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Dynamics of Social and Ecological Adaptation in Multi-Level Governance: A Community Social Perspective in Environmental Management

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ABSTRACT

***Purpose**: This study examines the dynamics of social and ecological adaptation in multi-level governance, emphasizing the role of community perspectives in environmental management.*

***Subjects and Methods:** A quantitative, descriptive, and correlational design was applied using a cross-sectional survey of 200 households in coastal, upland, and urban areas of South Sulawesi. Data were collected through structured questionnaires and analyzed using descriptive statistics, Pearson correlation, and multiple regression analysis.*

***Results:** The findings reveal that governance effectiveness, community participation, and trust in institutions are positively associated with adaptation capacity. Community participation emerges as the strongest predictor, followed by trust and governance effectiveness. These results highlight the importance of social engagement and relational dynamics alongside institutional structures. Regional variations further indicate that adaptation is shaped by context-specific environmental and social conditions.*

***Conclusions:** Adaptive capacity is strengthened through integrated governance approaches that combine institutional effectiveness, active community participation, and trust-building strategies.*

INTRODUCTION

In recent decades, environmental challenges, such as climate change, deforestation, and resource depletion, have prompted a paradigm shift in the way natural resources and ecosystems are managed (Solangi & Jianguo, 2023). This shift has led to the emergence of adaptive governance models, which emphasize flexibility, collaboration, and multi-level participation in addressing complex environmental issues. Akamani (2020) said that, the concept of adaptive governance is underpinned by the recognition that traditional, top-down governance structures are often insufficient to address the dynamic and interconnected nature of social-ecological systems.

The integration of community perspectives, local knowledge, and multi-level governance frameworks has gained increasing importance as a means of enhancing resilience and promoting sustainable environmental management (Ghayoumi et al., 2023). This study examines the dynamics of social and ecological adaptation in multi-level governance, with a focus on the community social perspective in environmental management, particularly in areas experiencing rapid ecological change.

The importance of adaptive governance in environmental management cannot be overstated. Recent studies have emphasized the necessity for governance systems to be responsive to the fast-changing dynamics of ecological and social systems. Scholars such as Janssen & Van (2016) have highlighted that adaptive governance involves the capacity of social systems to manage change by embracing flexibility, inclusiveness, and learning at multiple levels. In a world increasingly defined by interconnected environmental and social challenges, effective governance requires not only the involvement of formal institutions but also the active participation of local communities, civil society organizations, and other non-governmental actors (Bernauer & Betzold, 2012; Fisher & Green, 2004).

As such, understanding how these actors collaborate across different levels of governance becomes critical in fostering resilience and addressing environmental crises. The growing body of literature on social-ecological resilience (Sehrsweeney & Fischer, 2022) suggests that local communities' adaptive capacity plays a vital role in shaping environmental management outcomes. This study contributes to the growing body of research by exploring the role of communities in environmental governance, emphasizing their pivotal position in shaping adaptive governance structures.

Despite the growing interest in adaptive governance, several key challenges persist in understanding its dynamics, particularly from a community perspective. One of the central issues is the tension between centralized and decentralized governance structures (Ran, 2017). While decentralized governance allows for more localized decision-making, it can also lead to fragmentation and inefficiencies. On the other hand, centralized governance may stifle local innovation and disregard local knowledge, which is often crucial for addressing region-specific environmental challenges.

The integration of community perspectives into governance structures remains a complex and often contested process (Ojha et al., 2016). While the inclusion of community knowledge is widely recognized as a valuable resource, the practicalities of incorporating such knowledge into formal decision-making processes are often fraught with challenges. This study seeks to address these issues by investigating the dynamics of multi-level governance in the context of environmental management, with a particular focus on the role of communities in shaping governance processes and outcomes.

To address these challenges, existing literature has proposed a variety of solutions. One of the most frequently cited strategies is the concept of collaborative governance, which seeks to bridge the gap between formal institutions and local communities through joint decision-making and knowledge sharing (Doberstein, 2016). Collaborative governance has been shown to improve the effectiveness of environmental management by enhancing trust, cooperation, and social capital among diverse stakeholders. In particular, studies have demonstrated that collaborative processes can lead to more equitable and sustainable outcomes by ensuring that the voices of marginalized or underrepresented groups are heard.

Multi-level governance frameworks, which allow for the coordination of policies and actions across different levels of government, have been identified as an effective mechanism for addressing the complexities of environmental challenges (Paavola, 2016). By integrating local knowledge and fostering cooperation between different levels of governance, multi-level governance can promote more adaptive and resilient systems. Several studies have proposed specific solutions to the issues identified in the literature. For instance, Hasselman (2017) suggests that adaptive management frameworks, which incorporate continuous learning and feedback loops, can enhance the resilience of governance systems by allowing them to adapt to unforeseen changes and uncertainties.

