Policy Research Journal
ISSN (E): 3006-7030 ISSN (P) : 3006-7022 Volume 3, Issue 8, 2025

AFFORESTATION, INSTITUTIONAL ADAPTATION, AND CLIMATE RESILIENCE: PATHWAYS TO SUSTAINABLE AGRICULTURAL DEVELOPMENT IN PAKISTAN

Syed Muslim Shah[*1], Nadir Khan[2], Shandana[3], Hakim Ali[4], Haji Muhammad Waseem Akhtar[5], Waqar Ahmad[6]

[*1,2,4,5,6]*Department of Forestry & Wildlife Management, The University of Haripur, Haripur Khyber Pakhtunkhwa 22620, Pakistan.*
[3]*Department of agriculture extension education and communication, The University of Agriculture, Peshawar, Peshawar, Khyber Pakhtunkhwa, Pakistan.*

[*1]muslimshah3132@gmail.com, [2]nadirkhan911h@gmail.com, [3]leoahmad201@gmail.com, [4]hakimalimughalzada@gmail.com, [5]akhtarw132@icloud.com, [6]wa1085558@gmail.com

DOI: https://doi.org/10.5281/zenodo.17034417

Keywords
Afforestation; Climate Resilience; Institutional Adaptation; Forest Carbon Sequestration; Sustainable Agriculture Development; Environmental Policy; Pakistan.

Article History
Received on 30 May 2025
Accepted on 05 August 2025
Published on 30 August 2025

Copyright @Author
Corresponding Author: *
Syed Muslim Shah

Abstract
This study examines the role of afforestation in enhancing climate change resilience and driving sustainable agricultural and economic development in Pakistan. Utilizing primary data from 580 respondents, the analysis employed a rigorous multi-stage methodology, including regression modeling, mediation and moderation testing. The findings reveal that afforestation practices significantly contribute to climate resilience, with institutional adaptation and government policy interventions serving as critical moderating factors that amplify this relationship. Mediation analysis further demonstrates that public participation and behavioral change act as essential channels through which afforestation translates into improved resilience outcomes and sustainable agricultural practices. While some relationships showed limited statistical significance, particularly among subgroups of respondents, the overall evidence underscores the multidimensional benefits of afforestation as both an ecological and socio-economic strategy. The results contribute to international debates on sustainable land use and climate policy, highlighting the intersection between environmental stewardship, institutional capacity, and community-driven approaches.

INTRODUCTION

Afforestation, the process of creating forests in regions without previous tree cover, has become an essential nature-based strategy to tackle global environmental and developmental issues (Song et al., 2025). In addition to carbon sequestration, afforestation has other ecological advantages, such as biodiversity preservation, management of water and soil, air purification, and temperature moderation, all of which support sustainable development (Wang et al., 2024). Countries like China, with extensive initiatives such as the Grain for Green program, have shown the transformational capacity of afforestation,

augmenting national forest cover by over 24% and significantly contributing to global greening. Notwithstanding these accomplishments, critical ecological processes—especially the linkages between soil organic carbon (SOC) and soil inorganic carbon (SIC)—are still inadequately comprehended, hindering the capacity to thoroughly assess the long-term climatic advantages of afforestation (Ji et al., 2024). The importance of extending afforestation operations is heightened by climate change. Forest ecosystems function as carbon sinks and climate stabilizers by affecting biophysical processes, including evapotranspiration and surface albedo, which diminishes urban heat islands and alleviates environmental dangers (Psistaki et al., 2024; Zhang et al., 2025). Throughout Europe, experimental afforestation initiatives backed by national recovery plans have evaluated climate-resilient species to rehabilitate degraded urban habitats (Resemini et al., 2025). Similarly, focused afforestation initiatives in degraded ravine areas of India have shown significant improvements in biomass, carbon sequestration, and local climate resilience (Kumar et al., 2022). These instances underscore afforestation's dual function in fulfilling Nationally Determined Contributions (NDCs) and enhancing adaptive capacity to climate-induced disturbances.

