

Climate Change, Gender and Rural Livelihoods: Understanding Women's Pathways to Resilience in Odisha

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ABSTRACT

The paper examines the affiliation between climate change, gender & rural livelihoods in the 'KBK' region of Odisha, mainly focusing on the districts of Koraput and Nuapada. Irregular rainfall, rising temperatures, and environmental degradation have created uncertainty among rural households that continue to depend heavily on agricultural and natural resources in recent years. But these changes are experienced unevenly across their communities and rural areas. In particular, women face greater livelihood insecurity due to lack of accessibility to land, credit, institutional support, and part-taking in local administrative processes. Due to movement of men in search of work, women's responsibilities within both agriculture and household care have led to a visible 'feminisation of rural labour', and it also shows that respondents are simply left to vulnerability. Across the study area, women were actively responding to environmental stress through everyday adaptive practices rooted in local knowledge and collective support systems. In addition to adopting techniques such as millet cultivation and mixed cropping, many

households have diversified their sources of income and have depended on self-help groups for social collaboration, financial support and information exchange. These tactics are crucial for maintaining household survival in the face of shifting climate conditions. Using resilience as a conceptual lens, the study argues that it should be viewed as a socially and economically structured process shaped by institutional structures, community networks, and access to resources, rather than as a fixed capacity. The study needs more inclusive & gender sensitive policy responses in rural eastern Odisha by emphasising women's lived experiences.

KEY WORDS : *Climate Change, Gendered Pathways, Livelihood, Rural Women, Resilience.*

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Available online at :

thirdvoice.voiceforvoiceless.in

DOI:

<https://doi.org/10.5281/zenodo.21619212>

Article No - TVR00115

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Received	Reviewed	Accepted	Published
28-Jan.-2026	26-Mar-2026	15-May-2026	01-June-2026
Volume	Issue	June	ISSN
No. 8	No. 1	2026	2583-1852(P), 2584-0878(O)
How to Cite this Article: Sahoo, D. M., Nath, N., Mohapatra, M., Sahoo, U., Bal, R.R., Rana, L.; Climate Change, Gender and Rural Livelihoods: Understanding Women's Pathways to Resilience in Odisha. THE THIRD VOICE: REALITY AND VISION. 2026. Vol No-8. Issue No-1. June. Pp: 70-82, DOI : https://doi.org/10.5281/zenodo.21619212 .			

INTRODUCTION

We live in the 21st century, where one of the most vital worldwide issues is ‘climate change’, which is considerably shifting social relationships, economic systems, and ecological systems. It is because livelihoods in rural areas are mainly linked to natural resources like forests, land, water and their effects are most severe there, effects include rising temperatures, droughts, irregular rainfall and environmental degradation. These create vulnerabilities in India and particularly in Odisha, as agriculture is their prime source of income. However, existing social hierarchies are particularly based on ethnicity caste and gender which mediate these vulnerabilities, so they are not perceived evenly. Among these social hierarchies, “gender” emerges as a critical axis through which the impact of vulnerabilities is both negotiated and experienced, but situation of women is very much contradictory in Indian villages. Since, they mostly rely on forest-based resources, they are disproportionately affected by climate-related instabilities. But they play a very crucial role in maintaining home economics & communal resilience through their labour contributions, adaptive practices and their indigenous knowledge systems. Women are the most important actors in climate change and rural livelihoods, because of dichotomy & great agency. Though, families are typically treated as homogeneous units in policy frameworks and scholarly calculations, and their contributions are frequently underappreciated or unnoticed, which leads to intrahousehold inequalities.

To know connection between rural livelihoods, gender & climate change, an investigation is needed, and an interesting setting is found in the state of Odisha, in eastern India. Historically marginalised ‘KBK’ (Koraput-Bolangir-Kalahandi) region of Odisha, which includes the districts of ‘Koraput’ and ‘Nuapada’, is marked by socio-economic hardship, ecological fragility and long-lasting poverty. Because the rural people mostly rely on ‘rain-fed agriculture, inadequate irrigation infrastructure, & mild ecosystems, these areas are tremendously vulnerable to climatic volatility. These sectors like agricultural production and livelihood security have been harshly impacted by repeated droughts, irregular monsoon patterns, weakening soil fertility & deforestation. Such

environmental changes have profound effects on communities that depend on forest-based resources and subsistence farming, frequently resulting in seasonal migration, debt and food insecurity.

In this larger context, rural women in Koraput and Nuapada face climate change in ways that are clearly gendered. Women now have more duties in family administration, caregiving and agricultural production due to the feminisation of agriculture, which is partly triggered by male out-migration. Concurrently, their labour burden has increased due to loss of natural resources, making it necessary for people to travel greater distances in order to gather forest products, fuel, wood and water. Their ability to effectively respond to environmental pressures is further hampered by limited access to basic needs and institutional support. Furthermore, their ability to influence adaptation tactics is often limited by intensely ingrained patriarchal norms that prevent them from joining in decision-making processes at grassroots institutional level.

