

# Arrangement of Coastal Area Management Institutions Bantul and Kulon Progo Regencies

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**Abstract:** The most dominant community activities are sand farming and tourism, while government intervention is in the form of infrastructure development, establishing conservation areas, protection, and tourism. The coastal areas of Bantul and Kulon Progo Regencies in DI Yogyakarta are naturally influenced by the supply of sand sedimentation from Mount Merapi, wind, and beach wave energy. However, this area has now become an area for agriculture, tourism, and other economic businesses, supported by various infrastructures. The condition shows that there is interpenetration of the ecological system by the social system and the development policy system. This research aims to organize coastal area management institutions as a result of interpenetration. The method used combines the social-ecological systems theory approach with social systems theory, which aims to get an overview of the dynamics of interpenetration. The research results show that interpenetration between the three systems occurs repeatedly and creates reciprocal symptoms. This research recommends that institutional governance be used as a middle way to reduce vulnerability, increase resilience, and strengthen sustainability. Institutional governance places the social system and development policy system as subjects, and the ecological system and the other two systems as objects.

**Keyword :** Coastal areas; Governance; Institutions

## Introduction

The threat to coastal areas cannot be separated from global environmental changes which place them as increasingly vulnerable areas (Rudiarto et al., 2018). Many protection initiatives have emerged (Magnan et al., 2022), but because of their complexity, coasts are referred to as low-lying areas. The characteristics of the coastal areas of Bantul Regency and Kulon Progo Regency are influenced by the activity of Mount Merapi. The most dominant community activities are sand farming and tourism, while government intervention is in the form of infrastructure development, establishing conservation areas, protection, and tourism. The private sector plays a role in shrimp farming activities and

tourism. These various uses, referring to (Gao et al., 2022), show the consideration of complex spatiotemporal relationships and interactions of various systems, thus directly referring to (Anālayo, 2021), the occurrence of mutual interpenetration in relationships and interactions. Their interactions and interpenetration illustrate that the ecological system of coastal areas cannot be seen as an independent system. According to (Javanmardi et al., 2023), each domain shows increasingly chaotic complex situations that have no clear boundaries because what happens outside continuously influences the ecological system, merging and creating changes that never stop.

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For this reason, Taylor advises anyone not to stick to previously agreed boundaries, especially regarding their knowledge and interpretation of the environment. Emphasized the need to carry out continuous synthesis, especially in the face of modern capitalism and its market economy which interpenetrates coastal areas. The boundaries as stated by Cole et al. (2019); Ferreira et al. (2018) are identical to the concept of common-pool resources and the social-ecological system/SES framework. Its application applies to almost all natural resources and their management which includes the function of protection and utilization with the main object being natural resources, and the subject being humans.

Understanding humans in the construction of modern society, the social system is formed from communication (Meyer & Jepperson, 2000). Communication is a synthesis of three processes, namely information selection, utterance selection, and understanding selection (Zamiri & Esmaeili, 2024). Luhmann wants to underline that viewing society as a system means viewing society as a process of communication of meaning that forms a social reality that is complex, temporal, and autopoiesis or a system that recursively reproduces elements in the system through the elements themselves (Chettiparamb, 2020; Knio, 2023). The social system is also influenced by the perspective and measures of development policies. The measure generally used to assess the success of development is economic improvement (Hariram et al., 2023; Miladinov, 2020; Zhu et al., 2022). If the achievement is low, then what needs to be focused on is

policy production (Farida & Setiawan, 2022; Obaideen et al., 2022). Even though its implementation in Indonesia adheres to the Weberian bureaucratic model, the policy formulation process requires a long period and absorbs large resources. Ironically, the costs required are often greater than the benefits obtained, the decision-making process becomes slow, which results in a loss of momentum in resolving problems that arise, or there is overlapping or non-synchronization of policies.

Based on these conditions, this research aims to develop a design for institutional management of the western coastal region of DIY. Institutional governance is built based on the reality of interpenetration between ecological, social systems, and development policies which occurs continuously, and repeatedly and creates reciprocal phenomena. This institutional governance is important as a representation of various parties who penetrate the ecological system of coastal areas so that their vulnerability and resilience are always known to ensure their sustainability.

### Method

The research location is the coastal area of Bantul Regency and Kulon Progo Regency which covers an area 47.86 km long, 400 meters wide from the coastline, or an area of 2,023.78 hectares. The research location is located at coordinates 110.125580, 8.019456 and 110.346680, - .862362.