Research by Van et al. (2022) emphasizes the importance of institutional flexibility and the capacity to learn from past experiences in fostering adaptive governance. The authors argue that governance systems that are capable of adjusting to new information and changing circumstances are more likely to succeed in the long term. Similarly, the concept of "resilience thinking" (Ding et al., 2019) has been applied to governance to explore how systems can be designed to be more adaptive and responsive to environmental stressors. These studies highlight the potential of

adaptive governance frameworks to address the complexities of environmental management, but they also point to the need for more research into the specific mechanisms that facilitate successful adaptation at the community level.

The existing literature on adaptive governance and social-ecological resilience provides a strong foundation for understanding the dynamics of governance in the face of environmental change (Karpouzoglou et al., 2016). However, there remains a significant gap in research that explicitly focuses on the role of communities in shaping governance processes. While much of the literature emphasizes the importance of local knowledge and community involvement, there is limited understanding of how communities themselves adapt to changing environmental conditions and contribute to governance structures.

This study seeks to fill this gap by examining how communities in South Sulawesi, Indonesia, navigate the complexities of multi-level governance in the context of environmental management. By focusing on the social perspective of adaptive governance, this research aims to shed light on the specific dynamics that enable communities to influence governance processes and contribute to more resilient environmental management systems. The purpose of this study is to explore the dynamics of social and ecological adaptation in multi-level governance, with a particular emphasis on the community social perspective (Tai, 2015).

By examining the interactions between communities, institutions, and knowledge systems, this research aims to provide insights into how governance structures can be designed to enhance resilience in the face of environmental change. This study builds on previous research by highlighting the central role of communities in adaptive governance processes and exploring the mechanisms through which local knowledge and social capital can be integrated into governance frameworks. The novelty of this study lies in its focus on the community perspective, which has often been overlooked in previous research on adaptive governance. Through this investigation, the study aims to contribute to the development of more inclusive, flexible, and resilient governance frameworks that can better address the challenges posed by environmental change.

The dynamics of social and ecological adaptation in multi-level governance are complex and multifaceted, requiring a nuanced understanding of the interactions between local communities, formal institutions, and governance structures. This study seeks to contribute to this understanding by focusing on the community perspective in environmental management. By examining the role of communities in adaptive governance processes, this research aims to inform the development of more effective and resilient governance frameworks that can address the pressing environmental challenges of our time. The study's findings will provide valuable insights for policymakers, practitioners, and researchers seeking to promote sustainable environmental management practices through inclusive and adaptive governance.

METHODOLOGY

Research Design

This study employed a quantitative research approach using a descriptive and correlational design to examine the dynamics of social and ecological adaptation within a multi-level governance framework. The quantitative approach was selected to enable the measurement of relationships between key variables, including environmental change perception, governance effectiveness, community participation, trust in institutions, and adaptation capacity. Through this design, the study aims to identify patterns, trends, and statistical relationships that explain how governance structures and social factors influence community resilience. The research adopted a cross-sectional design, in which data were collected at a single point in time to capture the current conditions and perceptions of communities facing environmental challenges.