Despite these limitations, they are active agents of resilience, adaptation leading towards mitigation. Women create creative solutions to deal with and adjust to shifting environmental situations by drawing on indigenous knowledge systems, social networks, and their daily routines. These include adopting climate-resilient agricultural practices like mixed cropping and millet cultivation, diversifying livelihoods through livestock rearing, wage labour and small-scale businesses and joining self-help groups (SHGs) that offer social support, information and credit. Collaborative work of women has often been essential in enhancing community resilience, making households more resilient to climate shocks and uncertainties. So, idea of resilience offers a cooperative analytical framework for understanding how rural women deal with difficulties brought on by climate change. This study takes a more comprehensive approach, emphasising the ability to adapt, transform and sustain livelihoods in the face of continuous environmental change, rather than just seeing resilience as the capability to bounce back from shocks. Access to resources, social capital, institutional support and cultural norms are just a few of the enabling and structural elements that interact intricately to create women’s pathways to resilience. Crucially these paths are

profoundly ingrained in regional socio-ecological systems and are neither consistent nor linear; they differ depending on the setting.

Impact of climate change on 'rural livelihoods' in India have been subject of an increasing amount of research, but very few studies have specifically addressed the gendered aspects of resilience, especially in understudied areas like the KBK districts of Odisha. Research that is now available frequently highlights fragility, depicting women mainly as victims of environmental change while ignoring their agency and contributions to adaptive processes. Moreover, context-specific evaluations that depict rural women lived experiences and the tactics they use to manage climate threats in their daily lives are lacking.

In light of this, study examines how gender, rural livelihoods and climate change interact in districts of Koraput and Nuapada in an effort to close this gap. By examining how women concurrently experience, react to, and influence processes of environmental change, it seeks to transcend binary narratives of vulnerability and resilience. Mainly, this study challenges, with three specific questions: What impact does climate change have on rural livelihoods in these areas? How are these effects gendered? And given the limitations of their socio-economic and ecological environments, how do women create and maintain resilience?

This research goal is to find out a more comprehensive understanding vulnerability highlighting experiences of & practices of women in eastern Odisha. The study emphasises necessity of acknowledging women as both vulnerable subjects and dynamic change agents whose labour, expertise and group efforts are essential to developing inclusive and sustainable variation solutions. So, by doing this, the study also emphasises how decisive it is to integrate it in gender views into development interventions and climate policy, especially in marginalised areas, where effects of environmental changes are most severe.

BACKGROUND:

Bond between livelihoods, climate change & gender has attracted great scholarly attention over the past 20 years

in the Global South. Major work demonstrates that 'climate change' is a profoundly social spectacle that is influenced by present power dynamics and inequality rather than environmental issues. In that dimension, gender has become a vital analytical category for grasping the local experiences, mediations and reactions to climate effects. There are three interconnected issues covered in this literature review, such as "climate change and rural livelihoods", "gendered vulnerabilities and pathways to resilience".

CLIMATE CHANGE & RURAL LIVELIHOODS

Detrimental effects of climate change on rural livelihoods especially in agrarian economies have been extensively studied. Researchers contend that agricultural productivity and food security have been severely impacted by climate variability, which is manifested through irregular rainfall rising temperatures droughts and extreme weather events (Morton, 2007; IPCC, 2014). Research has indicated that shifting monsoon patterns and more frequent droughts have exacerbated rural poverty by causing crop failures lower yields and unstable income (Deshpande & Shah, 2010).

For analysing how households deal with environmental challenges is the 'Sustainable Livelihoods Framework' (SLF) is a popular tool used. This method holds that in a vulnerable environment, access to 5 methods of capital natural human social financial and physical shapes livelihoods (Chambers & Conway, 1992). These resources, especially natural capital, are disrupted by climate change, which has an effect on the livelihood system as a whole. Degradation of natural resources directly affects livelihood security in areas like Odisha that rely heavily on agriculture and forests. Research from eastern India has shown that households have been forced to use coping mechanisms such as migration, livelihood diversification and reliance on unofficial credit institutions due to decreasing forest production, soil degradation and water scarcity (Pattnaik & Lahiri-Dutt, 2020). However, critics of the SLF contend that they frequently ignore intra-household disparities particularly gender by treating families as homogeneous elements. For this constraint, livelihood studies now majorly include gender-sensitive viewpoints highlighting the importance

of the distribution of resources and responsibilities within the households.

GENDERED DIMENSIONS OF CLIMATE VULNERABILITY

The research has shown that impact of climate change is naturally gendered. Due to their socio-economic status and restricted access to resources that they are regularly more vulnerable to environmental stressors especially in rural and marginalised populations (Agarwal, 1994; Dankelman, 2010). The concept of Feminist Political Ecology (FPE) looks at how gendered authority relations disturb access to control over and understanding of, natural resources and also offers a supportive lens through which to view these processes.