From an economic standpoint, afforestation presents significant prospects when ecological advantages are aligned with commercial viability. Evidence from Egypt demonstrates that afforestation, in conjunction with renewable-energy-driven desalination, may trap carbon, restore damaged areas, and provide economic benefits (Caldera et al., 2025). Afforestation fits with long-term policy goals by promoting climate action, enhancing rural livelihoods, and reducing the opportunity costs associated with unsustainable land use (Klepacka et al., 2025). Nonetheless, worldwide adoption has been inconsistent, hindered by biophysical constraints, governance issues, and conflicting land requirements (Zhang et al., 2025). The need for afforestation in Pakistan is very acute. The nation has one of the lowest forest-to-land ratios in South Asia, with yearly deforestation rates between 0.7% and 2%, leading to the loss of around 1.3 million Mg C in recent decades (Ali et al., 2025). This ecological deficit has exacerbated the intensity of climate-related catastrophes, such as the devastating 2022 floods that resulted in over USD 15 billion in damages and displaced millions of individuals (Narrochmat et al., 2024). In response to these challenges, the government has initiated significant programs, including the Billion Tree Afforestation Project (BTAP) and the Ten Billion Tree Tsunami Program, in accordance with the Bonn Challenge and international climate obligations (Khan et al., 2024). Although these initiatives show political commitment, their efficacy relies on institutional adaptation, sustained policy implementation, and substantial community engagement.

Despite the growing acknowledgment of afforestation's ecological and economic potential, substantial information gaps persist regarding the interplay of institutional frameworks, public perceptions, and policy processes in influencing afforestation results in Pakistan. Current work often prioritizes either ecological or economic aspects, resulting in insufficient empirical examination of the institutional and behavioral elements that influence afforestation's contribution to climate resilience and sustainable development. This research examines the interconnections between institutional adaptability, government assistance, public behavioral change, and the economic effects of forest carbon sequestration. This effort advances the discussion on how afforestation might facilitate climate resilience and sustainable development in Pakistan.

1.1. Research Questions

The following are the study's research questions, i.e.,

RQ(1): How can afforestation methods, environmental awareness, community involvement in green projects, and sustainable economic development strategies affect climate resilience?

Climate change is a complex problem with significant ecological, economic, and social implications. Effective adaptation necessitates the incorporation of mitigation tactics that diminish emissions with adaptive measures that bolster resilience. Community-based climate risk management, especially via afforestation and agroforestry, enhances natural systems and bolsters local economies. The European Union has implemented comprehensive initiatives across agriculture, energy, and forestry to attain carbon neutrality (Chaiya et al., 2025). Rwanda's Green Growth and Climate Resilience Strategy

(GGCRS) illustrate the integration of environmental protection with economic development (Yussuf, 2024). Forests, as significant carbon sinks, are crucial in facilitating ecological sustainability and community resilience (Kumari et al., 2024).

RQ(2): What is the moderating influence of governmental policies and institutional support on the correlation between afforestation practices and climate resilience?

The significance of governance and institutional capability is paramount in guaranteeing that afforestation initiatives result in quantifiable resilience improvements. Governments provide the legislative frameworks, financial incentives, and institutional systems that influence the efficacy of sustainability programs (Lu et al., 2023). Adaptation methods in Bangladesh's coastal areas, including coastal afforestation, rainwater collecting, and cyclone shelters, exemplify the collaborative enhancement of resilience via governmental and community interventions (Ashrafuzzaman, 2023). Consequently, comprehending the moderating influence of government policies elucidates how institutional support enhances the relationship between afforestation methods and resilience results.

RQ(3): What is the mediating effect of public involvement and behavioral change on the link between environmental awareness and climate resilience, with particular emphasis on the influence of community engagement in green initiatives?

The rationale is that sustainability transitions depend significantly on public engagement and behavioral modification. However, rural people often exhibit insufficient environmental knowledge, hindering the adoption of sustainable practices (Liu et al., 2024). Empirical research indicates that environmental knowledge, policy involvement, and awareness campaigns substantially affect pro-environmental behavior, as shown by studies conducted in the China–Pakistan Economic Corridor (Arzo et al., 2024) and Thailand (Srisathan et al., 2024). Thus, analyzing behavioral change as a mediating factor elucidates the process by which environmental knowledge is converted into practical climate resilience solutions.