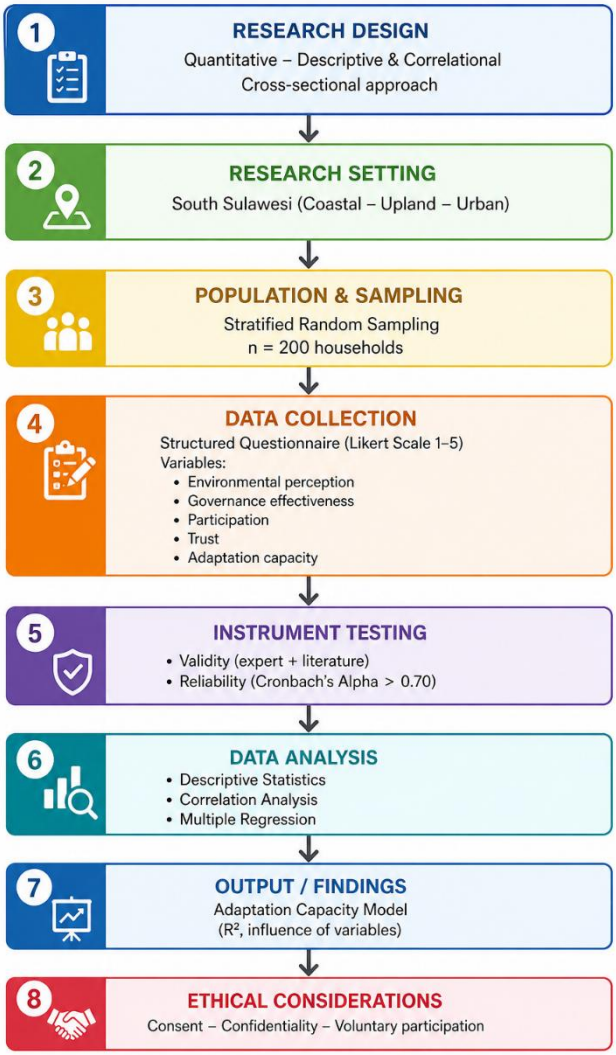

Figure 1. Research Methodology Flowchart

Figure 1 illustrates the overall research process, including research design, sampling procedures, data collection, instrument validation, and statistical analysis applied in this study.

Research Setting

The research was conducted in South Sulawesi, Indonesia, encompassing coastal, upland, and urban areas to represent diverse socio-ecological contexts. Coastal regions are characterized by exposure to flooding and coastal erosion, upland areas experience changes in rainfall patterns and land degradation, while urban areas face challenges related to waste management and infrastructure pressure. The inclusion of these varied settings enables a comparative understanding of how adaptation dynamics differ across environmental and social conditions.

Population and Sampling

The target population consisted of households living in environmentally vulnerable areas in South Sulawesi. A stratified random sampling technique was employed to ensure representation across different geographical contexts, including coastal, upland, and urban communities. The population was divided into strata based on regional characteristics, and respondents were randomly selected within each stratum. A total of 200 households were included as the sample, which is considered sufficient to support statistical analysis and to capture variations in environmental exposure and governance experiences across communities.

Data Collection Technique

Data were collected using a structured questionnaire developed based on existing literature on adaptive governance and community resilience. The questionnaire included constructs measuring environmental change perception, governance effectiveness, community participation, trust in institutions, and adaptation capacity. All variables were measured using a five-point Likert scale ranging from low to high levels, allowing for quantification and statistical comparison. In addition, demographic information such as age, gender, education, and occupation was collected to provide contextual insights into respondents' backgrounds and their relationship with environmental conditions.

Instrument Validity and Reliability

To ensure the quality of the research instrument, both validity and reliability were assessed. Content validity was established through a review of relevant literature and expert evaluation to ensure that the questionnaire accurately reflects the constructs being measured. A pilot test was conducted prior to the main data collection to refine the instrument and improve clarity. Reliability was evaluated using Cronbach's alpha, and all variables exceeded the acceptable threshold of 0.70, indicating strong internal consistency and confirming that the instrument reliably measures the intended constructs.

Data Analysis

Data analysis was carried out using statistical techniques to examine relationships between variables. Descriptive analysis was used to summarize respondent characteristics and to calculate mean values and standard deviations for each variable. Correlation analysis was conducted to identify the strength and direction of relationships between governance effectiveness, community participation, trust in institutions, and adaptation capacity. Furthermore, multiple regression analysis was applied to determine the influence of independent variables on adaptation capacity as the dependent variable. The regression model follows the general form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon$$

In this model, adaptation capacity is treated as the dependent variable, while governance effectiveness, community participation, and trust in institutions function as independent variables. The coefficient of determination (R^2) was used to assess the explanatory power of the model in explaining variations in adaptation capacity. Ethical considerations were carefully observed throughout the research process. Participation was voluntary, and all respondents were informed about the purpose of the study prior to data collection. Confidentiality and anonymity were ensured by excluding any personal identifiers from the dataset. Respondents were also given the right to withdraw from the study at any stage without any consequences.

RESULTS AND DISCUSSION

Respondent Characteristics

A total of 200 respondents participated in this study, representing coastal, upland, and urban areas in South Sulawesi. The demographic profile of respondents is an important foundation for interpreting the findings, as it reflects the socio-economic background and environmental exposure of the population under study. Understanding these characteristics helps contextualize how individuals perceive environmental change, engage with governance processes, and develop adaptive strategies. The diversity of respondents ensures that the data capture a wide range of experiences across different socio-ecological settings.