In rural India natural resources like water, forests, & land are vital to women's source of revenue. Women are excessively affected by resource scarcity caused by climate change, because they are the main gatherers of fuelwood water and non-timber forest products (NTFPs). Study shows that women's workloads are mainly increased by environmental degradation, which often necessitates longer travel times & major time spent on sustenance tasks (Rao et al., 2019). To impair their physical health also restricts their access to school, employment possibilities and community decision-making power. Another significant aspect of gendered vulnerability is that women were restricted from accessing institutional assistance and productive resources. In India, women still own very little land, which directly or indirectly limits their access to government programs, financing and agricultural supplies (Agarwal, 2018). In addition, gender biases and social conventions commonly prevent women from accessing climate-related basic information and extension services. Therefore, women are less ready to undertake climate-resilient activities and technology.

The gendered aspect of climate vulnerability is further demonstrated by the phenomenon of the feminisation of agriculture. Women are becoming more involved in agriculture due to increase in male migration. Although women are now more involved in farming activities, this change hasn't always resulted in more control over resources or decision-making authority (Deere, 2005). Studies have shown that confluence of

poverty, gender and marginalisation in Odisha exacerbates the vulnerabilities that are faced by tribal & rural women. For example, previous studies conducted in the KBK area show that women's dependence on forest resources makes them more vulnerable to ecological changes which are brought on by climate change while socio-cultural norms restrict female involvement in institutions of governance & resource management (Mishra & Sethi, 2019).

WOMEN'S AGENCY AND PATHWAYS TO RESILIENCE

In early research women's vulnerability was frequently emphasised in gender & climate change, but now the more recent studies have focused on women's self-sufficiency & their part in fostering resilience. This change is telling in a larger trend that development studies away from deficit-based methods & towards more complex viewpoints that recognise the abilities & contributions of marginalised groups. The analysis shows that how people and communities react to environmental shocks has made extensive use of the idea of resilience. Scholars advised against considering resilience as a simply technical or apolitical concept, nevertheless. Rather, resiliency needs to be understood in terms of social justice power and inequality (Cannon & Muller-Mahn, 2010). From a gender perspective this entails looking at how women negotiate and modify structural conditions that define their vulnerability in addition to how they deal with climate change.

A variety of adaptive tactics used by women have been documented by empirical research conducted in India & other countries of the south. These include the approval of climate resilient agricultural follows, such as mixed cropping, agroecology and the cultivation of drought-resistant crops like millets livelihood diversification such as combining agriculture with livestock rearing wage labour and small-scale businesses and collective action through self-help groups (SHGs), which offer access to credit, information and social networks (Agarwal, 2010; Garikipati, 2008).

Initiatives like the Odisha millets mission have shown how combining traditional knowledge with contemporary interventions can improve climate resilience in Odisha. Participation in these programs by women has been

associated with increased empowerment, income-generating and food security. Similarly, by easing access to financial resources and encouraging community-based approaches to development, Mission Shakti under the National Rural Livelihood Mission (NRLM) have significantly strengthened women's adaptive capacities. Additionally, women's adaptive methods are greatly influenced by indigenous knowledge systems. Research indicates that women from rural and tribal communities are well-versed in local ecosystems including crop diversification, soil management and water conservation techniques. They can create context-specific solutions to environmental problems thanks to this expertise, which is frequently passed down through the generations (Berkes, 2009). However formal policy frameworks that prioritise scientific and technocratic approaches frequently undervalue such knowledge sources.

RESEARCH GAP AND CONTRIBUTION OF THE STUDY

A large number of studies have examined gender rural livelihoods and climate change yet several important areas remain underexplored. Much of the existing research mainly highlights women's vulnerability to environmental change while giving less attention to the everyday experiences coping strategies and practical efforts through which women gradually build resilience in their daily lives. In many climate studies, India's social cultural and ecological circumstances are not replicated satisfactorily. The KBK region of Odisha, in particular, has received very little academic attention despite of facing serious climate-related challenges & persistent socioeconomic deprivation. Moreover, these ideas, such as adaptation and resilience, are often debated in general terms, with a partial understanding of how these processes actually operate within houses and local societies. In this situation, this study focuses on their real life experiences in districts of Koraput and Nuapada and examines how they perceive, manage, & respond to climate change in their everyday lives. Using insights from feminist political ecology and livelihood approaches, this study purposes to provide a deeper understanding of their resilience within a marginalised regional setting.

