

Comparative Analysis of Just Transition Pathways in Urban and Rural Communities under Climate Change Pressures

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ABSTRACT:

This study presents an innovative comparative methodology that assesses the pathway of just transition in both urban and rural areas in light of climatic change. Filling the void in a holistic analysis on a spatial basis, the study integrates four dimensions of analysis into one coherent evaluation model that conforms to the principles of just transition: equity, inclusiveness, resilience, and sustainability. It has been observed that there are some different but complimentary patterns found out from these results. Firstly, urban areas are vulnerable to heat waves and pressure on infrastructure, but have more institutional competence and manage to gain high resilience due to technological efforts. On the other hand, rural areas suffer from drought and water scarcity, but are more inclusive and sustainable as compared to urban regions. This study presents a model that has multidimensional methods to compare in various settings and empirical data on how these two transitions are complementary and can be compared. The current study demonstrates the significance of using urban technology and the community-based process in rural areas to bring about sustainable climate transition.

Keywords: Just transition, climate resilience, urban–rural comparison, socio-economic vulnerability and sustainable adaptation.

1. Introduction

The problem of climate change has become one of the biggest global challenges of our time because it creates a lot of environmental, economic, and social pressure on people living on different continents (Wright et al., 2024). Climate warming and changes in the pattern of precipitation, the increase in the occurrence of natural disasters affect the vulnerability of the population, especially in the countries of the developing world, where there is not enough adaptive capacity to withstand the impact of the processes of global warming (Arshed et al., 2024). One of the main ideas used to respond to such challenges is the concept of a just transition

(Galanis et al., 2025). The term just transition denotes the process of shifting from high-emission economies to environmentally friendly ones without imposing negative consequences on society.

The significance of just transition pathways is best highlighted when one looks at the features of cities and rural societies which differ greatly from each other (Moore-Cherry et al., 2025). Cities, which are densely populated with industry and well developed infrastructures, contribute to a great extent in greenhouse gas emissions but they have sufficient funds, expertise, and technology to adopt mitigation and adaptation measures (Rasebechele et al., 2024). Rural

societies depend heavily on climatically sensitive sectors like agriculture and mining which make them highly susceptible to the changing conditions of the environment (Abebaw, 2025). Despite being relatively low contributors to global emissions, they are faced with the risk of climate change impacts due to their lack of resources (Saxena, 2025).

Climate justice in urban settings can be defined through transitions that are influenced by the desire to transition towards carbon neutrality, improve infrastructure resilience, and socioeconomic equity amid fast-growing communities (Almulhim and Cobbinah, 2026). Urban transition is a process that involves the development and execution of various strategies aimed at ensuring sustainability in different aspects, including energy sources, transportation, green infrastructure, and more (Sharma et al., 2025). Nonetheless, urban transitions come with many challenges related to issues such as affordability, employment opportunities, and accessibility to basic services for those who reside in slums (Asnakew et al., 2026).

Conversely, the transition process in the rural context is highly dependent on issues such as livelihood security, land use, and sustainability of the ecosystem (Gusha et al., 2026). It may negatively affect some areas such as food production, water scarcity, and biodiversity loss (Jing et al., 2025). This means there is a need for adaptation measures such as climate-smart agriculture, ecosystem-based adaptation, and income diversification (Dong-Uuro and Peprah, 2024). Community-based strategies are more relevant in rural areas since community knowledge and collaboration can enhance their resilience capacity (Palma et al., 2025). Indeed, community-level adaptation and livelihood initiatives have been recognized as key mechanisms in creating climate justice in areas with scarce resources (Njenga et al., 2025). Unfortunately, the rural transition process may be confronted by various barriers such as lack of adequate infrastructure and institutional capacity.