Table 1. Respondent Characteristics (n = 200)

Variable	Category	Frequency	Percentage (%)
Gender	Male	112	56.0
	Female	88	44.0
Age	18–30 years	46	23.0
	31–45 years	78	39.0
	46–60 years	52	26.0

	>60 years	24	12.0
Education	Primary	38	19.0
	Secondary	102	51.0
	Higher Education	60	30.0
Occupation	Farmer/Fisher	82	41.0
	Private Sector	48	24.0
	Informal Sector	42	21.0
	Others	28	14.0

The demographic distribution presented, indicates that the sample is composed of individuals with varying socio-economic backgrounds and levels of environmental dependence. The respondents are largely within productive age groups and are actively engaged in livelihood activities that are closely linked to environmental conditions. This composition strengthens the relevance of the data, as respondents are likely to have direct experience with environmental changes and governance processes. Furthermore, the variation in education and occupational backgrounds provides a broader perspective on how different social groups perceive and respond to environmental challenges. These characteristics support the representativeness of the sample and enhance the credibility of subsequent analyses on adaptive governance and community resilience.

Instrument Reliability

Before proceeding to further statistical analysis, it is essential to assess the reliability of the measurement instrument to ensure that each construct is consistently captured across respondents. Reliability testing evaluates the degree to which the items within each variable produce stable and coherent results, reflecting the underlying concepts of adaptive governance and community resilience. In this study, internal consistency was examined using Cronbach's alpha as a widely accepted indicator in quantitative research.

Table 2. Reliability Analysis of Variables

Variable	Number of Items	Cronbach's Alpha	Interpretation
Environmental Change Perception	5	0.82	Reliable
Governance Effectiveness	5	0.79	Reliable
Community Participation	4	0.81	Reliable
Trust in Institutions	4	0.83	Reliable
Adaptation Capacity	5	0.85	Highly Reliable

All constructs used in this study exhibit satisfactory levels of internal consistency. This indicates that the measurement items are well-aligned and capable of capturing the intended dimensions of environmental perception, governance, participation, trust, and adaptation. The consistency of these constructs suggests that respondents interpreted the questionnaire items in a relatively uniform manner despite differences in background and regional context. Overall, the reliability outcomes confirm that the instrument is robust and suitable for subsequent statistical analyses, thereby strengthening the validity of the findings related to adaptive governance and community resilience.

Descriptive Statistics

Descriptive statistical analysis was conducted to provide an initial overview of the data distribution and to understand the general patterns of the key variables examined in this study. This analysis serves as a foundational step in quantitative research, allowing researchers to identify tendencies, variability, and overall data characteristics prior to conducting more advanced statistical tests. By examining measures of central tendency and dispersion, the study ensures that the data are suitable for further inferential analysis. Descriptive statistics help to contextualize respondents' perceptions and experiences related to environmental and governance factors. Given the multidimensional nature of adaptive capacity, it is important to first capture how each variable is generally perceived within the community. This step also enables a

preliminary comparison across variables, highlighting which aspects appear more prominent or less developed in the study setting.

Table 3. Descriptive Statistics of Key Variables

Variable	Mean	Std. Deviation
Environmental Change Perception	4.21	0.68
Governance Effectiveness	3.32	0.74
Community Participation	3.65	0.71
Trust in Institutions	3.78	0.69
Adaptation Capacity	3.84	0.66

The descriptive findings indicate that respondents demonstrate a relatively strong orientation toward environmental awareness and adaptive behavior, while governance-related dimensions appear to be perceived with more variation. This suggests that although communities are cognitively and socially prepared to respond to environmental challenges, institutional factors may not always be experienced with the same level of consistency or effectiveness. The relatively stable dispersion across variables implies that respondents share broadly similar perceptions, indicating a certain degree of homogeneity within the sample. This strengthens the reliability of subsequent statistical analyses, as extreme variations or inconsistencies are limited. The findings also point to the interconnected nature of social and institutional dimensions in shaping adaptive outcomes. These results provide an important baseline for the next stage of analysis, particularly correlation and regression tests. Understanding the general tendencies of each variable allows for a more nuanced interpretation of how governance effectiveness, participation, and trust interact in influencing adaptation capacity within diverse socio-ecological contexts.

Correlation Analysis

Correlation analysis was conducted to examine the strength and direction of relationships among the key variables included in this study. This step is essential in quantitative research, as it provides an initial understanding of how variables are associated with one another before proceeding to more complex inferential techniques such as regression analysis. The use of a correlation matrix allows for a comprehensive visualization of interrelationships across all variables simultaneously. This approach is particularly relevant in studies involving governance and social dynamics, where multiple factors interact in shaping adaptive outcomes. The matrix format also facilitates easier interpretation by presenting both the magnitude and direction of relationships in a structured and comparative manner.