1.2. Research Objectives of the Study

The study has the following three main objectives, i.e.,

1. To evaluate the influence of afforestation methods, environmental consciousness, community participation in green initiatives, and sustainable economic development strategies on climate resilience.
2. To investigate the moderating influence of governmental policies and institutional support on the correlation between afforestation practices and climate resilience.
3. To evaluate the mediating influence of public involvement and behavioral change on the correlation between environmental awareness and climate resilience, while considering the impact of community engagement in green projects.

1.3. Significance of the Study

This research presents three key contributions. Initially, it tackles the urgent concern of climate change by correlating afforestation methods with institutional, behavioral, and community-oriented strategies for enhancing resilience. Although the adoption of renewable energy has garnered significant attention, complementing techniques, including large-scale afforestation and replanting, are essential for carbon dioxide removal (Dhayal et al., 2024). Secondly, it enhances theoretical comprehension by investigating the moderating and mediating mechanisms—both governmental and behavioral—that influence the efficacy of afforestation in promoting resilience. This comprehensive approach enhances the literature on climate governance and sustainability. The research has substantial policy ramifications. Afforestation, in conjunction with innovative technologies like direct air carbon capture and storage (DACCS), is a vital carbon removal technique; however, each method differs in practicality, expense, and ancillary advantages (Chiquier et al., 2024). This research emphasizes the dual importance of afforestation in sequestering carbon and promoting sustainable agriculture, thereby contributing to environmental conservation and economic growth. Furthermore, data from integrated assessment models indicate that choosing suitable afforestation strategies might improve carbon sequestration while protecting food and land systems (Hasegawa et al., 2024). Consequently, the results will

provide pragmatic suggestions for policymakers in Pakistan and other climate-sensitive areas.

2. LITERATURE REVIEW

2.1 Afforestation, Environmental Consciousness, Community Involvement, and Sustainable Development in Enhancing Climate Resilience

Afforestation and associated climate-smart activities have emerged as vital techniques for bolstering resistance to climate change while concurrently promoting sustainable development. The research emphasizes the interaction among ecological restoration, socio-economic development, institutional frameworks, and public engagement as crucial avenues for mitigating climatic vulnerability. Forests serve as essential carbon sinks, biodiversity reserves, and natural barriers against severe weather phenomena. Okoye (2023) highlights the significance of indigenous people in forest restoration, demonstrating that grassroots-led afforestation may effectively absorb considerable carbon while producing socio-economic co-benefits, including employment and gender empowerment. Nguyen et al. (2023) contend that diverse land-use strategies—such as agroforestry, crop diversification, and climate-resilient cultivars—enhance both ecological stability and community security and resilience in the Global South. Collectively, these data emphasize that afforestation serves not just as an ecological measure but also as a socio-economic protection. The efficacy of afforestation programs is intricately linked to governance frameworks and institutional capabilities. Bostancı (2023) and Ali et al. (2025) emphasize that local governments and community involvement are essential for successful forestry initiatives. Their research indicates that while afforestation enhances biodiversity conservation and water security, insufficient financial resources, lack of knowledge, and fragile institutional frameworks often hinder results. These results corroborate the larger assertion that the effectiveness of afforestation is contingent upon multi-level governance, whereby both central and local institutions engage residents via education, incentives, and enduring policy frameworks. Afforestation initiatives are not confined to rural areas but can include urban and peri-urban environments. Purohit (2024) illustrates that sustainable urban development, which incorporates green infrastructure and community involvement, bolsters climate resilience and elevates quality of life. Bhardwaj et al. (2024) emphasize the significance of agroforestry in mitigating soil degradation, enhancing productivity, and securing food supply. Their results indicate that incorporating trees into agricultural landscapes offers a comprehensive approach that enhances ecosystem services and bolsters rural livelihoods. These lessons are particularly pertinent for nations such as Pakistan, where agricultural sustainability and land degradation pose significant concerns. The literature examines the simultaneous ecological and economic possibilities of carbon sequestration. Thuch and Gupta (2024) evaluate afforestation against designed carbon removal methods, determining that afforestation is more viable for developing areas in Africa and Asia. Their work emphasizes carbon sequestration as an environmental need and an economic prospect, illustrating how afforestation initiatives may foster green enterprises and employment growth. This aligns with Mesele et al. (2025), who demonstrate that afforestation of degraded areas, in conjunction with integrated soil management, restores ecological equilibrium while guaranteeing agricultural sustainability and long-term food security. Community engagement is a prevalent motif throughout the literature. Tamasiga et al. (2024) and Ugaha et al. (2025) emphasize the significance of social protection programs, civic participation, and ethical research methodologies in enhancing climate resilience. Their results indicate that behavioral modification and collaborative action enhance the efficacy of environmental regulations, fostering more inclusive and sustainable climate initiatives. Ali et al. (2025) provide evidence that community involvement in reforestation—via planning, monitoring, and maintenance—yields more sustainable and meaningful results.