Comparative examination of the processes of transition towards sustainability in rural and urban areas highlights the similarities as well as the unique characteristics of the approaches in question (Shtjefni et al., 2024). In the case of both urban and rural areas, the need for an integrated approach that considers mitigation as well as adaptation remains key, however, the specifics vary greatly (Prall et al., 2024). Specifically, technology and infrastructure become focal aspects in case of urban areas whereas livelihoods and ecosystems remain crucial factors in case of rural areas (Rajendran et al., 2024). Another aspect that requires consideration is governance since the effective governance framework remains necessary for overcoming existing differences (Croft et al., 2024). The key principles of governance include multi-level governance, inclusive engagement of all stakeholders, as well as sufficient institutional capacity, however, some obstacles may arise such as poor leadership coordination and inadequate community involvement (Asibey et al., 2024).

Following these, the search for the means to have a just transition while faced with the problems brought about by climate change requires a more comprehensive outlook that should take note of the connection between socio-economic and environmental factors. By looking at both the urban and rural pathways to transition, the objective of this paper is to gain a clearer understanding of what a just transition strategy in light of climate change would entail.

The rest of this paper is organized as follows. In Section 2, there is a literature review on the issues of just transition, climate resilience, and urban-rural relations, along with an explanation of the conceptual framework underlying this paper's research. In Section 3, the methodological approach to the research is explained, covering the comparative analysis design, data, and criteria for evaluation of just transitions. Section 4 contains results and discussion with the comparative assessment of urban and rural conditions in relation to the dimensions of just transition. Finally, Section 5 concludes this paper.

2. Literature Review and Conceptual Framework

Just transition refers to a key approach in handling socioeconomic issues relating to climate change adaptation and mitigation efforts (Streimikiene et al., 2025). Just transitions began as an approach within the labor movement, aiming to safeguard the interests of workers who were adversely affected by industrial restructuring (Behuria, 2025). Today, however, the concept of just transition is more inclusive in that it emphasizes environmental sustainability through social justice and equality in making a move towards low carbon climate resilient practices (Yeung et al., 2026). Modern research points out that just transitions should focus on integrating social justice into environmental sustainability such that vulnerable groups do not suffer as a result of climate policies (Tikkakoski et al., 2024).

The impacts of climate change vary from one area to another and hence lead to different challenges and opportunities in the transition process (Rial, 2024). The urban context is typified by large populations, infrastructure, and economic activities, hence resulting in significant greenhouse gas emissions in cities (Monkkonen et al., 2024). On the other hand, urban centers are increasingly becoming vulnerable to climate threats, including heatwaves, floods, and infrastructure disruptions (Akinsanola et al., 2025). The research findings on the concept of urban resilience show that an integrated approach is required in the process of mitigation and adaptation through the use of renewable energy, sustainable transportation, and resilient infrastructure (Zhong and Li, 2024). However, there have been reports showing the existence of inequalities in the urban environment, whereby some societal groups struggle with access to basic services and environmental hazards (Kirkbride et al., 2024).

On the other hand, the effects of climate change on rural regions emanate from its direct effect on natural resource-based livelihoods (Roy, 2026). This implies that agricultural activities, forestry, and fisheries are vulnerable to the effects of

climate change due to their sensitivity to climatic variability. In literature, the importance of adopting a resilient approach to climate change in rural areas has been emphasized through the adoption of climate smart agriculture, diversified economic activities, and ecosystems adaptation (Ma and Rahut, 2024). Moreover, decentralized energy generation through solar photovoltaic (PV) and battery energy solutions have been found as one of the means of ensuring energy security in off-grid regions (Chinnaperumal et al., 2025). Decentralized energy generation systems not only ensure energy security, but they also promote sustainable development through local energy provision (Li et al., 2024). However, rural transition is hindered by poor funding and institutional arrangements.

There is a rising trend of studies on just transition pathways in both urban and rural areas. Nevertheless, studies that make a comparative study of such transitions are relatively few (Gather et al., 2025). As far as urban areas are concerned, there have been many pathways in urban transition which involve technology-driven innovations in order to reduce the emissions level and increase efficiency in operations (Zhang et al., 2024). This involves the use of innovative ideas like smart grids, mobility solutions, and green buildings in urban areas (Ahmed et al., 2025). Scholars argue that such urban transition initiatives will only contribute to increasing social inequalities, especially when problems of access and affordability are not considered (Cui et al., 2024).

