

Strategic Planning of Infrastructure and Natural Resources in Urban Spatial Planning: Challenges and Solutions in the Era of Climate Change

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Abstract. *This study aims to explore the challenges and solutions in strategic planning of infrastructure and natural resources in Jayawijaya Regency, especially in the context of climate change. It was found that dependence on non-renewable energy sources contributes to climate change and disrupts energy supply. Proposed solutions include the development of renewable energy infrastructure, such as hydropower and solar energy, which can be integrated with sustainable natural resource management. Utilization of natural resources, such as air and sunlight, is expected to reduce carbon emissions and increase energy security. Spatial planning that considers energy networks is crucial to ensure accessibility and equitable distribution of energy throughout the region. Through this study, Jayawijaya Regency can not only face the challenges of climate change, but also create a more efficient and sustainable energy system, support economic growth, and improve the quality of life of the community.*

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INTRODUCTION

Climate change is a global challenge that has a significant impact on various aspects of life, especially in the context of urban spatial planning (Sinaga et al., 2025; Andrzejewska, 2021). Jayawijaya Regency, with its unique geography and ecosystem, faces increasing risks due to climate change, such as increased extreme rainfall, flooding, and changes in temperature patterns. In facing these challenges, strategic planning of infrastructure and natural resources is very important to ensure the continuity and resilience of the region, including the transmission of transportation infrastructure which is vital for mobility and economic growth (Duarte et al., 2024; Okolo et al., 2023).

Verico et al. (2024) said that, optimization of infrastructure, especially Wamena Airport as a transportation and accessibility hub, is crucial in supporting economic activities and community mobility. As the main gateway for Jayawijaya Regency, improving facilities and services at Wamena Airport not only strengthens regional connectivity but also contributes to mitigating the impacts of climate change (Sapioper & Priyanto, 2024; Wurarah, 2024). With adequate infrastructure, people can more easily access important resources and services, thereby increasing economic and social resilience amid ongoing climate change in urban design (Agustin & Hariyani, 2023).

However, the design of big cities in Indonesia, including in Jayawijaya Regency, still pays little attention to climate aspects, especially the wet tropical climate (Marlina et al., 2021; Sari,

2021). Problems caused by the wet tropical climate, such as high rainfall, air temperatures that are generally above comfort tolerance, scorching solar radiation, high humidity, and relatively slow air flow, are often not anticipated by city planners or designers (Rondonuwu & Gosal, 2011).

City planners need to pay attention to equipping organizational areas with supporting facilities, such as post offices, banks, health clinics, schools, and markets, so that residents do not have to travel long distances that are sometimes impassable on foot (Borsenberger, 2014). Many residents of organizational areas in cities or suburbs have to use vehicles just to go to the post office, bank, or even for daily needs (Muta'ali & Nugroho, 2019).

In the context of Jayawijaya Regency, this challenge requires a more holistic approach to spatial planning (Wijaya et al., 2017; Wagistina et al., 2025; Adi et al., 2025; Rumere et al., 2025). Efficient and sustainable energy networks, as well as natural resource (SDA) buildings such as sediment and drainage systems and energy networks, must be integrated with organizational area planning that considers accessibility and comfort for its residents (Hasddin et al., 2025).

Fahmi (2025) and Aditya et al. (2025) said that, on the other hand, efficient and sustainable energy networks are also important factors in infrastructure planning. Jayawijaya Regency has the potential for renewable energy resources that can be utilized to reduce dependence on fossil fuels. By developing an environmentally friendly energy network, this region can increase energy security, reduce carbon emissions, and adapt to the challenges of climate change and natural resources.

Furthermore, natural resource (SDA) buildings such as dams, irrigation, and drainage systems are essential to manage air effectively. This infrastructure not only supports agriculture and provides clean water but also plays a role in preventing flooding and ensuring water availability during the dry season (Joshua et al., 2022).

This study aims to explore the challenges and solutions in infrastructure and natural resource strategy planning in Jayawijaya Regency. Therefore, research is needed to analyze current conditions and identify opportunities for the development of adaptive spatial plans that can provide significant contributions in creating urban spatial planning that is more resilient to the impacts of climate change.

Therefore, this research is needed, entitled Strategic Planning of Infrastructure and Natural Resources in Urban Spatial Planning: Challenges and Solutions in the Era of Climate Change, which is expected to form a framework that can be implemented by stakeholders, including local governments, spatial planners, and the community, to improve the resilience and survival of Jayawijaya Regency in the future.

METHODS

Research Approach

This study uses a qualitative approach based on observation to obtain a comprehensive picture of the strategic planning of infrastructure and natural resources in Jayawijaya Regency. This approach allows researchers to explore the challenges faced and possible solutions.