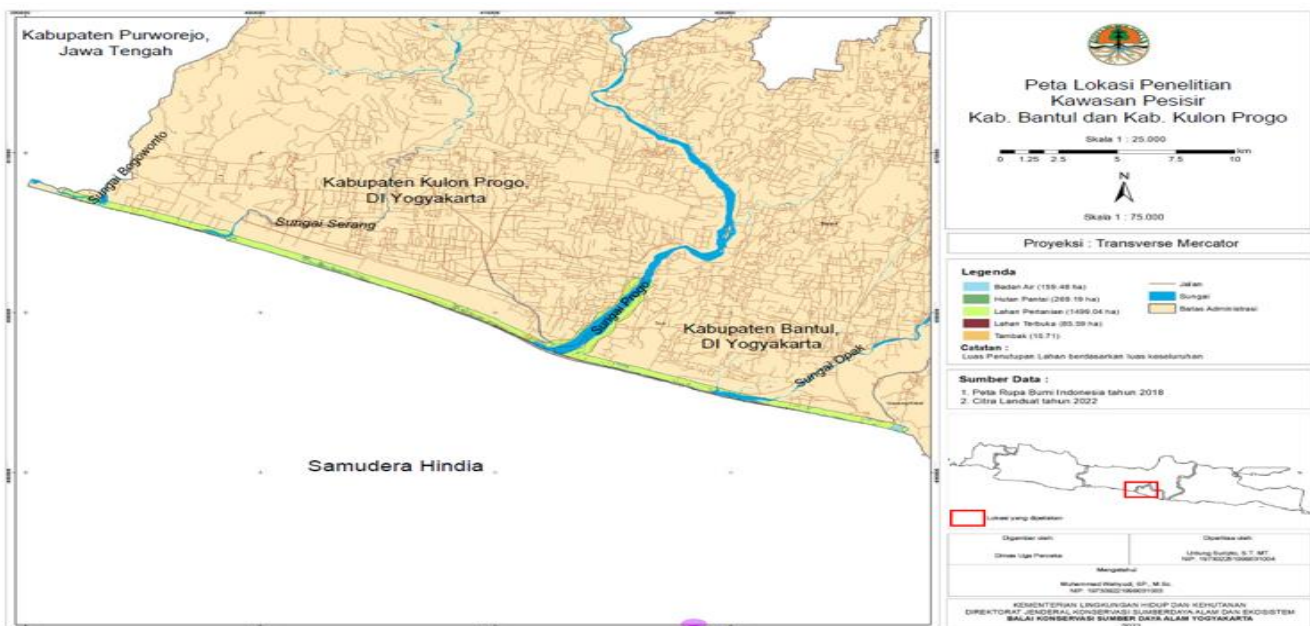


Figure 1. Research location in coastal areas of Bantul Regency and Kulon Progo Regency, DI Yogyakarta

This research uses qualitative methods, combining the social-ecological systems theory approach referring to Bruckmeier with Niklas Luhmann's social systems theory (Herrero-Jáuregui et al., 2018). The integration aims to obtain a more complete picture of the dynamics of systems that influence coastal areas, including ecological systems, social systems and development policy systems. To find a relationship that explains the facts and the measurable level of change, empirical data, direct observation and interviews were conducted with 75 selected informants consisting of ordinary citizens, community leaders, academics and researchers, government bureaucrats and non-governmental organizations.

Collection and analysis of ecological data begins by looking at land use changes, using supervised digital classification techniques referring to (Amini et al., 2022), Flora data was collected using the Nested Sampling technique, at the understory and seedling, sapling, pole and tree levels. Fauna data was collected using the Line Transect technique which includes mammals, birds and herpetofauna. The data was then analyzed to determine the diversity of species using the Shannon-Wiener index with the following formula:

$$H' = - \sum P_i \ln P_i \tag{1}$$

Where  $P_i = \frac{\text{i-th plant or wild animal}}{\Sigma \text{ total plants or wildlife}}$

Information:

$H'$  = Shannon-Wiener diversity index

$P_i$  = Abundance index

Determination of criteria:

$H' < 1$  = Low diversity

$1 < H' < 3$  = Medium diversity

$H' > 3$  = High diversity

Data analysis of social systems and development policy systems was carried out repeatedly during the research. Analysis of the two systems was carried out by looking at communication, meaning and the work of autopoiesis. The institutional management of coastal areas refers to Bruckmeier regarding vulnerability, resilience and sustainability of coastal area management.

