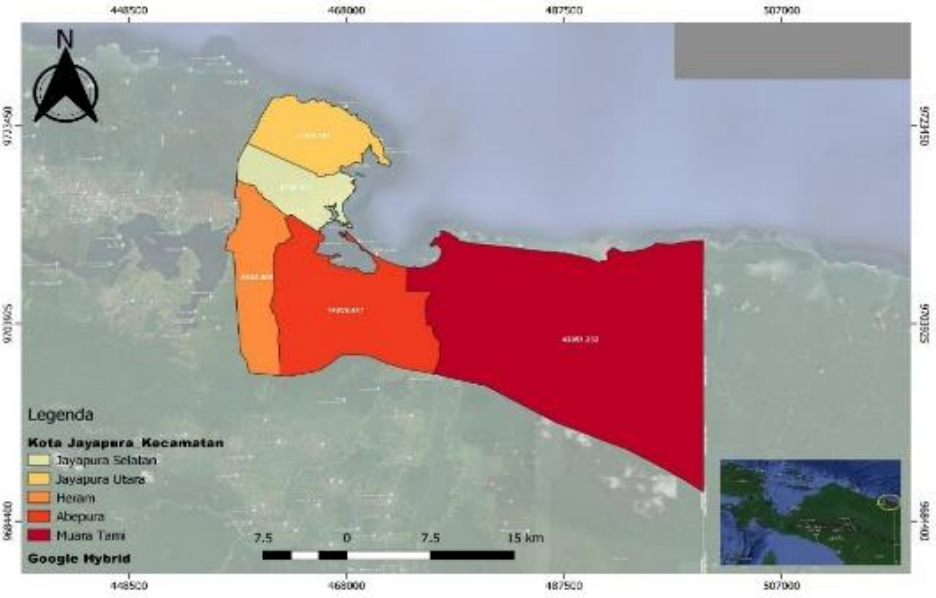


Figure 1. Administration Map of Jayapura City

Climate Change is closely related to various factors that are on the coast (Gething & Puckett, 2019). Therefore, this phenomenon can be correlated with changes in land use and cover that have many impacts such as in Jayapura City. The survival of marine life as food and livelihoods for residents around the sea is the main focus in developing strategies based on natural resources and the environment to reduce future threats and vulnerabilities. In addition, the ocean can be harnessed to produce renewable "blue energy", such as wind power, waves, heat, and biomass (Cavagnaro et al., 2020).

This research focuses on monitoring aspects in coastal areas where the concept of disaster mitigation must be considered (Dechezleprêtre et al., 2020). In this case, the study uses geospatial techniques related to changes in land use and cover with the spatio-temporal method in 2017 and 2022. Disaster mitigation is the basis of developing coastal resilience strategies based on natural resources and the environment that have been implemented by various countries in the world (Howard et al., 2017). The principles in this concept become the foundation of sustainable development by making balanced use of natural resources and conservation of coastal areas (Rahman et al., 2022).

(2017) (2022)

Source: USGS, 2022

Figure 2. Landsat-8 OLI TIRS Data for Jayapura City area 2017 and 2022

In Figure 2 shows secondary data used to analyze these in land use and cover change. Landsat-8 OLI TIRS imagery of USGS products taken in 2017 and 2022. First image processing was carried out, namely geometric and radiometric corrections (Leroux et al., 2018). Second, this Image Product was previously verified by the image checking method using a basemap such as Google hybrid (Correia et al., 2018). Then, the third validation is carried out with the Virtual Building Tools method and the Dzetzaka Plugin in other words can be mentioned with the term Semi-Automatic Classification Tools (Congedo, 2021). By using QGIS 3.22.4 with combination of bands 7, 6, and 4 (R,G,B) to display the results of the imagery according to the characteristics of each band (see Table 1). Describe about the characteristics of each band of Citra Landsat-8 OLI-TIRS products.