Tools and Materials

The tools that will be used in this research are ATK, mapping drones, Digital Thermometer, Wind Direction, Anemometer, Hygrometer, Computer Devices, Arc-Gis, GPS. While the materials used for this study include Secondary Data from stakeholder agencies in Jayawijaya Regency.

Types of Data Sources

The types of data and data sources collected in this study consist of: on primary data and secondary data, namely Primary Data is data obtained through direct measurements in the field in the form of direct measurement results about Direct observation will be carried out to assess the condition of existing infrastructure, such as infrastructure networks at Wamena Airport,

Energy and natural resource networks (SDA) and Accessibility between organizational areas and public facilities. Meanwhile, secondary data is a general description in Jayawijaya Regency. This data is obtained from the results of previous relevant research, books, journals and literature sources. Furthermore, using data to formulate sustainable social policies, in accordance with the preparation of the Papua mountainous province spatial plan for 2024-2044.

Participants

The research participants consisted of: (1) Local Government officials will be involved to gain perspective on infrastructure policy and planning; (2) Spatial Planners will be involved to understand the challenges and solutions applied in spatial planning; (3) Local communities will be involved through interviews and questionnaires, where they will provide their views and experiences regarding infrastructure needs and the impacts of climate change.

Data Collection

Data will be collected through several methods as follows: (1) Literature study to review documents and reports related to infrastructure planning and climate change; (2) Conduct semi-structured interviews with participants to dig deeper into information; (3) Distributing questionnaires to the community to obtain quantitative data on their needs and expectations regarding infrastructure.

Data Analysis

Data analysis will be carried out with the following steps: (1) Descriptive Analysis to describe the condition of existing infrastructure; (2) Thematic Analysis to identify themes and patterns emerging from interview and questionnaire data; (3) Data Triangulation to obtain data from multiple sources to ensure the accuracy and validity of the results.

RESULTS AND DISCUSSION

Administrative Conditions of the Papua Mountains Region

The Papua Mountains Province is an expansion of Papua Province with an area of 5,121,333 hectares. The boundaries of the Papua Mountains Province are as follows: (1) North, bordered by Mamberamo Raya Regency, Sarmi, Jayapura, and Keerom Regency; (2) East, Bordering the country of Papua New Guinea; (3) South, Bordering Boven Digoel Regency and Asmat Regency; (4) West, Bordered by Puncak Jaya Regency, Puncak Regency, and Mimika Regency.

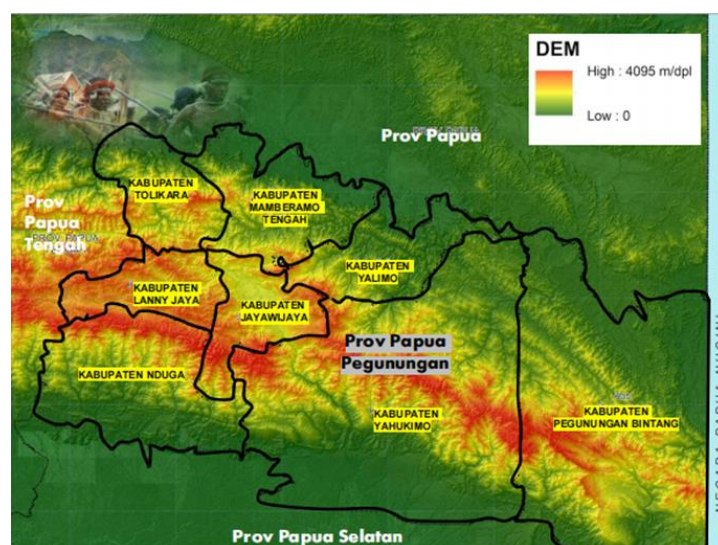


Figure 1. Administrative Conditions of Jayawijaya Regency

Source: Personal Image from the Papua Mountains Province RTRW (2024).

Physical Conditions of Climatology

The physical climatology conditions in this area show an average air humidity ranging from 79.70% to 85.80%. The average air pressure is in the range of 1,007.80 mb to 1,012.00 mb. The average wind speed is recorded at 5.00 m/sec. Rainfall also varies, with a total of between 2,500 mm³ and 4,500 mm³. This data provides an important picture of the climate characteristics that affect the environment and planning in the area.