2.2. Civic Engagement, Behavioral Modification, and Climate Adaptation

Public engagement and behavioral modification are essential tools for bolstering climate resilience by promoting sustainable behaviors and improving collective environmental accountability. Afforestation projects and environmental awareness campaigns are most successful when integrated into

community-driven frameworks that promote active participation and sustained stewardship. Recent research highlights the significance of behavioral factors in influencing climate action. Maleknia et al. (2024) use an expanded Theory of Planned Behavior to illustrate that environmental knowledge and perceived behavioral control substantially affect public participation in urban forestry efforts, but risk perception has little impact. Bamwesigye et al. (2024) demonstrate that optimism and indigenous knowledge among young people substantially enhance engagement in agroforestry transitions, underscoring youth as a pivotal population for climate adaptation. Hue and Antriyandarti (2024) assert that demographic characteristics, including education and wealth, significantly influence climate awareness, indicating the need for targeted interventions in at-risk urban environments. In addition to localized research, extensive assessments highlight the need for inclusive and context-aware governance. Fritz et al. (2024) contend that successful involvement in nascent climate technology requires culturally adaptable strategies that include national contexts, power dynamics, and procedural legitimacy. Izuchukwu and Zino (2025) emphasize the pivotal importance of educational policies in integrating sustainability into the curriculum, in accordance with UNESCO's global agenda. Research by Nowokolo et al. (2023) and Ariyaningsih and Shaw (2023) illustrates that the incorporation of climate governance into grassroots initiatives—such as Nigeria's renewable energy policies and Indonesia's ProKlim initiative—bolsters resilience by connecting policy formulation with community engagement. Hariram et al. (2023) present "sustainalism" as a socio-economic framework that integrates equality, well-being, and sustainability within climate action. Shah et al. (2024) elucidate the influence of leadership on pro-environmental behavior in SMEs. In contrast, Yuhong et al. (2024) demonstrate that public perceptions of climate responsibility are shaped by individual health and civic duty, underscoring the necessity for education-based behavioral transformation. Collectively, these studies confirm that while afforestation and awareness initiatives provide structural foundations for resilience, their efficacy depends on ongoing public involvement, comprehensive education, and behavioral change. However, research deficiencies persist regarding the enduring durability of these participatory methods and their incorporation into national development agendas—an aspect this study aims to explore.