MATERIALS & METHODS

This study has used a mixed-method to understand the link between gender, rural livelihoods & climate vulnerabilities in districts of Nuapada and Koraput, in Odisha. Specifically, the study used both qualitative & as well as quantitative approaches so that study can capture not only the assessable impact of climate unpredictability on rural livelihoods but also the everyday experiences and responses of women living in these conditions. This research is mainly descriptive and exploratory in nature even though analysing how climate change creates different forms of vulnerability and resilience among women. Throughout the study, a gender-sensitive standpoint has been followed to ensure that women's experience local knowledge and everyday realities, remain at the centre of the research. The study has chosen 2 districts i.e, Koraput & Nuapada, which are situated in the KBK (Koraput-Bolangir-Kalahandi) area of Odisha. These 2 areas were selected due to their highly vulnerable to climate related challenges and mainly the socio-economic scarcity. Among these 2 districts Koraput is known for its large tribal population dependent on natural resources and forest. Similarly, Nuapada district is taken due to recurring droughts & has a strong dependence on rain farming & seasonal migration for its survival. Reviewing these 2 districts at a time helps to understand that the different environmental & social situations influence livelihood practices & shape women's replies to climate pressure. A multistage purposive sampling has been used for selecting the study areas as well as respondents. First, the district was chosen based on dependence on natural resources, climate vulnerability & poor socio-economic conditions. In the second phase, blocks were taken that were more affected by climatic changes, identified within each district. Then villages were selected purposefully to represent their different livelihood patterns such as forest-related activities, agriculture & wage labourers. In the last phase, those rural women were chosen as respondents for this study, who are engaged in climate-related occupations, meanwhile they are directly involved in dealing with both household responsibilities & livelihood related activities. So, their experiences are more central for understanding the resilience & adaptation at the community/societal level.

The study has taken a total of 60 respondents, which was considered sufficient to capture variations across the selected areas, while also permitting detailed qualitative interaction. Most of the respondents belong to socially and economically marginalised groups, including scheduled tribes (STs), scheduled castes (SCs), and other backward classes (OBCs), reflecting the broader demographic structure of their district. The major focus of this study is on women in 25 to 60 age group. As per the study, they play a vital role in nourishing family livelihoods & coping with environmental & economic challenges.

Table 1: Sampling Profile of Respondents

Category	Description
Study Area	Koraput & Nuapada Districts
Sample size	460 Respondents
Respondents	Rural Women
Age Group	25 to 65 years
Occupation	Agriculture, NTFP Collection, Labour
Education Level	Illiterate to Secondary
Social Category	ST, SC, OBC
Sampling	Multi-stage Purposive sampling
Source: Field study, 2026	

The table 1 represents the basic sampling features of the respondents selected for the study. It distributes an outline of the study area, sample size, respondents, age group, occupation, education, & sampling relevant to understanding the research theme.

The primary data collected has been designed to understand both individual experiences & shared communal realities. To explore their understanding regarding climate change, changes in livelihood patterns, gender responsibilities, the qualitative interviews were carried out with rural women, & the ways they cope with environmental difficulties in everyday life. Here, respondents were allowed to speak openly & explaining their experiences, in their local language, which makes the data richer & more detailed one. Not only interviews but also FGDs were engaged, especially in self-help groups (SHGs). These discussions were helped to capture their collective experiences of the women group, and how they adopt & their replies to climate-related

challenges. Case studies were also taken to understand women lived experiences in greater depth. These case studies provided detailed explanations of how women & their families deal with environmental & economic stress and emphasised different pathways of resilience and their adaptation ability. Further, non-participant observations strengthened the study more academically and found the insights from their day-to-day life, livelihood practices, use of local resources, & gendered based division of work within their families and also in their societies.

Furthermore, primary data and secondary information were gathered from several sectors such as academic studies, district statistical handbooks, government reports, climate policy documents, and reports published by 'NGOs. Qualitative data were analysed using thematic analysis, for identifying common patterns related to gendered vulnerabilities, climate impacts & adaptation tactics. For a better understanding, narrative analysis was used, and also case studies for in-depth data with their everyday experiences and findings were organized into tables to ensure clarity and easy interpretation.

The entire research process was cautiously followed, and ethical principles & all contributors were informed before data collection. Their involvement was entirely voluntary; anonymity & privacy were continued at every stage of this research. Certain care was also taken to adopt a "gender-sensitive approach" during fieldwork, especially while appropriately interacting with women respondents. On the other hand, the study has certain limitations. Since the research was conducted in only two districts, with a relatively small sample size, which may not fully generalise to other regions, the limited duration of the research may not capture the seasonal nature of climate changes, and also the long-term effects on livelihoods.

THEORETICAL FRAMEWORK

Hence, an interdisciplinary theoretical framework that combines 'Feminist Political Ecology' (FPE), the 'Sustainable Livelihoods Framework' (SLF), and 'Resilience Theory' to understand the gendered vulnerabilities in the Koraput and Nuapada districts of Odisha has been adopted. Together, these perspectives help to explain how environmental changes interact with

existing social inequalities & influence patterns of vulnerability, adaptation, & livelihood sustainability among rural women.