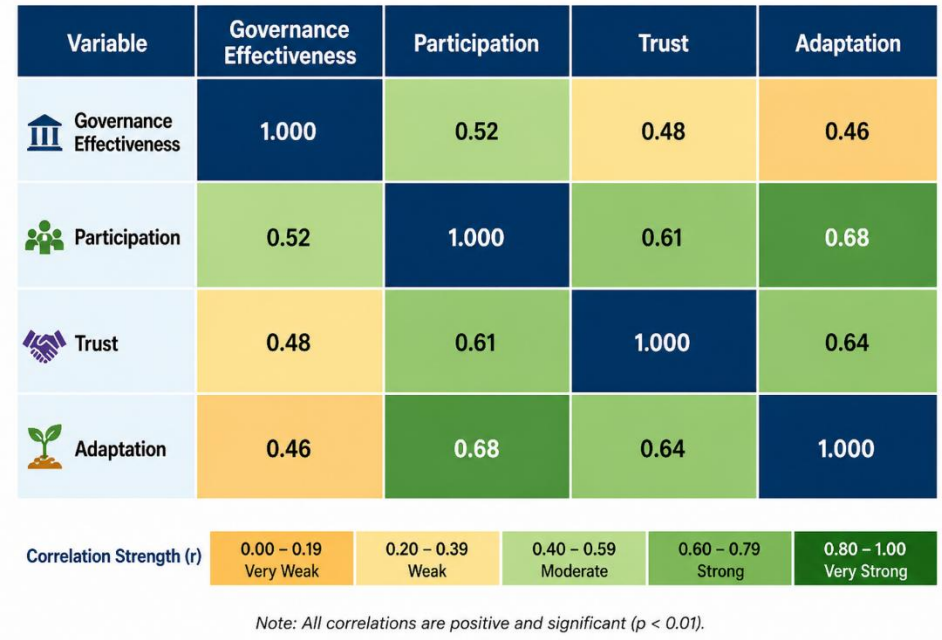

Figure 2. Correlation Matrix

The results indicate that all variables are positively and significantly correlated. Community participation shows the strongest relationship with adaptation capacity (r = 0.68), followed by trust (r = 0.64), and governance effectiveness (r = 0.46). The correlation results demonstrate a consistent pattern of positive associations among all variables, suggesting that improvements in one dimension tend to be accompanied by enhancements in others.

This finding highlights the interconnected nature of governance effectiveness, community participation, trust, and adaptive capacity within socio-ecological systems. In particular, social dimensions such as participation and trust appear to play a more prominent role in shaping adaptive outcomes compared to structural governance factors. This indicates that community-driven processes and relational dynamics may be critical drivers of resilience, especially in contexts characterized by environmental uncertainty.

The absence of negative or negligible relationships suggests that there are no conflicting dynamics among the variables, reinforcing the theoretical assumption that these factors work synergistically rather than independently. These findings provide a strong empirical foundation for subsequent regression analysis, where the relative influence of each variable on adaptation capacity can be examined in greater depth.

Multiple Regression Analysis

Multiple regression analysis was employed to assess the extent to which the selected independent variables collectively and individually influence adaptation capacity. This analytical approach is particularly appropriate for examining complex social phenomena, as it allows for the simultaneous evaluation of multiple predictors while controlling for their interrelationships. By using this method, the study aims to identify not only whether relationships exist, but also the relative strength and significance of each contributing factor.

In the context of adaptive governance, regression analysis provides a more robust understanding compared to simple correlation, as it distinguishes between direct and overlapping effects among variables. Given that governance effectiveness, community participation, and trust in institutions are conceptually interconnected, it is essential to disentangle their unique contributions to adaptation capacity. This ensures that the findings reflect a more precise estimation of influence rather than mere association.

The regression model serves as a predictive framework that helps explain variations in adaptation capacity across different socio-ecological contexts. By integrating institutional and social dimensions into a single analytical model, the study captures the multifaceted nature of community resilience. This approach aligns with contemporary perspectives that emphasize the importance of both structural governance mechanisms and grassroots engagement in addressing environmental challenges.

Table 4. Multiple Regression Results

Variable	Beta (β)	t-value	Sig.
Governance Effectiveness	0.21	3.01	0.003
Community Participation	0.39	6.50	0.000
Trust in Institutions	0.34	6.12	0.000

The regression model explains 62% of the variance in adaptation capacity. Community participation is the strongest predictor, followed by trust in institutions and governance effectiveness. The results indicate that all examined variables contribute positively to adaptation capacity, reinforcing the assumption that both institutional quality and social dynamics play integral roles in shaping adaptive outcomes. The significance of all predictors suggests that adaptation is not driven by a single dominant factor, but rather emerges from the interaction of governance structures and community-level processes.