Table 1. Spektral Data Characteristics of Landsat-8 OLI-TIRS

Band Number	Description	Wavelength	Resolution
Band 1	Coastal/Aerosol	0.433-0.453 µm	30 Meters
Band 2	Visible Blue	0.450-0.515 µm	30 Meters
Band 3	Visible Green	0.525-0.600 µm	30 Meters
Band 4	Visible Red	0.630-0.680 µm	30 Meters
Band 5	Near-Infrared	0.845-0.885 µm	30 Meters
Band 6	Short Wavelength Infrared	1.56-1.66 µm	30 Meters
Band 7	Short Wavelength Infrared	2.10-2.30 µm	60 Meters
Band 8	Panchromatic	0.50-0.68 µm	15 Meters
Band 9	Cirrus	1.36-1.39 µm	30 Meters
Band 10	Long Wavelength Infrared	10.3-11.3 µm	100 Meters
Band 11	Long Wavelength Infrared	11.5-12.5 µm	100 Meters

Source: USGS, 2022

Spectral characteristics of the data in Table 1 serves as a reference for analyzing with the concept of remote sensing. To find out the Semi-Automatic Classification method using the Dzetzaka Plugin in QGIS 3.22.4, you can see the flow chart listed in Figure 3.

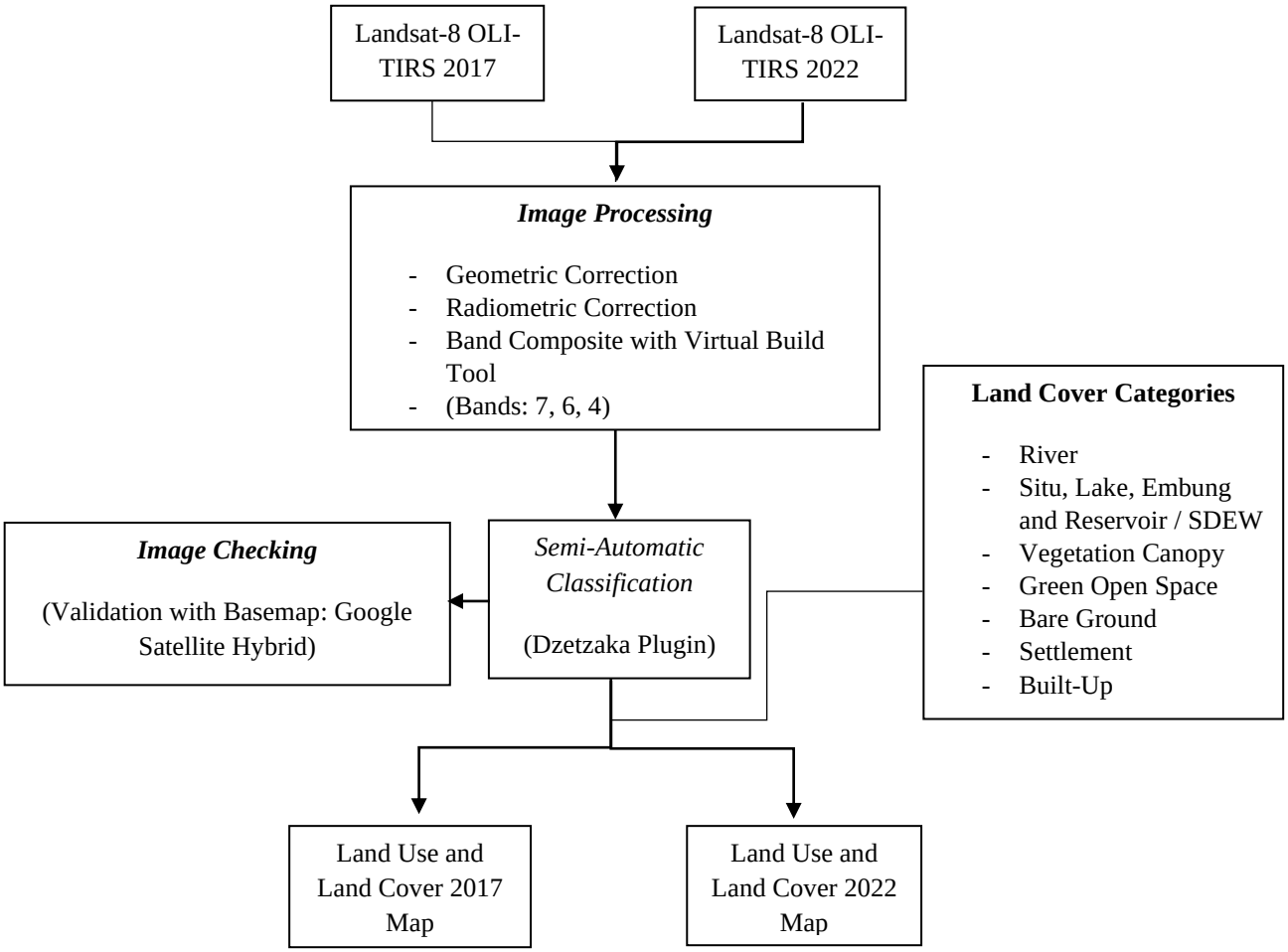


Figure 3. Flowchart of Remote Sensing Concept with QGIS 3.22.4

In the operation of this remote sensing data, researchers used QGIS software version 3.22.4. The first thing to do is to input Landsat 8 OLI/TIRS image data one by one between the products of 2017 and 2022. For the first analysis, researchers carried out image processing, namely geometric correction, and radiometric correction. The next step is still in the image processing stage, a band composite process is carried out which aims to find out the latest conditions by applying the land classification from the color differences produced by this USGS product. By using Virtual Build Tools, the bands used are in the 7th, 6th, and 4th band series.