Nevertheless, rural transition strategies have mostly concentrated on livelihoods' resilience and participatory approaches. Community-driven adaptation programs have generally gained recognition due to their high level of effectiveness when it comes to catering to local requirements and utilizing traditional knowledge systems (Huq et al., 2024). Such efforts focus on the process of decision-making, the development of capacities within the community, and the use of both traditional wisdom and technological innovations (Henrich and Muthukrishna, 2024). For the case of energy provision, decentralized

renewable systems, for instance, the use of PV-battery microgrids, can be considered as feasible options, consistent with the objectives of just transitions (Dawn et al., 2024). Nevertheless, further exploration is needed in terms of scalability and sustainability aspects.

It is through the comparison of what can be learned from the existing literature that one can realize that even though the transitions of both urban and rural settlements share the same goal of achieving sustainability and resilience, there are some distinctions between the two (Salem et al., 2025). While urban transitions involve issues like centralization and technological advancement, the rural counterpart is largely defined by decentralization and livelihood diversification (Hughes et al., 2025). In both cases, governance is a key determinant of the success and inclusiveness of transitions. The multi-level governance approach plays a key role in managing climate-related complexities (Dlamini et al., 2025).

Though there are several recent advancements in terms of recognizing these factors, however, various shortcomings still remain within this academic field (Holt-Lunstad, 2024). First, there remains a need for an analytical framework which can be used for comparing urban-rural just transitions under one analytical lens (Lewandowska and Chodkowska-Miszczuk, 2026). The second shortcoming relates to the fact that most research works tend to focus on one aspect or the other and rarely integrate both (Negt and Haunschild, 2025). Finally, the issue of equity in itself tends to be addressed as an afterthought, and not as a central element of transition (Ballet et al., 2025).

As a way of overcoming these shortcomings, this study proposes a comparative approach in exploring just transition models in urban and rural areas amidst the challenges of climate change. In conducting this research from a comparative point of view, the main goal is to give an enhanced perspective on how the transition model can be designed in both urban and rural settings and what kind of implications there will be from such an approach.

3. Methodology

The methodology applied in this study involves a qualitative comparative analysis of the process of just transition in urban and rural areas in the context of climate change. This method draws on an interdisciplinary paradigm that includes climate change policies, development studies, and sustainable science. Comparison of the urban and rural settings helps understand the similarities and differences in the processes involved in the process of just transition.

3.1. Research Design

Figure 1 represents the transformation of urban-rural relations from segregation to integration. On the top, the urban-rural dual system depicts two relatively separate systems, namely, the urban and rural systems, which co-exist without much interplay between each other. The relations at this level have the nature of oppositions, disharmony, and imbalance, such as resource inequality. Then follows a process of change resulting in the integration of the urban and rural. With growing interaction, the boundary between the two systems becomes increasingly interlinked and complementary. Such a transformation marks a movement towards a higher stage in urban-rural relations.

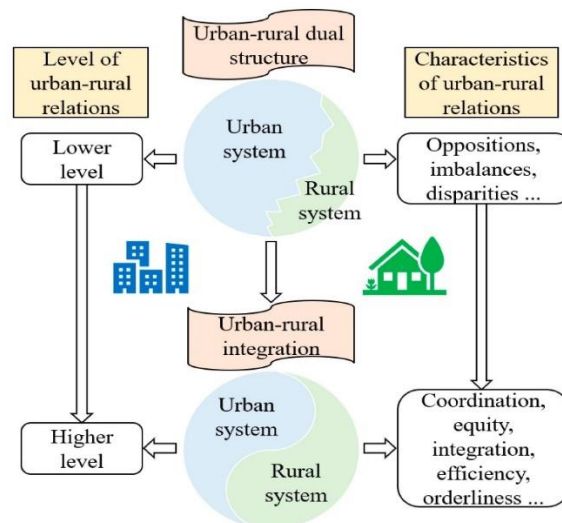


Figure 1: The evolution of urban–rural relationships from separation toward integration.