“Feminist Political Ecology” forms the fundamental origin of this study. It argues that tenure and ownership over natural resources were influenced by unequal social & gender relations. Mainly in rural areas, contextual analysis of eco-feminism needs to be analysed. As a result, the effects of climate change & environmental degradation are more often experienced more unswervingly by women in their normal lives. This perspective shows that women possess central environmental knowledge developed through their regular interaction with local atmospheres, but they frequently remain excluded from decision-making processes & institutional support systems. In areas like Koraput and Nuapada, where livelihoods mainly depend on forests and rain-fed agriculture, these inequalities become more visible under conditions of poverty & environmental uncertainty.

The “Sustainable Livelihoods Framework” further supports the analysis by focusing on how houses depend on different livelihood assists. Climate change affects the foundation of rural livelihoods, which are the resources, mainly forests, water, and agricultural land. This framework helps to enlighten how females respond to changing livelihood circumstances through plans such as wage labour, livestock rearing, seasonal migration-related work, & participation in self-help groups. However, they are often having restricted access to financial resources, land, technology, & institutional support, which affects their capacity to withstand livelihoods throughout ‘environmental stress.’

“The Resilience theory, make available as supplementary perspective for understanding how individuals and societies respond to ‘environmental ambiguity and tragedy situations. It refers to the dimensions of rural women to handle with, regulate to, and reorganise their livelihoods under changing climatic situations. This theory also includes both short-term & long-term adaptive tactics such as crop variation, climate-resilient farming practices, and collective public contribution. The study also recognises that vulnerability and resilience are interconnected & rural women may experience it due to

poverty, social marginalisation, & unequal access to resources, while simultaneously indicating resilience in sustaining families & dealing with livelihoods under problematic situations. The study developed a comprehensive framework analysis for the multidimensional impacts of climate change on rural women, by integrating “feminist political Ecology, the Sustainable Livelihoods framework & resilience theory together. These perspectives explain how women in the Nuapada & Koraput convey environmental challenges, sustain their livelihoods, and donate to local governance processes despite structural limitations.

RESULT OF THE STUDY

People in the districts of Nuapada & Koraput depend mainly on rain for farming, forest resources for their survival & informal labour; that’s why even small environmental fluctuations have serious consequences for their livelihoods, because climate change has become deeply entangled with the everyday lives of rural people. Field survey findings show that local people experience it directly through declining agricultural productivity, food insecurity, and lower income, increasing stress for their family survival. These problems strongly affect women because they accept the dual responsibility of handling family work along with their livelihoods.

One of the greatest visible result in the study area, is the increasing irregularity of rain-fall. There are several respondents continuously describing about late monsoons, sometimes sudden heavy rains, & volatile weather situations that severely disturb agricultural activities. In both the district (Nuapada & Koraput) farming depends deeply on monsoon rainfall, and these changes directly disturb sowing, crop growth, & harvesting patterns etc. Such crops as pulses, paddy, millets, & vegetables have become gradually unclear, resulting in condensed yields & unstable domestic incomes. Drought has historically been a recurring problem, seasonal insecurity, repeated crop failures have deepened economic hardship found in Nuapada. In Koraput, fluctuating rainfall patterns, soil erosion, and declining soil fertility have weakened subsistence farming, particularly among tribal people that they rely closely on local ecological systems.

The study also discloses that ‘climate change’ is contributing to the weakening of natural resources, especially forests & water sources that rural households depend upon for daily survival. Forests mainly provide fuelwood, fodder, fruits, medicinal plants, and other non-timber forest products that support both subsistence and income generation. Women, explained that forests are gradually becoming less productive and more difficult to access, those who are mainly responsible for collecting these resources. In that area, water scarcity has similarly become a serious issue, with streams drying up seasonally and wells losing water much earlier than before. These certain changes not only affect agriculture and livestock but also increase the burden of domestic work within the families.

The workload of women has increased significantly, as ecological resources become scarce. Alongside family responsibilities, women are actively engaged in agricultural activities such as sowing, transplanting, weeding, harvesting, caring for livestock, and collecting forest products. Women were travel longer distances & places in search of water or firewood, which adds another stress in their daily routine. This increasing stress in their daily lives creates what may be described as “time poverty,” leaving women with scratched chances for education, income-generating work, rest, or involvement in community-level & ‘decision-making processes.

There is another significant pattern observed in this study, i.e., growing pattern”feminisation of agricultural labour.”From our previous knowledge, we known that farming becomes more undefined&economically uneven, &male migration in search of wage labour from rural to towns & other states has become verycommonly found in both Nuapada& Koraput. That’s why women are left behind in families &in many cases to manage agricultural work as well as theirfamily responsibilities, they struggle a lot. Though,women gradually takingaccountability for farming, & supervised their own agricultural field, still they have minimal rights over land & restricted access to formal credit system, technology, &official support, due to their gender.