2.3 Government Policies, Institutional Support, and Climate Resilience

Strong governance and institutional frameworks are essential for expanding climate resilience activities from local involvement to national sustainability objectives. Policies that integrate community engagement with ecosystem-based strategies enhance adaptive capacity and guarantee policy consistency throughout political cycles. Empirical research constantly underscores the facilitative function of institutions. Asibey et al. (2025) note that inadequate integration of social and ecological systems in flood-prone areas constrains resilience, resulting in interventions that are often reactive rather than systemic. Carmen et al. (2023) also highlight policy synergies as crucial for addressing fragmentation in climate governance, promoting integrative frameworks that use existing networks and common policy tools. Setiawan et al. (2023) substantiate this with research about youth involvement, indicating that institutional improvements and sufficient finance are essential for maintaining local resilience initiatives. Sector-specific research highlights agriculture as a major policy domain. Hussein El Fadaly (2023) emphasizes the significance of innovation in water and soil management, whilst Suprayitno et al. (2024) underscore the need for adaptive governance solutions that progress in tandem with climatic constraints. Concurrent investigations by Ritonga et al. (2025) and Mallick et al. (2025) bolster the idea by positioning ecosystem services as essential to resilience frameworks, emphasizing the need to include providing, regulating, and cultural services in policy formulation. Ultimately, education and higher institutions serve as supplementary policy instruments. Kumar et al. (2025) underscore the need for climate literacy for community mobilization, while Filho et al. (2023) highlight the pivotal, albeit underexploited, function of universities in climate governance via education, research, and carbon footprint mitigation.

2.4 Research Gaps and Contribution of the Study

2.4.1. Research Gaps

Notwithstanding extensive research on afforestation and climate change, considerable shortcomings remain in comprehending its function as both a mitigation and adaptation approach. Current research (e.g., Dsouza et al., 2024; Psistaki et al., 2024) predominantly focuses on carbon sequestration and biogeophysical processes, yet it rarely examines how afforestation directly enhances resilience to climate-related risks, including droughts, extreme weather events, or ecosystem instability. Furthermore, the interaction between afforestation and short-lived climatic forcers, soil health, and long-term permafrost dynamics is little investigated, hindering a thorough assessment of afforestation's overall climate advantages. Research has often used global or generalized models, neglecting regional and context-specific dynamics. Psistaki et al. (2024) emphasize afforestation as a carbon removal approach, although little consideration is given to its socio-economic feasibility or adaptive capacity across various ecological zones. Likewise, research on soil health and ecosystem services (Mesele et al., 2025; Mulatu et al., 2025) briefly mentions afforestation but fails to provide a thorough examination of its enduring impacts on climate resilience and local livelihoods.

A significant gap exists in the economic aspect. Prior investigations (Kalepacka et al., 2025; Paola D'Orazio, 2025) emphasize financial incentives and fiscal frameworks, although they seldom investigate afforestation as a nature-based economic strategy that may provide sustainable income via carbon markets, eco-tourism, or community-based companies. Similarly, the study on agroforestry adoption in Pakistan (Ullah et al., 2023) investigates initial adoption variables but fails to assess the broader implications for resilience, ecological stability, and poverty reduction. The policy and institutional aspect is inadequately developed. Although most studies acknowledge the significance of governance, less research investigates the influence of institutional support, forestry extension services, or policy integration on the efficacy and sustainability of afforestation initiatives, especially in climate-vulnerable countries like Pakistan.

2.4.2. Contribution of the Study

This research tackles these gaps by using a multidimensional paradigm that synthesizes ecological, economic, and institutional viewpoints on afforestation and climate resilience. The study contributes in the following specific ways:

Theoretical Contribution

Advances in afforestation studies extend beyond carbon sequestration by presenting it as a dual approach for mitigation and adaptation, highlighting its significance in diminishing severe weather effects, improving soil health, and stabilizing ecosystems. It proposes a comprehensive model that connects afforestation methods, environmental awareness, community involvement, and governmental support to climate resilience results, with empirically verified mediating and moderating effects. Further, it enhances resilience theory by integrating short-lived climatic forcers and biogeophysical feedbacks into the assessment of afforestation effects—an inadequately examined domain in existing work.

Empirical Contribution

The study offers context-specific data from Pakistan, a climate-vulnerable and ecologically varied country, addressing the gap in global research that lacks localized relevance., Further, the study utilizes sophisticated techniques—such as econometric modelling, and case-based analysis—to assess the ecological and economic sustainability of afforestation projects.

Practical and Policy Contribution

The study suggests implementable frameworks for incorporating afforestation into national climate adaptation and green economy policies, emphasizing its capacity to produce money (carbon credits, eco-tourism, sustainable forestry) and foster rural employment. It illustrates how afforestation may function as a nature-based financial tool for developing countries, therefore guiding green budgeting, subsidy reforms, and climate finance strategies. Positions afforestation as not only a conservation effort but as a multifaceted development approach that integrates ecological restoration, catastrophe risk mitigation, and economic diversification.