Community participation appears to exert the most substantial influence, highlighting the critical role of active engagement and collective action in enhancing adaptive capacity. This finding supports the argument that locally embedded practices and participatory mechanisms are essential for translating policies into effective responses on the ground. It also suggests that

communities that are more involved in decision-making processes are better equipped to respond to environmental changes. Trust in institutions also demonstrates a strong contribution, indicating that confidence in governance systems facilitates cooperation and compliance with adaptive strategies. When communities perceive institutions as credible and reliable, they are more likely to support and engage in initiatives aimed at managing environmental risks. This underscores the importance of building transparent and accountable governance frameworks to strengthen adaptive resilience.

Governance effectiveness, while still significant, shows a comparatively smaller influence, suggesting that formal structures alone may not be sufficient to drive adaptation. Instead, their impact may depend on how well they are complemented by participatory processes and social trust. This highlights the need for a balanced approach that integrates top-down policy implementation with bottom-up community involvement. The overall explanatory power of the model indicates that a substantial proportion of variation in adaptation capacity can be accounted for by the included variables. However, it also implies that there are additional factors not captured in the model that may influence adaptive outcomes, such as economic conditions, cultural values, or environmental exposure. This opens avenues for future research to incorporate a broader set of determinants. These findings provide strong empirical support for the integrated governance perspective, which emphasizes the synergy between institutional effectiveness, social participation, and trust in shaping resilience. The results also offer practical implications for policymakers, suggesting that strengthening community engagement and institutional credibility may yield more impactful outcomes than relying solely on formal governance mechanisms.

Regional Comparison

To further understand the variation of adaptive dynamics across different socio-ecological contexts, a comparative analysis was conducted based on regional classifications. This analysis aims to capture how environmental conditions and governance experiences differ between coastal, upland, and urban communities. Considering that each region faces distinct environmental pressures and institutional arrangements, it is important to examine whether these differences are reflected in key variables related to adaptation. A regional comparison also provides deeper insight into the contextual nature of adaptive capacity. Rather than assuming uniform patterns across all areas, this approach highlights how local characteristics shape community responses to environmental change. By comparing mean scores across regions, the study is able to identify patterns of strength and potential gaps that may not be visible in aggregated data.

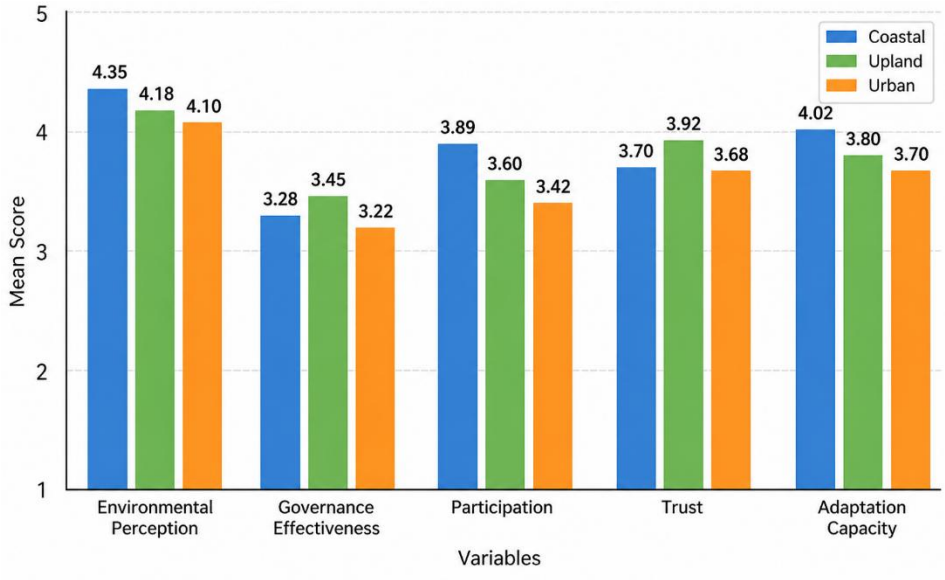

Figure 3. Regional Comparison of Key Variables

The data show that coastal communities have the highest participation and adaptation capacity, while upland communities exhibit higher trust in institutions. Urban areas show comparatively lower participation. The comparative analysis reveals that adaptive capacity is shaped by distinct regional characteristics, reflecting the interplay between environmental exposure and social-institutional dynamics. Coastal communities, which are often directly exposed to environmental risks such as flooding and erosion, appear to demonstrate stronger engagement in adaptive practices. This suggests that higher exposure to environmental challenges may encourage more proactive community responses.