There is another serious implication i.e., ‘climate stress’for food & nutritional security within families. In

the time of crop failure, tiny agricultural productivity,lower profits, that time also women sacrifice their own nutritional foods, to prioritise their children, aged family members, &other dependent relatives. These coping mechanisms shows that how environmental crises intensify existing gender inequalities within the societal & family system. Gradually, the females are combining farming with other income sources such as, wage labour under rural employment schemes, livestock rearing, leaf-plate production, petty trade, &small-scale activities linked to self-help groups etc. the study findings also shows that their continued indigenous ecological knowledge helps in building resilience. In koraput, a tribal based district, found that tribal women continue to practiseoldfarming methods such as, millet cultivation, seed preservation, mixed cropping & local water protection techniques. These indigenous practices are often more sustainable & better modified to changing climatic situations than commercial. Mainly the self-help groups help a lot in rural areas, their collective small economic support system helps the women very strongly & strengthen their status in their society. It not only supports the women financially, but also SHGs work as place, where women share their raw experiences, exchanging their own knowledge, discussed about livelihood problems, &provide emotional support to their colleagues & their family. Through these groups, women found access to small loans, learning tactics for dealing with crop failures and in the time of household crises how to survive, & also sometimestake part in collective livelihood events. Overall, the study findings recommend that generated vulnerability in Nuapada& Koraputhas its impact on food security and other socio-economic challenges linked with rural livelihoods & survival of people. It also suggests that women are the most vulnerable group in rural areas due to their minimal income, family responsibilities and agricultural burden, but they also appear as main actors in the processes of adaptation, adjustment & resilience.

DISCUSSION:

Women’s Pathways to Resilience: Case-based Findings

The field reports from Nuapada& Koraput make known that, how the rural women respond to climate change

and how they deal with this & what are the strategies they follow. Climate is a long-term effect which can reduce the fertility, creates problem mainly for the human being. Due to everyday interactions with changing social, economic & environmental situations, their resilience capacity develops. Constantly, women adopt the uncertainties happening in their areas by their indigenous knowledge, & collective societal support. Though there are many problems faced by women like poverty, inequality, ecological imbalance, degradation of fertility, minimal financial support, still women sustain their livelihoods & families due to their strong determination.

One of the most visible forms of resilience, found in Koraput district that they return to old-style farming systems. Particularly from the tribal communities, many women slowly decrease their dependence on water related cultivation or farming & they shifted their farming from paddy cultivation to millet & mixed cropping methods. This is not simply an agricultural change but a new strategy to revive their indigenous knowledge, that declined the spread of commercial farming. Among the case studies “one woman said that irregular rainfall made their cultivation loss, & this loss encouraged her to restart millet cultivation in their paddy field, which was earlier done by their previous generations.” In passing time, she started millet farming with some vegetables, non-timber forest products, pulses etc to create a more diverse cropping that reduce the risk of crop loss. These small adjustment in their cultivation method shows that how resilient the women are & their connection with ecological sustainability & local knowledge system. Those women who are dependent upon non-timber forest products (NTFPs) have modified their old farming practices, in declining to forest availability. They choose that instead of selling raw forest products at low price, now they selling the tamarind & leaf plates in their local markets, in better prices. So, it is found that SHGs helps the women in these activities by giving them small loans & providing them market supports. Through this support women strengthen their bargaining ability & become less exploited by intermediaries & local traders.

In opposite the Nuapada district were facing drought situations, which directly affected their livelihood

diversification & labour mobility. In many family's people migrate for survival, due to repetitive crop failure & less agricultural productivity.

In that time women are the key actors whose role is “responsibility”, they are trapped & managed family responsibility, agricultural activities, taking care of their family members, & another side they do wage labour simultaneously. One case study shows that “one women respondent shared her life that after passing years due to poor harvests, her husband travelled to another state for construction work. While her husband worked out of state, she started a small plot for farming for their family consumption and also, she joined daily wage labourers. Additionally, for more stable income she started keeping goats, sheeps etc. this story shows that how resilience built through rely on multiple resources for their survival rather than depending on fully in agriculture.

Another serious challenge found in the district of Nuapada, e.g., “Water scarcity” where they play main role in dealing with the local water resources as well as scarcity. Women collectively organize in one village to ensure the fair distribution of water in the period of water shortage. These collective works lessen the conflict in between them and they keep in mind that the distribution should be equal & equal access to water. Even if such local systems are rarely acknowledged & recognized in formal policy discussions, but these are important for sustain their livelihoods during crises. Though women are directly involved in water collection and family management, but in the time of solution they were ignored, they have practical experience that can bring solution. So, it is found that across both the districts SHGs have become an important source of resilience and mutual support. The field case studies suggest that resilience & coping mechanisms are usually built through everyday adjustments rather than sudden changes. Where women uninterruptedly adjust farming practices, diversify income sources, & depend on social networks & community relationships to cope with environmental uncertainty. These strategies are shaped by local ecological conditions, cultural traditions, and the availability of resources.