## Result and Discussion

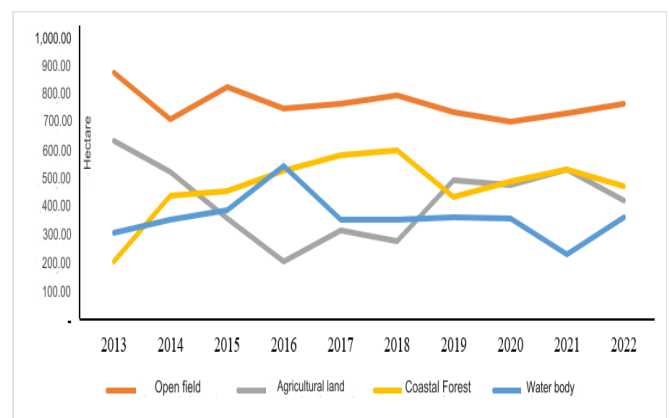
### Ecological System Dynamics

Pes-caprae is an ecosystem native to the west coast of Yogyakarta before afforestation. This ecosystem is characterized by mounded topography with sandy textured soil and a loose structure, high air and soil temperatures, high sunlight intensity, strong sea

breezes, high temperatures, and high salt levels as factors that form environmental stress (Xiong et al., 2020). With dry environmental factors and high salinity, the types of plants that are able to survive predominantly in shrubs include *Spinifex littoreus* as the dominant type, *Ipomea pescaprae*, *Calotropis gigantea*, *Crotalaria tridax*, and *Physalis sp.* There are relatively few types of trees as land cover that can grow, These, include waru (*Hibiscus tiliaceus*), siwalan (*Barossus flabellifer*), Ketapang (*Terminalia cattapa*) and little keben (*Barringtonia asiatica*). The type of undergrowth that grows tall and resembles a tree is Pandan (*Pandanus tectorius*).

Changes in the original ecosystem were triggered by the community's opinion that dry coastal land should become productive agricultural land that could improve the economy. A series of trials in collaboration with academics for almost a decade, were directed at building forests (afforestation) that function to block the wind (wind barrier) or break the wind (wind breaker) to reduce deadly air salinity or reduce the productivity of agricultural crops. The type of afforestation plant is shrimp cypress, which became successful in 1994 on Samas Beach. The momentum of successful afforestation was then replicated along the west coast as a reforestation movement by the Government and community groups. This finding is in line with Gallina et al. (2022) report, which is supported by knowledge and technology for water extraction and utilization (Kandean et al., 2022).

These findings and reports were validated through observations of satellite imagery during the 2013-2022 period, which found an increase in coastal forest area and a massive decrease in open land area which eliminated most of the original ecosystem, as illustrated in Figure 2.



**Figure 2.** Trends in land use changes over the years in coastal areas of Kab. Bantul and Kab. Kulon Progo 2013 – 2022

The decrease in open land area that needs attention is the barkhan type sand dune in Parangkusumo

covering an area of 413 ha which is the only natural phenomenon in Southeast Asia. Another change is the construction of NYIA Airport which converts agricultural land. The dynamics of changes in water bodies are influenced by tides, rainy and dry seasons, and the existence of vaname shrimp ponds. The changes are categorized as agrogenic and urbanogenic disturbances (Rebolledo Monsalve & Verduga Vergara, 2023). The dynamics of changes in the pes-caprae ecosystem have consequences for the diversity of plant and wildlife species. Identification of the diversity of coastal forest plant species, from 96 samples of measuring plots, 21 tree-habitus plant species were identified with a species diversity index value of 2.31 or classified as medium.

The dominant type is shrimp cypress (*Casuarina equisetifolia*) with a fairly high canopy density which creates a more humid microclimate than before. This micro-humidity triggers the emergence of 37 types of undergrowth with a diversity index value of 3.06. The dominant types are kerinyu (*Chromolaena odorata*), bitter grass (*Axonopus compressus*), grinting grass (*Cynodon dactylon*), and suket bone (*Eleusine indica*). This species diversity is higher than the vegetation before afforestation (Dahlan et al., 2023). In wildlife, 19 types of mammals, 40 types of birds and 24 types of herpetofauna were found.