Upland communities show stronger institutional alignment, which may indicate more stable or cohesive relationships between communities and governing bodies. This pattern highlights the importance of institutional trust in supporting adaptation, particularly in areas where environmental changes are more gradual but still significant. Urban areas, on the other hand, display relatively different dynamics, where structural challenges such as population density and infrastructure pressure may influence levels of social engagement. This suggests that adaptation in urban contexts may require different strategies, particularly those that focus on strengthening community participation and coordination. The findings emphasize that adaptation is not uniform across regions, but rather context-dependent. These differences underline the need for region-specific policy approaches that consider local environmental conditions, social structures, and governance capacity in order to effectively enhance community resilience.

Discussion

The Effect of Governance Effectiveness on Adaptation Capacity

The findings of this study confirm that governance effectiveness has a positive and significant influence on adaptation capacity. Effective governance provides regulatory frameworks, resource allocation mechanisms, and coordination platforms that enable communities to respond systematically to environmental challenges (Potts, 2020; Giwah et al., 2021; Ansell & Gash, 2018; Danielsen et al., 2022). From a statistical perspective, the regression results demonstrate that governance effectiveness contributes meaningfully to explaining variation in adaptation capacity, although its effect is comparatively smaller than other predictors. This suggests that while governance structures are important, they may function more as enabling conditions rather than primary drivers of adaptation.

In other words, governance effectiveness alone is insufficient unless it is complemented by strong social dynamics. This finding is consistent with adaptive governance theory, which emphasizes that institutional arrangements must be flexible, inclusive, and responsive to local contexts. In the case of South Sulawesi, variations in governance effectiveness across regions likely reflect differences in policy implementation, administrative capacity, and accessibility of public services. These variations influence how communities perceive and engage with institutional support systems. The moderate strength of governance influence may indicate gaps between formal policies and their practical implementation.

Even when governance systems are designed to support adaptation, their effectiveness depends on how well they are translated into actionable programs at the community level. This highlights the importance of bridging the gap between policy formulation and on-the-ground execution. Another important aspect is the role of governance in reducing uncertainty. Environmental challenges often involve unpredictable risks, and effective governance can provide guidance, information, and resources that help communities navigate these uncertainties (Dewulf & Biesbroek, 2018; Ulibarri, 2019; Sword-Daniels et al., 2018; Ahmad, 2024). However, if governance systems are perceived as inefficient or inconsistent, their ability to support adaptation may be diminished.

The findings also suggest that governance effectiveness interacts with other variables, particularly participation and trust. Rather than acting independently, governance appears to function within a broader network of social relationships. This reinforces the idea that adaptation is a multi-dimensional process that requires both institutional and social components. From a policy perspective, the results imply that improving governance effectiveness should focus not only on strengthening institutional capacity but also on enhancing responsiveness and inclusivity.

Policies that are designed without considering local needs and community input may fail to achieve their intended impact.

The relatively lower contribution of governance effectiveness compared to other variables suggests that top-down approaches alone are insufficient. Policymakers need to adopt integrated strategies that combine institutional support with community-driven initiatives to maximize adaptive outcomes. The findings confirm that governance effectiveness remains an essential component of adaptive capacity, but its impact is contingent upon its interaction with social factors (Salajegheh et al., 2020; Dressel et al., 2020; Hamilton & Lubell, 2019). This underscores the importance of adopting a holistic governance approach that integrates institutional strength with community engagement.

The Effect of Community Participation on Adaptation Capacity

According to Khatibi et al. (2021), indicating that community participation is the most influential factor in shaping adaptation capacity. This finding highlights the central role of collective action and local engagement in responding to environmental challenges. Communities that actively participate in decision-making processes are more likely to develop effective and context-specific adaptive strategies. The strong influence of participation reflects the importance of bottom-up approaches in adaptive governance. Unlike top-down policies, participatory processes allow communities to contribute their knowledge, experiences, and priorities, leading to more relevant and sustainable solutions. This is particularly important in regions with diverse environmental conditions, such as South Sulawesi.

Participation also enhances social learning, which is a key component of adaptive capacity. Through interaction and collaboration, individuals and groups can share information, develop new skills, and adapt their behaviors in response to changing environmental conditions. This process strengthens the collective ability of communities to cope with uncertainty. The high contribution of participation suggests that adaptation is deeply rooted in social practices rather than purely institutional mechanisms (Patterson et al., 2019; Mikulewicz, 2020; Jiménez et al., 2019). Communities that are actively involved in environmental management are more likely to take ownership of adaptation initiatives, increasing their effectiveness and sustainability over time.