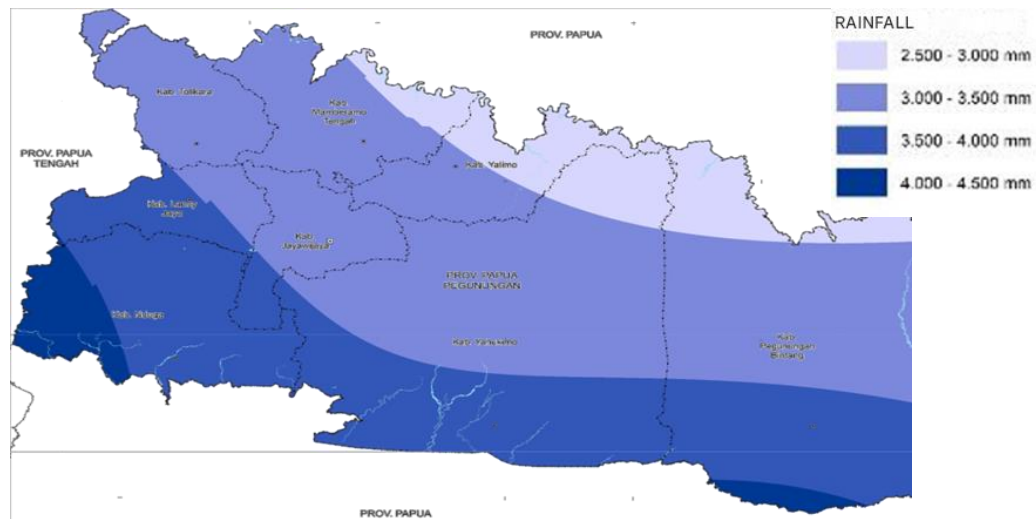


Figure 2. Physical Climatology Conditions

Source: Personal Image from the Papua Mountains Province RTRW (2024).

Infrastructure Development Priorities

Wamena Airport

The collector airports in this region consist of two main locations. First, Wamena Airport located in Jayawijaya Regency, functions as a tertiary collector airport (Figure 3).

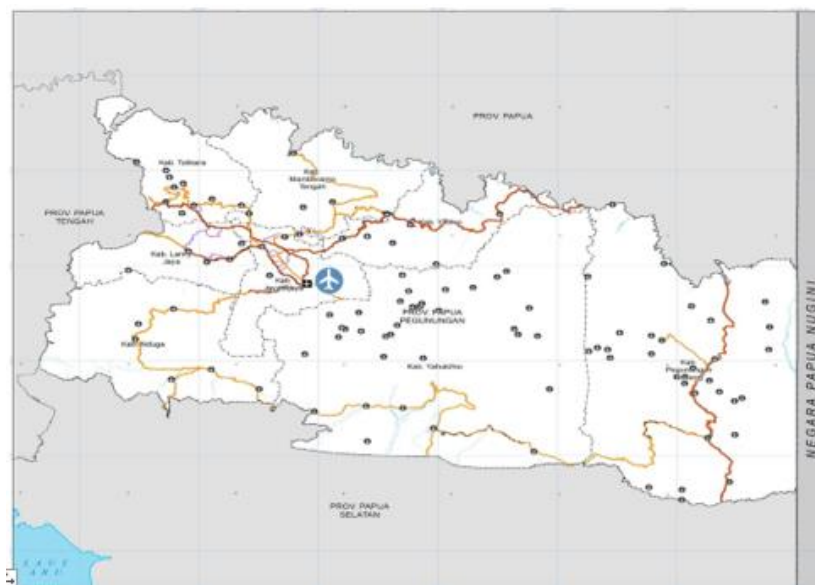


Figure 3. Optimization of Wamena Airport

Source: Personal Image from the Papua Mountains Province RTRW (2024).

Optimization of Wamena Airport can be done through several strategic steps, including the development of feeder and pioneer airports. One important step is the expansion of the

Wamena Airport runway, which will allow larger capacity aircraft to land and take off, and increase flight frequency. Thus, this optimization can improve connectivity and accessibility in the region, support economic growth, and improve transportation services for the community. This is related to Meliala's research (2024) that the expansion of the airport runway is a crucial step that can allow larger capacity aircraft to land and take off. In order to increase flight frequency, which in turn will improve connectivity and accessibility in the region, support economic growth, and improve transportation services for the community.

In Jayawijaya Regency, infrastructure strategy planning and natural resource management are very important, especially in facing the challenges of climate change. The energy network in this area plays a crucial role in supporting sustainable development and community welfare (Figure 4).