**Table 1.** Wildlife mammals, birds and herpetofauna in the west coast of DI Yogyakarta

Wild animal	Information
Mammals	Protected species found are leopard cat ( <i>Prionailurus bengalensis</i> ), regul ( <i>Lutrogale perspicillata</i> ), Javan squirrel ( <i>Tupaia javanica</i> )
Bird	Vulnerable status: buffalo starlings ( <i>Acridotheres javanicus</i> ), dominant species include linchi swallows, Javan vultures, buffalo egrets, sparrows and rice field blekoks
Herpetofauna	Protected species with high conservation status: hawksbill turtle ( <i>Eretmochelys imbricata</i> ), olive ridley turtle ( <i>Lepidochelys olivacea</i> ), green turtle ( <i>Chelonia mydas</i> ), and leatherback turtle ( <i>Dermodochelys coriacea</i> ). Having Appendix II status according to CITES: cobra ( <i>Naja sputatrix</i> ). Common types that are easy to find are the village gecko ( <i>Draco volans</i> ), the kadut snake ( <i>Acrochordus granulatus</i> ), the monitor lizard ( <i>Varanus salvator</i> ), the panther ( <i>Duttaphrynus melanostictus</i> ) and the house gecko ( <i>Gekko gekko</i> ).

The types found are generally generalists who are able to adapt to various types of habitats, including those that have been modified by human activities.

#### *Interpenetration of Social Systems towards Ecological Systems*

The vulnerability of the ecological system of the west coast of DI Yogyakarta originates from the supra-system environment, namely the physical environment, social changes and development policies. The vulnerability of the physical environment is related to the morphology of the coastal area which was formed from the supply of sand from the eruption of Mount Merapi (Pradipta et al., 2023). Another opinion refers to the (Rocha et al., 2020) that vulnerability also comes from routine events every year in the form of changes in sea level, large waves, strong winds and estuary flooding. This physical vulnerability is increased by the presence of society (social system) and infrastructure development (development policy system) which interpenetrates the ecological system.

The independent presence of the community in the west coast area is estimated to have been going on since the 1940s (Kiaghadi et al., 2021). Another story that has developed in the community is that migration to the coastal area had taken place before that period. The presence of the community facilitated by the Regional Government occurred in 2004 and 2005 in the Ring 1

Transmigration program of Kulon Progo Regency because the area of origin, namely the Menoreh Mountains, often experiences landslides (Asriyani & Hastuti, 2019). For entrepreneurs, land control is through permits from the Regional Government, for example the PT Indokor Bangun Desa shrimp pond and the PT Jogja Magasa Iron iron sand mine.

Differences in community presence illustrate different coastal area access mechanisms. Presence through independent migration assumes the existence of inactive land which encourages land tenure claims, while migration through transmigration and investment in land acquisition through mechanisms determined by the Regional Government. The similarity is the recognition of the status of coastal area land as Sultan Ground (SG) and Pakualaman Ground (PG). The land that has been accessed for more than the last 2 decades is dominated by production agriculture which shapes the social characteristics of the community. This is confirmed by (Liu et al., 2024) regarding community livelihood mechanisms through progressive agricultural strategies, namely trying to increase land productivity using knowledge and technology. This agricultural economic activity is related to the success of afforestation as indicated by land changes as presented in Figure 2 above, and is supported by the growth of tourism and trade businesses. This strategy is supported



by community institutions and supporting sub-systems. In agriculture, communities form farmer groups and farmer group associations, as well as an auction system as a marketing mechanism for their products.

As reported by (Stringer et al., 2020) this system provides greater returns to farmers than sales through middlemen. In its role in politics, the community formed the Sand Land Farmers Association (PPLP), which was initially formed to respond to plans for an iron sand mine by PT Jogja Magasa Iron. The same mechanism applies to tourism businesses, including forming the Parangtritis Jeep Adventure Association or the Glagah Beach Tourism Pondok Laguna Association. Likewise, in turtle conservation, the Bantul Turtle Conservation Forum (FKPB) was formed in 2002. The success of agricultural businesses supported by tourism has significantly changed the level of the economy. The capital and materials collected are used as tools to build a social system that is considered better, such as building houses, buying vehicles, procuring production equipment and expanding production, saving, and improving education.