In the last, most significantly, the findings challenge the simplistic assumptions that women are portrayed either as helpless or victims, or as idealised symbols of resilience in climate change discussions. The study, instead, represents a more compound reality in which vulnerability & agency co-exist. Women in Nuapada & Koraput face significant hardships due to environmental instability & socioeconomic inequalities, yet they continue to demonstrate resilience through everyday wage labour, local knowledge, & collective, cooperative action.

CHALLENGES AND CONSTRAINTS TO WOMEN'S RESILIENCE

Even though, women in Nuapada & Koraput show notable strength & adaptability in dealing with climate change, their ability to respond effectively is shaped by deep-rooted social, institutional, & economic challenges. As a result, most adaptation strategies remain focused on immediate survival rather than long-term livelihood security and sustainable development. The major barrier is unequal access to productive assets, particularly land. In rural Odisha, land ownership remains largely male-dominated despite women's active participation in agriculture. Since most women lack formal land rights, they face difficulties in accessing institutional credit, government schemes, insurance facilities, and agricultural extension services. Although women contribute significantly to cultivation and food production, they are rarely recognised officially as "farmers," which limits their visibility within policy frameworks and reduces their access to climate adaptation programs and improved technologies.

Limited financial & institutional support further weakens women's adaptive capacity. While self-help groups have improved access to savings & small loans, the available assistance is often insufficient for larger livelihood investments or long-term adaptation. Formal institutions such as banks, agricultural offices, and climate advisory services frequently fail to reach rural women because of bureaucratic procedures, low awareness, and gender bias. Consequently, many women remain dependent on low-income livelihood activities that provide only temporary support.

Mainly in Odisha, the gender roles and systemic oppression reduce their independence & decision-making authority. Regardless of their increasing participation in productive labour, they continue to be viewed exclusively

as caregivers, accountable for domestic duties and family care. Balancing family responsibilities with livelihood activities creates a heavy workload and leaves little time for training, community participation, or alternative economic opportunities. In many households, decisions regarding farming, land use, and financial investments are still dominated by men, even when women contribute most of the labour.

'Climate change has additionally, intensified women's workload and created severe time poverty. Environmental degradation, declining forest resources, and water scarcity have made everyday survival tasks more demanding. Women often spend long hours collecting water, fuelwood, & fodder, leaving them physically exhausted and limiting social exclusion and marginalization. In many cases, resilience is sustained only through additional labour & personal sacrifice, placing significant pressure on women's physical and emotional well-being.

Another important challenge is the lack of access to climate-related information & technological support. Many rural women do not receive timely information about weather changes, crop management, government schemes, or adaptation measures. Agricultural extension services are generally designed with male farmers in mind and rarely address women's specific needs and constraints. As a result, women often depend mainly on traditional coping practices without adequate institutional support to strengthen their adaptive capacities.

The study also highlights the limited recognition of indigenous ecological knowledge within formal climate and development policies. Women possess valuable traditional knowledge related to farming, seed conservation, forest use, and water management developed through generations of interaction with local ecosystems. However, policy interventions often prioritise technical and top-down solutions while overlooking local knowledge systems, reducing the effectiveness of adaptation efforts. Market-related challenges further weaken women's livelihood strategies. Women involved in small-scale enterprises and value-added activities often struggle to access markets, receive fair prices, and compete with larger producers. Dependence on middlemen, poor transportation, and limited bargaining

power reduce their earnings and discourage further investment in livelihood activities.

These challenges are intensified by the broader conditions of poverty and regional underdevelopment in the KBK region. Poor infrastructure, limited employment opportunities, weak institutional support, and long-standing socioeconomic marginalisation create additional barriers to resilience. Overall, the findings show that although women in Koraput and Nuapada continuously demonstrate resilience, their adaptive capacities remain constrained by structural inequalities and institutional limitations. Strengthening women's resilience therefore requires addressing unequal access to resources, gender discrimination, weak institutional support, and exclusion from decision-making processes while creating conditions that enhance women's rights, agency, and long-term livelihood security.

POLICY IMPLICATIONS AND WAY FORWARD

To report the organised challenges of vulnerabilities, the study mainly highlights the need for 'gender-sensitive & locally grounded policies' in Koraput & Nuapada. Though rural women validate substantial liveliness in working environment & livelihood weights, their adaptive capacity remains restricted by unequal access to resources, weak organised support, & social marginalisation. Therefore, setting resilience requires recognising women not only as vulnerable groups, but also as dynamic contributors to climate adaptation and rural growth, and one important policy concern is the recognition of women as farmers & resource managers. Women are often excluded from formal agricultural documents & official benefits, despite their major role in rural agricultural activities. Escalating women's land rights, encouraging joint land ownership, & improving access to credit, insurance, & welfare services can strengthen livelihood security & support climate-resilient agricultural practices.