At this highly advanced level, the features have undergone tremendous improvement by focusing much more on coordination, equity, efficiency, and balanced development. Instead of competition and inequalities, there prevails cooperation which arises due to efficient utilization of resources as well as facilities. In summary, this diagram portrays a process of evolution from a fragmented, unequal state to an integrated, balanced state, illustrating that enhanced connections between urban and rural areas result in improved outcomes.

3.2. Analytical Framework

Figure 2 represents the climate resilience performance curve that is utilized to describe the response of a system to climate change. It shows

that the performance of the system initially remains constant as it operates at equilibrium. Gradual reduction in performance is witnessed due to long-term climate changes; such reduction shows the capacity of the system to resist change. This is followed by an unexpected occurrence of extreme weather conditions resulting in rapid reduction in performance, thus indicating the resourcefulness capacity of the system to manage its operations. Finally, there is the recovery phase where performance gradually returns to the previous level. Recovery rate in this case shows the resilience of the system to adapt. Thus, from the discussion above, climate resilience requires three main capabilities, namely, robustness, resourcefulness, and recovery.

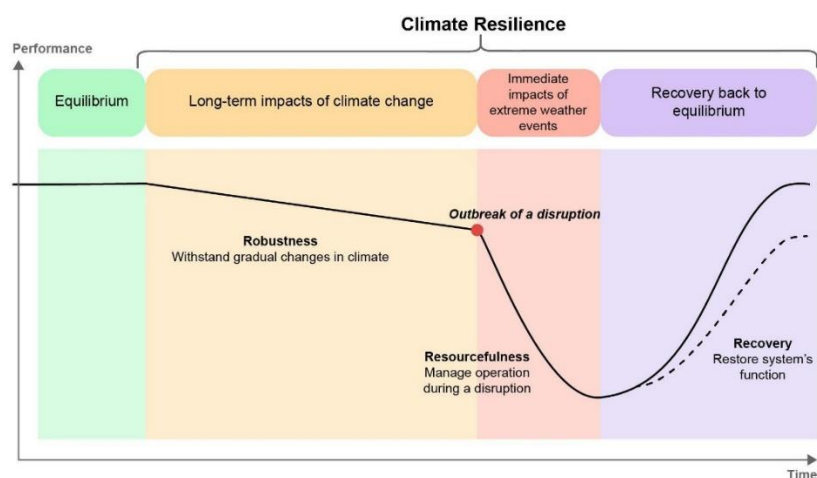


Figure 2: Climate resilience performance curve.

3.3. Data Sources

This research will utilize secondary data, which will include journal articles, international studies, and policy documents dealing with issues of climate change, just transition, and sustainable development. Sources will be drawn from scholarly sources such as international organizations, universities, and governments concerned with climate change mitigation, adaptation, and social justice. Moreover, case studies from various parts of the world will be analysed to show how just transition theories have been implemented. This will include a selection of cases from both urban and rural settings to provide for an even geographical distribution. Triangulation of information will help to strengthen the research's reliability through the validation of data points.

3.4. Comparative Analysis Method

The analysis will be carried out using thematic comparison, which means that data will be collected and analyzed in line with the four dimensions provided in the framework for analysis. The analysis will entail identification of similarities and differences in terms of challenges and opportunities. It will also entail the comparison of differences in priority setting and strategy. Evaluation of transition strategies' effectiveness in addressing equity and resilience will also be entailed. The results will be compiled to identify similarities and differences in transition paths. Special focus will be put on the impact of structural elements, including governance structures and resource endowment in each setting.