After knowing the characteristics of the land of each color, a sample is made in the form of polygons as a reference for the next process. Then the next stage is the Semi-Automatic Classification (Gaussian Mixture-Model with Machine Learning) method using the Dzetsaka Plugin. At this stage it produces a land classification, in the form of River; *Situ* (Lake), *Danau* (Lake), *Embung* (Retention Basin), and *Waduk* (Reservoir)/SDEW; Vegetation Canopy; Green Open Space; Bare Ground; Settlement; and Built-Up. Before going to the layout stage, image checking is carried out first where at this stage an online basemap is needed which functions as a vehicle for digital screen verification and validation of land using Google Satellite Hybrid. Then after validation, it will produce Land Use and Land Cover Change Maps between 2017-2022.

Results and Discussion

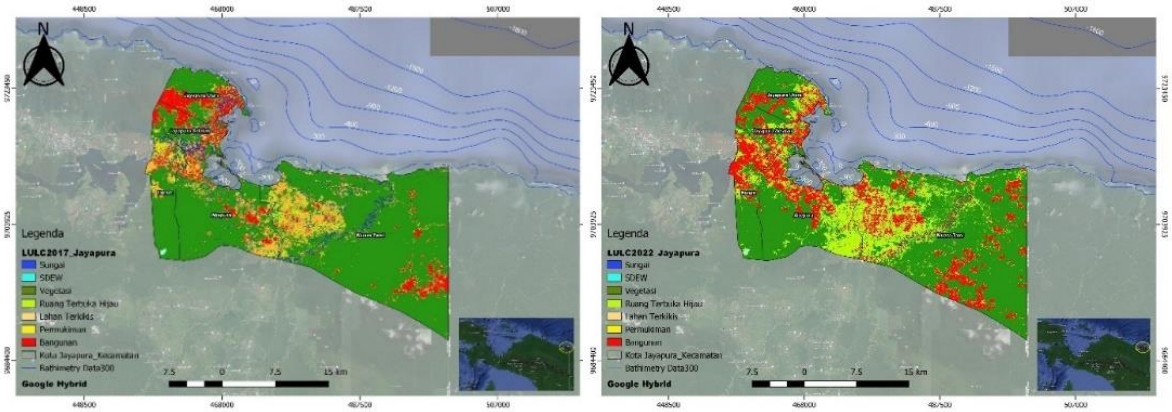
Jayapura is an area located on the coast of Papua Island, so that objects in Jayapura City are dominated by beautiful and exotic beaches (Hébert et al., 2020). Several beaches on the coast of Jayapura City that have natural resources and the environment and are recommendations in the conservation of marine life seen in Figure 4, include:

1. Base G Beach, located in Tanjung Ria Village, North Jayapura District;
2. Kupang Beach, located right in front of the Papua Governor's Office. This tourist spot is called Kupang Beach because it is synonymous with the existence of long concrete benches;
3. Hamadi Beach, located in the South Jayapura District or about 15 minutes from the Axis of Government of Papua Province;
4. Cibery Beach, located in the South Jayapura District, precisely in the Youtefa Bay Area. The beach is also located just below the Youtefa Bridge;
5. Holtekamp Beach, located on the territory of muara Tami District;
6. Yacoba Beach, located in South Jayapura District.

Figure 4. Geo-Spread Map of The Beach in Jayapura City, Papua Province, Indonesia

The diversity of these ecosystems makes Jayapura City one of the most exotic tourist destinations in Indonesia (Rahman, 2019). However, the most important part of these beaches has been damaged by socio-economic activities from both foreign tourists and locals. So that several points experienced land changes that emphasized the addition of Settlement and Built-Up and the reduction of Vegetation Canopy.

In Figure 4, which consists of various types of beaches in Jayapura City. The Red Bridge that stretches between Hamadi Beach and Holtekamp Beach is the longest bridge in Jayapura City. This bridge can be seen clearly at the Cibery Beach point. The landmark is one of dozens of built infrastructures. Despite its magnificent appearance, but what power can dozens of marine biotas such as mangroves become victims of the change of Vegetation land into Built-Ups such as mangrove land on the three beaches (Sari et al., 2020).



(2017) (2022)

Figure 5. LULCC Maps of Jayapura City 2017-2022

In Figure 5 shows a significant change in land cover with general categories, such as water bodies (river, lake, retention basin, reservoir), vegetation canopy, green open space, bare ground, settlements and built-up (Sejati et al., 2019). The results of this study identified categories in the form of land cover listed in Table 2 that in 2017-2022 has a drastically decreased vegetation area namely. This is a deforestation phenomenon that can cause climate change, especially in coastal areas because there are various types of biota that are very dependent on forest areas as their habitats (Pham et al., 2019).

As in the coastal area of the southeast of São Paulo City, Brazil, South America, there is urban expansion. This expansion affects the regeneration and socio-environmental vulnerability of vegetation areas, especially in mangrove ecosystems (Moschetto et al., 2021). Urban Expansion, according to Xian et al. (2019), is the expansion and expansion of the business with innovations to create new markets, expand the place of business. In other words, in the case of Jayapura City, it is a type of market expansion where the company's activities reach new target markets. The company's resources are successful in the area and want to expand its business, including the construction of various infrastructures, such as *Jembatan Merah*, with an emphasis on these geographical conditions.

Table 2. LULC Area of Jayapura City 2017 and 2022

LULC	Area 2017 (Ha)	Area 2022 (Ha)
Sungai	77.97	155.35
SDEW	71.50	104.10
Vegetasi	44,402.70	14,526.80
Ruang Terbuka Hijau	27,128.58	45,227.48
Lahan Terkikis	698.43	250.59
Permukiman	1,095.19	1,359.45
Bangunan Lain	2,345.49	14,196.09
Total	75,819.85	75,819.85

In Figure 6 displaying a fluctuating graph of the visualization results of Table 2. Buildings and settlements are focusing on this study because they are enough to contribute to the decrease in vegetation area, which is 67.28% or 29,875.90 Ha. Because this can adversely affect climate change, it is necessary to identify accurate strategies that can be prioritized to prevent vulnerabilities that will occur (Anderson et al., 2020).