The reproduction of this social system also eliminates the term *wong cubung* which is stigmatized as poor, lacking in education and knowledge, and with bad civility. This success places land as a complex concept regarding livelihood and identity (Moreda, 2023), the main resource of life, social assets and capital (Pritchard et al., 2017), so that any disturbance to land is a direct threat to livelihoods. Rejection of low-level disturbance is evident in the disapproval of coastal forest modifications aimed at restoring the natural cycle of formation of the Parangkusumo Sand Dunes. Very strong rejection was seen in the open, vertical conflict between the community and the government in the case of granting permits for iron sand mining and the construction of NYIA Airport, which raised the importance of land through the slogan "farm or die".

#### *Interpenetration of Development Policy Systems towards Ecological Systems*

The ecological system of the west coast area is also interpenetrated by the development policy system in the form of regulations and fairly massive infrastructure development, the direction of development of the coastal area is becoming a Minapolitan area, blue economy, and iron sand mining. This regional policy is supported by the development of YIA Airport infrastructure, the Southern Cross Road and the Srandakan 2 Bridge by the Central Government. In the future, the available infrastructure will be integrated with the NYIA Airport railway line to Bantul City, and the Semarang and Solo toll roads. Another interpenetration to maintain afforestation ecosystems is the establishment of protected areas.

The Ministry of Environment and Forestry (KLHK) has designated an Essential Ecosystem Area (KEE) covering an area of 217.65 hectares, which includes mangroves on Baros Beach covering an area of 22.7 hectares, migratory bird habitat on Trisik Beach covering an area of 101.28 hectares, and mangroves in the Tanjung District area measuring 101.28 hectares. 93.67 hectares. The policy by the Ministry of Maritime Affairs and Fisheries (KKP) is the establishment of a Conservation Area in Bantul Regency Waters (KKP) covering an area of 695.89 hectares which includes Kapanewon Kretek, Kapanewon Sanden, and Kapanewon Srandakan. This determination by the Ministry of Environment and Forestry and KKP directly emphasizes that the current ecosystem must be maintained, which is not actually a native ecosystem.

During the design process until its enactment, development policies tend to negate communities that have previously controlled coastal areas, because they only involve a small number of residents who are considered representative. According to (Avelino, 2021), coercion by the government with the assumption that its aim is to improve the welfare of society tends to be coercive, which on many occasions is accompanied by the use of instruments of violence using state tools. This fact is visible in the conflict over plans for an iron sand mine and the construction of NYIA Airport, which shows the marginalization of the role of the community, which is part of the state's claim to dominance through actions based on the ideology of economism. In a broader context, (Aiyede, 2023) sees that development policy is always a justification for the authorities (Government), which places the two parties in a position facing each other when different interests arise. The phenomenon of differences in interests between the Government and society creates substantial and direct contestation (Jubba et al., 2022) creating actual conflict groups and potential conflict groups to defend their interests antagonistically.

#### *Discussion*

##### *Institutional Governance for Sustainable Management of Coastal Areas*

##### *Vulnerability and resilience of coastal areas*

Interpenetration that changes the original ecosystem of the western coastal region of DI Yogyakarta, referring to (El Zaatari & Maalouf, 2022), shows meanings that tend to negate the role of ecological systems. Likewise, the phases of meaning are different in each period, which according to (Ren & Zhao, 2021) is triggered by the discovery or use of technology. The difference in meaning begins with afforestation whose

external appearance seems to refer to the concept of biocentrism, but actually tends to be anthropocentrism.

In modern anthropocentrism, the measures generally used by society and the government in development are economic growth with indicators of productivity and investment. The result is a trade-off on a system that has previously been very well established over a very long period, which in turn creates differentiation in land functions, social structures and policy structures. Interpenetration and differentiation will continue to occur because the social system and development policy system are supported by financial strength, technology and knowledge, as well as the infrastructure to accelerate it. At this point the choice preferred by the social system and the development policy system has reached a point that is difficult to correct. This reinterpretation is even directed at being able to support economic growth with a wider scope or not just limited to coastal areas.

The problem is, the ecological system of coastal areas with all its resources has a complexity that has not been completely defined by the social system and development policy system. There are reductions in meaning according to the wishes of the two systems, although accompanied by assumptions that make management easier, which nevertheless raises risks. The history of resistance that has occurred between the two systems will always be a dark record, showing different meanings of the ecological system of coastal areas. Moreover, there is an increasingly large accumulation of capital and materials by the two systems with different productivity measures; The community uses a measure of productivity per unit of land, while the government uses a measure of exponential and spatial economic growth.