Another important dimension of participation is its role in empowering communities. When individuals are given opportunities to engage in governance processes, they are more likely to feel a sense of responsibility and agency. This empowerment can lead to increased motivation to adopt adaptive behaviors and support collective action. The findings also indicate that participation may serve as a bridge between governance and trust. Active involvement in decision-making processes can enhance transparency and accountability, which in turn strengthens trust in institutions (Mappisabbi & Yappi, 2024; Androniceanu, 2021). This suggests that participation not only directly influences adaptation but also indirectly contributes through other variables.

it is important to recognize that participation is not uniform across regions. As shown in the regional comparison, certain areas exhibit higher levels of engagement than others. This variation may be influenced by factors such as socio-economic conditions, cultural norms, and access to information. From a practical standpoint, the results emphasize the need for policies that promote inclusive participation. Governments and institutions should create platforms that facilitate community involvement, such as public consultations, local forums, and collaborative planning processes (Falco & Kleinhans, 2018).

Efforts should be made to address barriers to participation, including limited awareness, lack of resources, and unequal power dynamics. Ensuring that all community members have the opportunity to participate is essential for achieving equitable and effective adaptation outcomes. Community participation emerges as the most critical driver of adaptation capacity, highlighting the importance of empowering communities and fostering collective action in addressing environmental challenges (Falco & Kleinhans, 2018; Dushkova & Ivlieva, 2024; Ali & Kamraju, 2024).

The Effect of Trust in Institutions on Adaptation Capacity

Trust plays a crucial role in shaping how individuals and communities interact with governance systems and respond to policy interventions (Correia, 2024; Liu et al., 2022; Edwards et al., 2019). High levels of trust indicate that communities perceive institutions as credible, reliable, and capable of addressing environmental challenges. This perception encourages cooperation and compliance with policies, which are essential for effective adaptation. When trust is present, communities are more willing to engage in collective efforts and support institutional initiatives.

The strong influence of trust suggests that adaptation is not only a technical or structural process but also a relational one. Social relationships between communities and institutions significantly affect the success of adaptive strategies (Suhaeb et al., 2024; Armitage et al., 2020). Trust facilitates communication, reduces conflict, and enhances collaboration among stakeholders. Trust can reduce uncertainty and perceived risks associated with environmental changes. When communities trust institutions, they are more likely to rely on the information and guidance provided, leading to more informed and coordinated responses. This is particularly important in situations where rapid decision-making is required.

The results also highlight the interplay between trust and participation. Trust can encourage individuals to participate in governance processes, while participation can, in turn, strengthen trust by increasing transparency and accountability. This reciprocal relationship reinforces the overall adaptive capacity of communities. The relatively strong contribution of trust compared to governance effectiveness suggests that perceptions of institutions may be more important than their formal structures (Farwell et al., 2019; Kaasa & Andriani, 2022). Even well-designed policies may fail if they are not supported by public trust.

Regional variations in trust further illustrate its contextual nature. In upland areas, higher levels of trust may reflect closer relationships between communities and local institutions. This indicates that trust is influenced by both institutional performance and social proximity. From a policy perspective, building trust requires consistent and transparent communication, as well as accountability in decision-making processes. Institutions must demonstrate reliability and responsiveness to community needs in order to maintain public confidence.

Efforts to strengthen trust should be integrated with strategies that promote participation and improve governance effectiveness. These elements are interdependent and collectively contribute to enhancing adaptation capacity. Institutions is a key determinant of adaptive capacity, acting as a catalyst for cooperation and collective action. Strengthening trust should therefore be a priority in the development of adaptive governance frameworks.

CONCLUSION

This study concludes that adaptation capacity in South Sulawesi is shaped by an integrated interplay between institutional and social factors within a multi-level governance framework. The findings demonstrate that governance effectiveness, community participation, and trust in institutions all have significant and positive influences on adaptation capacity, with community participation emerging as the strongest predictor, followed by trust and governance effectiveness. These results highlight that while formal governance structures provide essential support, adaptive capacity is more strongly driven by active community engagement and relational trust, which enable collective action and effective implementation of adaptive strategies. The study also reveals regional variations, indicating that adaptation is context-dependent and influenced by specific socio-ecological conditions. Overall, the findings underscore the importance of combining top-down governance approaches with bottom-up participation and trust-building efforts to enhance resilience, suggesting that sustainable adaptation policies should prioritize inclusive engagement, institutional credibility, and context-sensitive strategies.

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