3.5. Just Transition Evaluation Criteria

For measuring the extent of agreement between the transition pathways and the attributes of a just transition, a criterion for evaluation from the literature is considered in this study. There are four main evaluation criteria: equity, inclusiveness, resilience, and sustainability. Equity deals with the equal distribution of the burdens and advantages related to climate activities and ensures that no one gets disproportionately affected by these policies. The

concept of inclusivity is concerned with the involvement of different stakeholders in particular the disadvantaged and marginalized in the decision-making process. The aspect of resilience deals with the ability of the community to survive the climate threats. This includes the element of sustainability that takes into consideration environmental and socio-economic aspects of the transition strategy.

4. Results and Discussion

The comparative findings are outlined within this section to determine how the transition pathways in both urban and rural settings are congruent with the tenets of the just transition framework. This analysis is based on four important dimensions, namely climate risk and vulnerability, socio-economic vulnerability, governance and institutions, as well as adaptation and mitigation, and finally evaluates the findings based on equity, inclusiveness, resilience, and sustainability.

4.1. Climate Risk and Socio-economic Conditions

Table 1 below shows how both urban and rural communities perceive climate threats and their resilience to these threats. Both communities are highly vulnerable to climate threats, but what differs is the form of threat they are exposed to; for instance, the urban community experiences heat waves, floods, and stress on infrastructure, while the rural community faces the threats of droughts, land degradation, and water scarcity. Adaptive capacity in relation to the availability of technological capabilities and services tends to be high for urban settlements because of availability, and low for rural settlements because of a lack of infrastructure. There is socio-economic vulnerability within both settings; however, the form of the vulnerability differs, such that while there is inequality and disparity in access to services in urban environments, in rural environments, poverty rates and dependence on climate-sensitive industries are the forms of vulnerability present. The final variable is characterized by access to services, which is better in urban areas than rural.

Table 1: Comparison of urban and rural communities under climate change

Dimension	Urban Communities	Rural Communities
Climate Risk & Exposure	High exposure to heatwaves, flooding, infrastructure stress, and urban heat island effects	High exposure to droughts, land degradation, water scarcity, and ecosystem changes
Nature of Impacts	Indirect impacts through infrastructure disruption and service failures	Direct impacts on livelihoods (agriculture, natural resources)
Adaptive Capacity	Relatively higher due to access to technology and services	Lower due to limited infrastructure and access to services
Socioeconomic Vulnerability	High inequality, especially in informal settlements, and uneven service access	High poverty levels, limited income diversification, dependence on climate-sensitive sectors
Socioeconomic Vulnerability	Better overall, but unevenly distributed	Generally limited access to healthcare, education, and energy

Figure 3 represents estimated temperature variations in urban areas (indicated in red colour) and rural areas (represented by green lines) from approximately 2000 to 2100, with temperature plotted on the y-axis and year on the x-axis. As can be observed from these lines, there is a gradual increase with respect to time; however, the urban temperature is always higher than that of the rural one. In the initial stages, the urban temperature has been observed to be higher (about 19–20°C) as compared to the rural temperature (17–18°C). Gradually, the urban temperature increases to 26°C while that of the

rural area is around 21–22°C. The areas surrounding each line are the variations associated with the forecasts and indicate a greater variation for urban areas towards the end of the century. The overlap at the latter parts of the forecast indicates that in some instances, rural conditions could resemble temperatures of the lower range of urban areas under particular circumstances. Generally speaking, this illustration reveals that although climate change causes temperature increases in both environments, urban environments have higher increases.