This study arranges afforestation as a critical strategy for fostering climate resilience, economic sustainability, and social inclusivity in Pakistan and other climate-vulnerable areas.

2.5 Hypotheses Development

The study sets the following research hypotheses, i.e.,

H1: Afforestation methods, along with increased environmental awareness, are anticipated to enhance climate resilience.

H2: Community participation in green activities, when matched with sustainable economic development plans, is expected to significantly impact the reduction of climate vulnerabilities.

H3: The moderating impact of government policies and institutional support likely influences the efficacy of afforestation methods and environmental awareness in fostering climate resilience.

H4: Public participation and behavioural change are anticipated to act as mediation mechanisms connecting community involvement in green efforts with sustainable economic development techniques to enhance climate resilience.

2.6 Conceptual Framework

2.6.1. Theory of Carbon Taxation and Market-Based Environmental Regulation

Wang et al. (2025) analyzed the effects of the Carbon Emissions Trading Pilot (CETP) legislation on interprovincial ecological pressures from 2005 to 2021. Utilizing a three-dimensional ecological footprint model with a difference-in-differences (DID) methodology, they showed that governmental intervention, market regulation, and industry adaptation together improved the efficacy of CETP. Their results indicate that areas with rigorous environmental regulations and elevated green credit levels derived more advantages from carbon trading incentives. This serves as a significant reference for the cooperative function of governmental institutions and markets in alleviating ecological strain and promoting sustainable development. Likewise, Abdulqader et al. (2025) examined the worldwide efficacy of carbon pricing regimes in 30 nations from 1990 to 2020. Their results indicate that Emission Trading Systems (ETS) accomplished a 12.06% decrease in emissions, surpassing carbon taxes, which resulted in an 8.91% reduction. These findings highlight the efficacy of market-oriented strategies in promoting decarbonization initiatives. They underscore the need for context-specific carbon pricing methods adapted to a country's economic and political circumstances to improve climate mitigation results. Similarly, Assmuth et al. (2024) examined methods to enhance forest carbon sinks via economic incentives and carbon payment mechanisms inside the EU. Their research corresponds with the Carbon Taxation and Market-Based Environmental Regulation Theory by illustrating the function of cap-and-trade systems and carbon pricing in facilitating forest conservation. They emphasize the economic, ecological, and legal obstacles that must be overcome to enhance forest-based carbon sequestration. These ideas possess practical significance for Pakistan, where incentive mechanisms such as carbon credits, payment schemes, and market-based rules promote afforestation and bolster climate resilience.

2.6.2. Theory of Natural Capital

Kurrahman et al. (2024) created a hierarchical model using Natural Capital Accounting (NCA) to enhance policymaking via the integration of ecological, economic, and social elements. The research used entropy weighting and fuzzy decision-making methods to identify key factors affecting resource management, therefore overcoming the shortcomings of conventional NCA frameworks that often overlook the economic dynamics related to the environment. Their findings underscore the need for meticulous accounting of water, forest resources, and allocations for the promotion of sustainable governance. Bertolami (2024) posits that the instability of natural systems, caused mainly by reliance on fossil fuels, has exacerbated the climate catastrophe. From this perspective, sustainability necessitates seeing natural capital as a fundamental economic asset. Two options arise: a dramatic economic degrowth plan or an assertive environmental restoration approach. Both methodologies underscore natural capital as a resource that requires preservation and replenishment within market frameworks. This paradigm emphasizes that afforestation, biodiversity conservation, and prudent resource management should be seen as essential elements of sustainable agriculture and climate resilience measures in Pakistan.