As a result, it is precisely the increasing vulnerability of the social system and the development policy system that is becoming a reverse interpenetration of the ecological system. One indicator can be seen from the appearance of plants and wild animals that did not previously exist in the pes-caprae ecosystem and the compaction of sand that previously took the form of dunes. Other indicators in the water area include the booming of river sumpil (*Faunus ater*), abrasion which damages buildings, and the loss of aquatic animals that have been consumed by the public due to changes in water bodies. Likewise, the erosion of Kuwaru Beach and Samas Beach, which are the forerunners of successful afforestation, are the areas worst affected. Another reverse interpenetration is flight disruption at NYIA Airport by birds in the surrounding area, and peaks at the moment of coastal and coastal bird migration between August-October *be* addressed is the synchronization of the ecological system, social system,

and development policy system as well as the resultant struggle between the three systems which question about resilience, vulnerability and sustainability.

This note is important in the social system of the modern world which is exploitative, dominative and loves growth, and seems to be increasingly separated from the ecological system (Ahlborg et al., 2019). In social systems and development policy systems, their vulnerability and resilience are determined by the legalization of the legal status of land, especially community cultivated land. This reflects the history of the conflict over plans for iron sand mining and the construction of the NYIA Airport. In the ecological system, the threat of vulnerability and resilience is determined by the management of ecosystem restoration in some coastal areas with native plants, and the enrichment of plant species to reduce the dominance of prawn cypress. Special restoration attention needs to be given to the barkhan type sand dune ecosystem on the coast of Parangkusumo, which is a unique and distinctive geological museum. Another benefit is that the re-formation of sand dunes is very important as a better barrier to the threat of tsunami disasters (Rafliana et al., 2022).

#### *Institutional governance for sustainable coastal area management*

Sustainability in the management of the west coast of DI Yogyakarta requires a reinterpretation of its ecological system. Reinterpretation must be continuously reproduced to reduce doubts regarding complexity, uncertainty, distribution of benefits from growth, and its sustainability. The strategy refers to (Riswanto & Sensuse, 2021), namely developing a knowledge system through the following systematics: Continuous interdisciplinary research or observations to build shared knowledge about coastal area resources; Developing a framework template that is mutually agreed between subjects and objects in coastal area management; Build a qualitative interpretive synthesis based on an agreed framework template; Develop progressive synthesis to stimulate theory construction and develop adaptive capacity and transformability; Discussion and sharing of knowledge about the dynamics of ecological systems, social systems and development policy systems.

The five systematics above will document each dynamic in the three systems. The implementation is the social system and development policy system as subjects that interpenetrate the ecological system. The aim is to build an understanding of the value and function of the coastal area ecological system by the other two systems. However, there is much complexity and uncertainty regarding the outcome of each decision and action by the other two systems. The operationalization of the

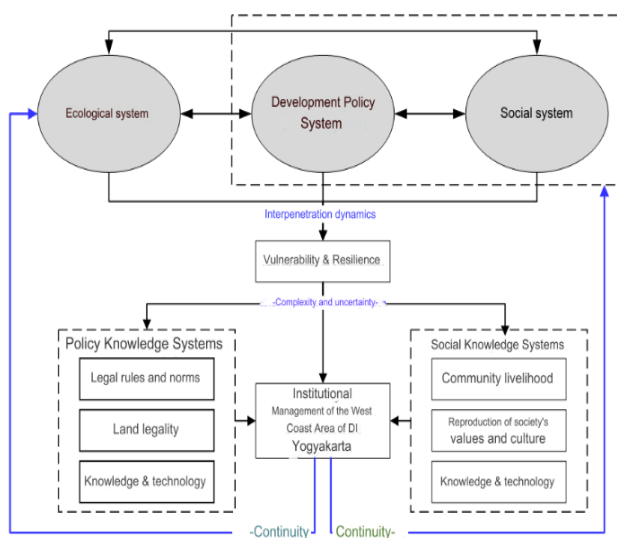
knowledge system above requires institutions that link the social system at the site (community) level with the Regional Government (along with the Yogyakarta Palace) as the authority for the development policy system. Institutional governance is a continuation after ensuring the legality of land, to build *awareness* of every intervention in the social system and development policy system which has implications for the three systems.