Figure 4. Energy Network

The challenges faced in Jayawijaya Regency include independence in non-renewable energy sources and the impact of climate change that disrupts energy supplies. The proposed solutions include the development of renewable energy infrastructure, such as hydroelectric power plants and solar energy, which can be integrated with natural resource management. By utilizing natural resources sustainably, such as air and sunlight, Jayawijaya Regency can reduce carbon emissions and increase energy security. Spatial planning that considers aspects of the energy network is also important to ensure accessibility and equitable distribution of energy throughout the region. Through this approach, Jayawijaya Regency is not only able to withstand the challenges of climate change but also create a more efficient and sustainable energy system, support economic growth, and improve the quality of life of the community. This is related to Aulia's research (2025) that in facing significant challenges related to dependence on non-renewable energy sources, which have an impact on climate change and disrupt energy supplies. As a solution, the development of renewable energy infrastructure, such as hydroelectric power plants and solar energy, which can be integrated with natural resource management, is proposed.

Water Resources Network

In Jayawijaya Regency, infrastructure strategy planning and natural resource management are very important aspects in facing the challenges of climate change. The energy network in this area serves as the main driver for sustainable development and improving community welfare. In this context, integration between the energy network and the air resource network is crucial. The availability of air capacity not only supports the operation of power plants, especially those based on renewable energy such as hydroelectricity, but also contributes to the efficiency of the overall energy system in Jayawijaya Regency (Figure 5).

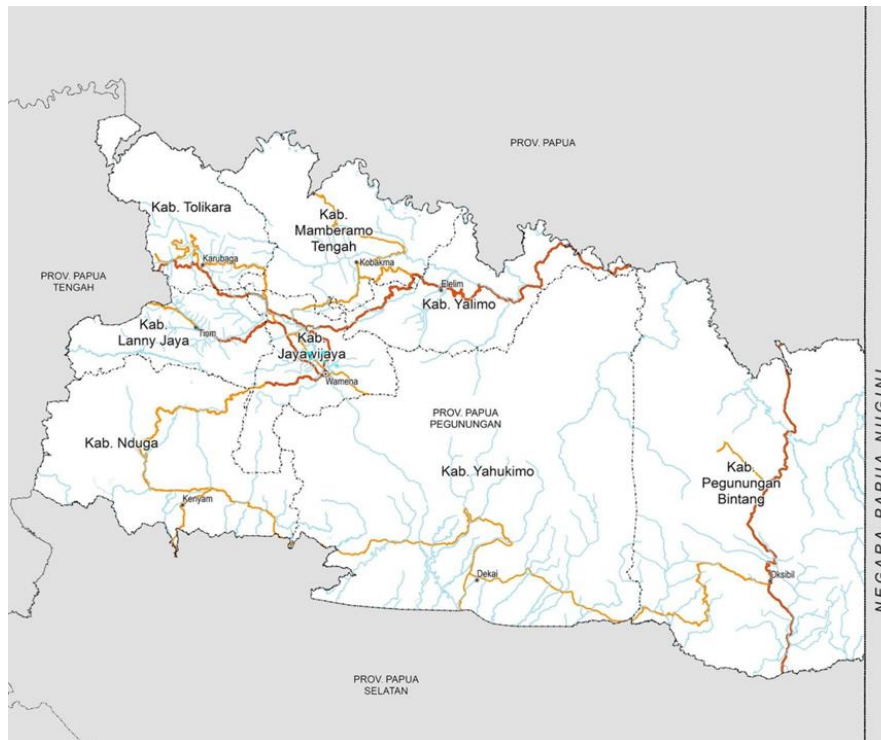


Figure 5. Water Resources Network

Source: Personal Image from the Papua Mountains Province RTRW (2024).

In Figure 5. The location designated for the water resource network is at the Rainfall Post located in Kurulu Village and Megapura Village, as well as the water estimation post in Pikhe Village, this post plays an important role in monitoring rainfall patterns and air availability. Data obtained from these posts can be used to plan more efficient water resource management and to predict the impact of climate change on air availability. Water resource management at these locations can help mitigate the impacts of climate change, such as floods and droughts, which can disrupt energy infrastructure. The sustainable use of energy networks and natural resources in urban spatial planning is an effective solution in facing challenges in the era of climate change in creating a more resilient system, supporting sustainable economic growth and improving the quality of people's lives.

CONCLUSION

This study examines "Strategic Planning of Infrastructure and Natural Resources in Urban Spatial Planning: Challenges and Solutions in the Era of Climate Change in Jayawijaya Regency." It was found that dependence on non-renewable energy sources disrupts energy supply and contributes to climate change. Proposed solutions include the development of renewable energy infrastructure, such as hydroelectric power plants and solar energy, to increase energy independence and reduce carbon emissions. Spatial planning that takes into account energy networks is important to ensure equitable distribution. Optimization of Wamena Airport will improve connectivity and attract investment in the renewable energy sector.

SUGGESTION

This research is expected to be a guide for policy makers in formulating adaptive spatial plans, supporting economic growth, and improving the quality of life of the community.

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