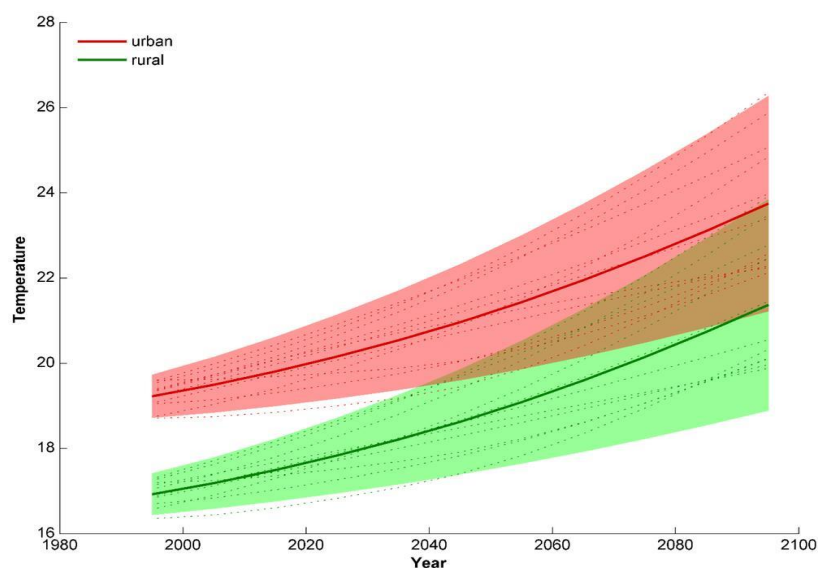


Figure 3: Climate risk & socio-economic conditions.

4.2. Governance and Adaptation Strategies

The distinctions between urban and rural governance, as well as their climate change responses, are made clear in Table 2. Urban governance can be defined as “centralized, formal,” with its policy implementation being characterized by being “strong but fragmented.” On the other hand, rural governance is considered to be “decentralized, under-resourced,” leading to “weak” policy implementation. The degree of participation in each type of governance varies greatly. Urban governance requires “moderate, often exclusionary” participation, meaning that some stakeholders, particularly the marginalized, can be

excluded from the process. Differentiation occurs in relation to adaptation and mitigation measures as well. Urban places use infrastructure and technology as key methods of tackling problems. Rural places place a higher priority on community and ecosystem approaches, which are usually more adaptive and environmentally sound. Likewise, urban places adopt measures related to “renewable energy and efficiency, while rural places utilize “small-scale, nature-based” initiatives. In general, as demonstrated in Table 2, urban systems have better institutional capabilities and technology, while rural systems are better at engaging the public and implementing local solutions.

Table 2: Governance and climate response in urban and rural communities

Dimension	Urban Communities	Rural Communities
Governance Structure	Centralized, formal	Decentralized, under-resourced
Policy Implementation	Strong but fragmented	Weak
Stakeholder Participation	Moderate, often exclusionary	Strong community participation
Adaptation Strategies	Infrastructure, technology-driven	Community-based, ecosystem-based
Mitigation Approaches	Renewable-energy, efficiency	Small-scale, nature-based

Figure 4 shows the scatter graph that relates the decade change rate in urban land area (previous decade) to the urbanization ratio (current decade’s end). In this case, the grouping into country types is "Urbanized (blue), steadily urbanizing (yellow), and rapidly urbanizing (grey). The former type of countries has higher values in terms of urban population share (0.7–1.0), while having much lower values when it comes to the rates of land expansion. Steadily urbanized ones are placed in the middle range (0.3–0.6), demonstrating a fairly good balance in both

aspects. The latter ones are those with low values in terms of urban population (less than 0.4), although their values are higher in terms of land area expansion (approximately up to 1.5). As seen on the graph, the dashed regression line is declining, implying a negative correlation between land expansion and the proportion of the population living in cities. In other words, the faster the rate of land expansion, the lower the proportion of people who live in cities. Conversely, the more urbanized the country, the slower the pace of land expansion.