In this condition, the three systems are the subjects and objects of coastal area development and management, while eliminating antagonistic conditions between systems. Especially for social systems and development policies, institutional governance is a joint consideration of development plans and management of coastal areas, as illustrated in the following figure.

which are supported by agricultural production systems and tourism production as preferred choices (favor). Both are currently tools for reproducing social and cultural values, using knowledge and technology as supporting tools. In line with this, the development policy system in other forms also creates a knowledge system which is reflected in the form of legal rules and norms in the management of coastal areas. These legal rules and norms often conflict with the de facto basic rules regarding the legality of land tenure with the status of Sultan Ground and Pakualaman Ground. by the community. This phenomenon forms an unwritten "rule of law", namely that anyone who wants to use coastal land requires approval from the party who currently controls the land, namely the community, even though it de jure belongs to the Yogyakarta Palace. For Regional Governments, the experience of conflicts over land use in coastal areas in the past has reproduced new knowledge and technology regarding mechanisms for allocating land for development purposes.

Reproduction of knowledge systems by social systems and development policy systems using the five systematics of (Xu, 2024) above, needs to be brought together in institutions so that the new synthesis that is built is the middle point of meeting interests. A meeting of interests between important systems is carried out in order to have a common knowledge and perspective regarding the best knowledge, best methods and best technology used to manage the ecological system of coastal areas (shown by the blue line) as the main target. The impact not only strengthens the resilience and reduces the vulnerability of the ecological system of coastal areas, which from another perspective has an impact on the social system and development policy system as well. And with an institutionalized knowledge system, the resilience and vulnerability, as well as the complexity and uncertainty of the future of ecological systems, social systems and development policy systems will continue to be identified, synthesized and informed by their dynamics. This stage or achievement is important because every decision contains consequences that must be realized.

Thus, institutional governance is the embodiment of a policy knowledge system that contains legal rules and norms, clarity on the legality of land control and management, as well as a knowledge system that places coastal area land as a social & capital asset to support livelihoods and the reproduction of community values and culture, as well as policy implementation mechanisms. development. To ensure this, the institution is filled with representatives of the community and the Government as a united camp for achieving the goals of sustainable coastal area development. Without exception, institutions are a



**Figure 3.** A bi-directional process of mutual interpenetration between ecological, social systems and development policies

The picture above illustrates that the social system and the development policy system are one main subject, which places the ecological system as an interpenetrating object. The dynamics of interpenetration between the three systems as subjects and objects which continuously occur spatially and temporally, directly continuously change the vulnerability, resilience and sustainability of the western coastal area of DI Yogyakarta, which is basically vulnerable because its morphology is formed as sand deposits from Mount Merapi. This dynamic of mutual interpenetration creates complexity and uncertainty regarding the future of the three systems, but is also a process of knowledge reproduction, which becomes input for the social system and the development policy system regarding the dynamics of the ecological system.

For the social knowledge system, the knowledge system that is formed concerns people's livelihoods

means of opening up opportunities for building compromises over potential disagreements or compensation (profit) as a middle way and as a means of consensual deliberations.

The institutional governance above must be understood as an asset that enables sustainable competitive advantage. The model can continue to be developed, flexible and following the adaptive capacity and transformation of the three systems in the coastal area. Likewise, the transfer and replication of knowledge, which may face obstacles due to differences in knowledge and context, can actually be strategic because it shows dynamic development between subsystems. For example, when dissemination by the Regional Government to the community regarding development plans in the early stages experiences disagreements, coastal area management institutions can become mediators to reach a compromise, the aim of which is to avoid or minimize conflicts as occurred in the past.

The important note is that institutional governance will continue to develop, obtained from joint observations and re-disseminated for mutual knowledge by the community and Regional Government. In this way, coastal area management will be integrated, interpreted as unified management or integrated management that unites the interests of the three systems. From here, institutional governance of coastal areas is basically more than just production, dissemination, or application, but goes further than developing joint capacity to face the complexity and uncertainty of its sustainability in the future.

## Conclusion

This research concludes that institutional governance is an important mechanism in managing the western coastal area of DIY, as a middle ground for interpenetration between ecological systems, social systems and development policy systems. The middle way is to build a knowledge system that is run by a social system and a development policy system. The middle way is also a compromise on the resultant dynamics of the interpenetration of the three systems.

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## Author Contributions

Conceptualization; M. W.; methodology.; E. P.; validation; M. T. T. H.; formal analysis; D.; investigation.; M. W.; resources; E. P.; data curation: M. T. T. H; writing—original draft preparation. D.; writing—review and editing: M. W.;

visualization: E. P. All authors have read and agreed to the published version of the manuscript.

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## Conflicts of Interest

The authors declare no conflict of interest.

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