The study findings indicate that there is more inclusive institutional support needed for them. Different Govt schemes, such as the 'National Rural Livelihoods Mission' (NRLM) and 'Mahatma Gandhi National Rural Employment Guarantee Act' (MGNREGA), can play a stronger role in supporting women's flexibility if they are

implemented with greater attention to women's everyday realities. Providing this access to women, like training programs, information related to climate, sustainable farming realities, and a financial support system, can improve women's adaptive capacity under changing environmental situations. Further, this study gives more emphasis to self-help groups & local organisations at the grassroots level. These groups create space for collective learning, mutual support & livelihood cooperation, beyond financial support. The SHGs can enhance women's economic independence & societal adaptation through better market linkages, skill development initiatives & formal assistance.

It is correspondingly significant to promote both the climate-resilient & livelihood practices. In the farming sector, encouraging drought-resistant crops, diversified farming systems, water conservation, & agroecological methods can reduce climate-related hazards. In conclusion, taking part in native ecological knowledge with scientific strategies can create more sustainable & locally suitable variation strategies. This study not only emphasises the status of reducing women's labour load but also increasing their participation in local governance. Livelihood opportunities can be upgraded by investigating the infrastructure in rural areas such as water, sanitation, transport, & energy facilities, & it can also cut the amount of unpaid labour. At the same time, strengthening their representation in local institutions such as forest committees "Panchayati Raj Institutions" (PRIs), & water management groups can make climate governance broader & more responsive to local needs. Finally, the study findings recommend that climate resilience in the districts like "Nuapada & Koraput" can't be separated from issues of gender equality, sustainable livelihoods, & social justice. Therefore, policies must move beyond short-term measures & address the deeper structural variations that shape women's vulnerability & adaptive capacity in village areas.

CONCLUSION

In India & particularly in Odisha, 'Climate change is not merely an environmental concern in the districts of Nuapada & Koraput, but also a serious social challenge that directly or indirectly affects the rural livelihoods.

Here women are facing the major difficulties in every sphere such as, in their family, in changing climate situation, rainfall patterns, droughts, less productivity, deforestation, ecological degradation etc. which is growing vulnerability. This is because rural women are heavily dependent upon natural resources for their household survival, & due to their limited access to land, finance, institutional support & participation in decision making, they also experience the impacts of climate more intensely. Women are not simply the victims of climate change; the study makes it very clear. They enthusiastically reply to environmental ambiguity through various adaptive practices such as continuing traditional farming methods, participating in forest-based activities, and engaging in self-help groups and community networks & diversifying livelihoods. Their resilience capacity is shaped by cooperation, local knowledge & everyday efforts to sustain household & livelihood security under shifting circumstances. Yet, women's ability to adapt remains delimited by structural barriers such as inadequate institutional recognition, limited market opportunities, unequal access to resources, and persistent gender discrimination. As a result, much of their resilience is centred on coping & survival rather than achieving long-term empowerment, security, & independence. Therefore, the study highlights the reputation of developing climate policies that are gender-sensitive & grounded in local realities. Recognising women as vital contributors to 'climate adaptation' & 'sustainable development' is essential. Escalating their access to resources, formal support, and decision-making places can benefit in building more inclusive, equitable, & sustainable forms of rural resilience in the face of climate change.

ACKNOWLEDGEMENT:

The authors gratefully acknowledge the financial support and institutional assistance provided by the Indian Council of Social Science Research (ICSSR), New Delhi, for facilitating this research. The authors also sincerely thank all the study participants for their valuable time and cooperation during the fieldwork.

AUTHOR CONTRIBUTIONS

The Research Assistant was primarily responsible for the execution of the study, including literature review,

research design implementation, data collection coordination, data cleaning, data analysis, interpretation of findings, preparation of tables and figures, and drafting the manuscript. The Principal Investigator provided overall conceptual guidance, project supervision, and critical review of the manuscript. The Co-Principal Investigators contributed to the study design, methodological inputs, interpretation of findings, and manuscript review. The Field Investigators conducted field data collection and assisted in respondent coordination as well as in case analysis. All authors reviewed, revised, and approved the final version of the manuscript.

FUNDING:

This study is the original work supported by the Indian Council of Social Science Research (ICSSR), New Delhi, under the Special Call of Punnyasloka Ahilyabai Holkar Call for Women Led Research for Women-Led-Development entitled **"Gendered Pathways to Resilience: Examining the Impact of Climate Change on the Livelihood of Rural Women in Odisha for a Sustainable Development."**

COMPUTING INTEREST:

The authors declare no competing interests.

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