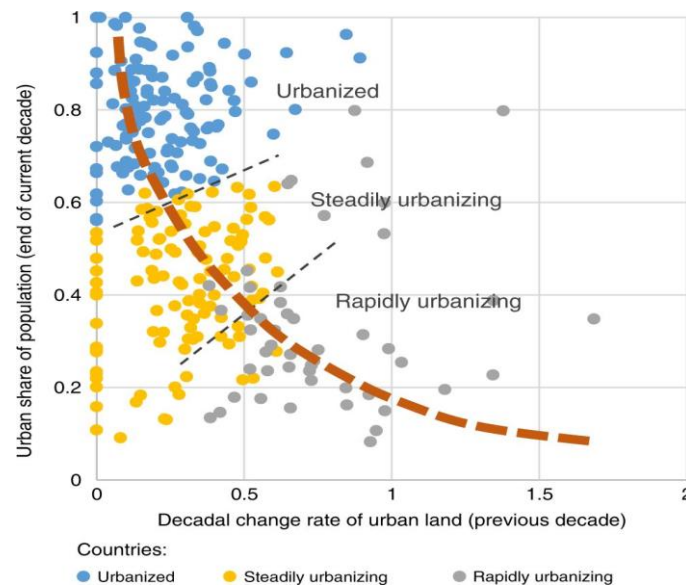


Figure 4: Governance and adaptation strategies.

4.3. Just Transition Evaluation Criteria

The performance of urban and rural communities is analysed in Table 3 in terms of their capacity to meet criteria such as equity, inclusiveness, resilience, and sustainability. The results show that both contexts have some problems related to the achievement of equity, whereby the urban context is rated poorly because of inequality while the rural context is poor because of neglect. With regard to inclusiveness, the rural community has achieved success, having a rating of high, implying that

there is strong participation and involvement of members within the community. The urban community shows only moderate performance in this criterion. In relation to sustainability, rural settlements are highly ranked, probably owing to the use of environmentally friendly practices. On the other hand, urban centres are moderately ranked, probably owing to a balanced equation of technologically-driven growth and environmental pressure. In general, the table reveals that urban systems are superior in infrastructure and resilience, whereas rural systems are superior in inclusiveness and sustainability.

Table 3: Comparison of equity, inclusiveness, resilience, and sustainability

Criteria	Urban Communities	Rural Communities
Equity	Low due to inequality	Low due to systemic neglect
Inclusiveness	Moderate	High
Resilience	High (infrastructure)	Moderate (social resilience)
Sustainability	Moderate	High

Figure 5 depicts a cyclic resilience planning process that is made up of five major steps. This starts with step 1 of setting the stage, where the goals and context are established, after which comes step 2, exploring hazards where climate or environmental risks may be identified. The process continues with step 3, assessment of

vulnerabilities and risks, whereby exposure and sensitivity are evaluated, and then onto step 4, development of adaptation strategies. Finally, step 5 is implementation and monitoring. The middle of Figure 5 identifies cross-cutting factors that are relevant to all the stages, such as networking, equity, and performance

management. The cross-cutting factors underscore cooperation, equality, and assessment throughout the whole process. In general, the figure depicts that the planning process for

resilience is not a linear process but rather an iterative process, which includes assessment, action, and performance management.



Figure 5: Resilience planning process.

4.4. Comparative Insights

Table 4 shows the comparison of strengths and weaknesses of urban and rural societies concerning climate change. Urban societies enjoy infrastructure, finance, whereas rural societies utilize indigenous knowledge, cheaper alternatives. Nonetheless, there are disparities like urban inequality and resource shortages in rural societies. In governance, urban societies have sound policies, but rural societies focus on community-based governance. However, there are disparities, including urban exclusion and

institutional weaknesses in rural societies. In regard to the capacity for adaptation, the urban system relies on technology-oriented measures, while the rural system uses nature-dependent and community-based measures. One of the main weaknesses is the absence of integration between these measures, indicating the possibility for synergy that may not be fully realized. Lastly, in terms of just transition compatibility, the urban system is strong in resilience and technology, while the rural system is strong in inclusivity and sustainability. However, the inequality issue remains common in both systems.