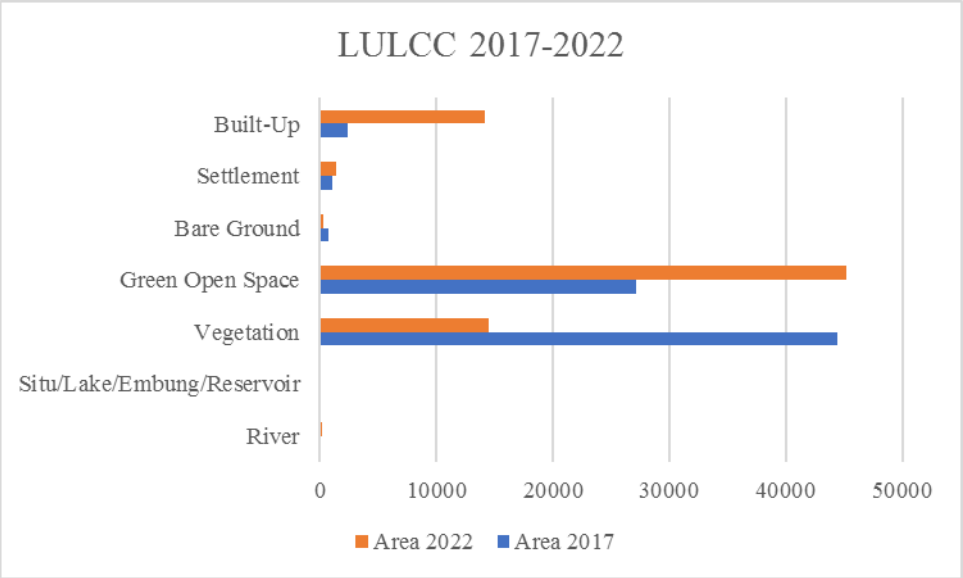


Figure 6. Graphic of Land Use and Land Cover Change in Jayapura City 2017-2022

The decrease in vegetation of the area is directly proportional to the increase in Settlement and Built-Up where Settlement has increased by 24.13 % or 264.26 Ha, while Built-Up has increased by 505.25 % or an area of 11,850.60 Ha. This is what triggers the carrying capacity of the ecosystem environment in stability to overcome climate change.

Changes that occur in the Jayapura Coastal Area based on LULCC in addition to affecting climate change can also have an impact on residents around vegetation land. As the increase in residential land, marine life in vegetation areas such as mangroves and marine fish is threatened with destruction. So that the following climate change factors can occur, namely: Increasing land surface temperature where each region has a certain degree standard, decreasing mangrove land as one of the vegetation objects which results in increased abrasion processes, prolonged dry seasons, reduced groundwater sources which are part of the needs of living things also including humans.

The coastal area of Jayapura City contains a source of life that is suitable for marine life to inhabit, with changes in the use and cover of the land, efforts are needed to prevent threats and vulnerabilities that arise due to natural factors (Pamungkas, 2021).

The strategy that can be put forward in this study is that as stated in the Paris Climate Agreement, efforts are needed to create resilience in the form of reforestation and even afforestation (Azahro & Ardi, 2017). In addition, local communities also need to adapt to vulnerabilities that arise significantly. The decrease in land area can also be affected by sea level rise, this is also a threat caused by climate change (Rahmani et al., 2021). Replanting by degraded land or re-establishment of forests from land that is not a forest area is very important in increasing this resilience that must be implemented by the local government.

Conclusion

Land in Jayapura City has changed in the last five years. There have been significant changes to Settlement and Built-Up Land. This change has increased per year by 4.83% or an area of 52.85 Ha of Settlement and 101.05% or an area of 2,370.12 Ha between 2017 and 2022. Natural resources and the local environment need to be improved by conserving forest areas, especially for mangrove plants so as to prevent threats and vulnerabilities caused. The Jayapura City Government also needs to include tribes in Papua known as the Local Customary Law Community (MHAP) and Integrated Coastal Zone Management (ICZM). The government and coastal communities are expected to unite in participating in preserving ecosystems for the survival of biota and creatures living in marine space. For its sustainability, it can be minimized the exploitation of marine products so as to create an area based on the blue economy and the green infrastructure.

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