Table 4: Comparison of urban and rural strengths and key gaps

Aspect	Urban C Strengths	Rural Strengths	Key Gaps
Resources & Infrastructure	Advanced systems	Local knowledge	Urban inequality, rural scarcity
Governance	Strong institutions	Community-driven	Exclusion vs weak institutions

Adaptation Capacity	Technology-driven	Nature-based	Lack of integration
Just Transition Alignment	Strong in resilience	Strong in inclusiveness	Equity gaps

Figure 6 presents a scatterplot representing the distribution of various forms of settlement according to two main components; PC1 and PC2. The dots have been classified into five groups namely; urban, semi-urban, rural and semi-rural, intense rural and extreme rural. The black dots represent the urban group and they are located towards the left side of the graph with negative values of PC1, showing that the urban group is unique from the rest of the groups. Semi-urban dots (grey) are found near the middle, making up a group that transitions between urban and rural. Vertical dispersion on PC2 is indicative of variance among categories, while horizontal dispersion on PC1 suggests variation among clusters. Overlapping on the plot reveals smooth transitions from one category to another, with some overlap occurring. The two dashed lines

drawn at $PC1=0$ and $PC2=0$ separate the plot into four quadrants, making it easy to understand where the clusters fall on the plot.

Overall, the findings show that no pathway for just transition for either urban or rural systems can achieve all aspects of just transition. While urban systems are more capable of meeting just transition needs through infrastructural and institutional capabilities, they suffer from major inequity problems. On the other hand, while rural systems are excellent at ensuring inclusiveness and resilience in communities, they lack necessary financial and institutional support. The conclusion we can draw from this is that a combined approach is needed to implement just transition effectively.

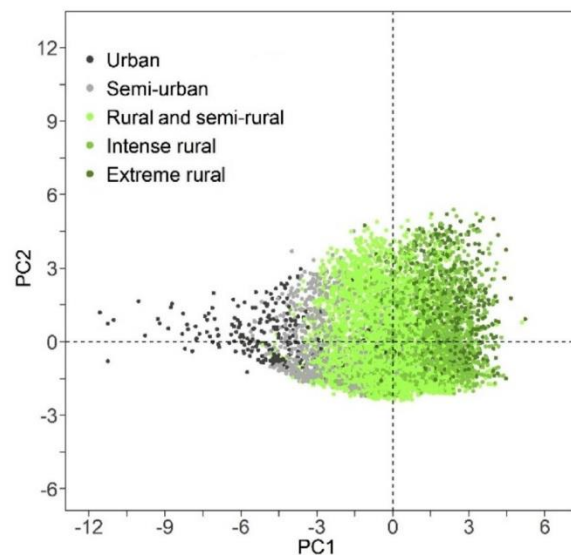


Figure 6: Distribution of different settlements.

5. Conclusion

This study offered an analysis of the just transition pathways for urban and rural environments under climate change stress. It is shown that even though both urban and rural areas experience considerable problems

associated with climate change, the methods used to address these problems vary greatly between these two types of territories. There is strength in urban communities in terms of infrastructure, institutions, and technological advancement. This has made it possible for urban communities to be more resilient and recover more quickly from

climate shocks. But at the same time, this strength has been weakened by inequality, which is evident in terms of the provision of services and the lack of inclusiveness in the area. In the case of rural communities, there is inclusiveness and sustainability due to participatory action and environmentally friendly practices.

It becomes clear from the evaluation with regard to just transition that neither the urban nor the rural system achieves all characteristics associated with just transitions. It is clear from the analysis that there are issues of inequity in terms of resource distribution in both systems, and hence the same remains an important consideration while undertaking just transitions. In light of the policy discussion, it can be seen that there is a requirement to incorporate elements from both systems in order to ensure that just transitions are achieved effectively through a combination of policies. Effective governance coordination, inclusive participation, and equitable resource distribution remain very important in this regard. The need for a just transition towards climate

change is not only based on technological or structural innovation; rather, it is essential that there be an element of social justice in this approach. Future research in the area should strive to establish a framework where such goals can be realized.

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Author Declaration

I confirm that this work is original, has not been plagiarised, and has not been submitted elsewhere for assessment. All sources used have been appropriately acknowledged and referenced in accordance with academic integrity standards.

I declare that there are no conflicts of interest regarding the publication of this work. No financial, personal, or institutional relationships have influenced the research, analysis, or interpretation of the findings presented in this study.

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