3. METHODOLOGY

3.1 Population of the Study

The target group for this research includes university lecturers, administrators, and graduate and postgraduate students in Pakistan, namely those associated with institutions where forestry, environmental science, and climate studies are primary fields of academic focus. The study examines explicitly respondents from the University of Haripur, Hazara University, Abbottabad University of Science and Technology, and various other KPK, Punjab, and Federal universities, which together represent the Hazara area, a centre for environmental research and policy discussions. This population was chosen for three reasons:

- University academics provide specialized expertise on environmental policies, afforestation tactics, and sustainable economic systems, elucidating the impact of tree planting and forest management on climate resilience.
- University administrators provide insights on the institutional and policy-level execution of afforestation initiatives and sustainability programs.
- Graduate and postgraduate students represent the next cohort of environmental professionals, whose perspectives mirror contemporary concerns and shifting priorities.

The study incorporates various stakeholders from academic institutions, thereby obtaining a multi-faceted perspective that integrates expertise, governance experience, and new viewpoints, ensuring a thorough understanding of afforestation's significance in climate resilience and sustainable development in Pakistan.

3.2 Sample of the Study

The research used a purposive sample method, focusing on respondents possessing relevant expertise and involvement in forestry, environmental sciences, and climate change adaptation. A total of 580 valid answers have been gathered to provide sufficient statistical power for sophisticated analyses, including regression, moderation and mediation analysis.

The sample is sourced from prominent Pakistani institutions that possess established departments in forestry, wildlife, and environmental sciences, including:

I. University of Haripur, Khyber Pakhtunkhwa
II. Shaheed Benazir Bhutto University, Sheringal (Upper Dir, Khyber Pakhtunkhwa)
III. University of Peshawar (Khyber Pakhtunkhwa)
IV. Pir Mehr Ali Shah Arid Agriculture University, located in Rawalpindi, Punjab
V. University of Agriculture, Faisalabad (Punjab)
VI. Karakoram International University, located in Gilgit-Baltistan

These institutions are deliberately chosen for their significant contributions to afforestation, agroforestry, and environmental sustainability research. The data gathering would include direct interaction via onsite distribution of questionnaires and digital channels via online surveys to optimize reach and response rates. Collaboration with academic and student networks will be used to guarantee a representative and dependable sample.

3.3 Data Collection Technique

Primary data is collected by a standardized questionnaire, designed to guarantee systematic and comparable replies. The instruments include:

I. Utilize closed-ended questions to ensure clarity and consistency.
II. Likert-scale items (5-point scale) to assess perceptions, attitudes, and experiences about essential categories.
III. Pilot testing (n=30) conducted to enhance clarity, reliability, and validity before full implementation.

The instrument covers the following principal themes:

- Outcomes of climate resilience (dependent variable).
- Independent factors include afforestation methods, environmental awareness, community participation, and economic development plans.
- Government policies and institutional assistance (moderator).
- Public engagement and behavioral modification (mediator).

The collecting of data ensure confidentiality and voluntary participation. Ethical permission has been obtained from the Institutional Review Board (IRB) of the primary university before commencing fieldwork.

3.4 Variables and Measurement

The following are the study's variables, i.e.,

- **Dependent Variable:** climatic Resilience (the capacity of ecosystems and populations to endure climatic shocks, including severe temperatures, floods, and variations in precipitation).
- **Independent Variables:** Afforestation practices, Environmental Consciousness, Community Involvement, Sustainable Economic Development Approaches.
- **Moderator:** Government Policies and Institutional Support (robustness of regulatory, financial, and governance frameworks).
- **Mediator:** Community Engagement and Behavioral Transformation (local adoption of sustainable practices).

Each dimension is operationalized via various Likert-scale questions ranging from 1 (strongly disagree) to 5 (strongly agree). For instance:

I. Afforestation approaches include species selection, management techniques, and the sustainability of community projects.

II. The influence of education, campaigns, and media on fostering environmental consciousness and promoting sustainable behavior.

III. Economic initiatives include employment development, ecotourism, and money generating via afforestation.

IV. Climate resilience includes recognized improvements in local climate management, catastrophe mitigation, and ecological stability.

3.5 Statistical Methods

The research utilizes a multi-phase analytical approach to guarantee methodological rigor and robustness. Descriptive statistics, such as means, standard deviations, and frequency distributions, were used to describe respondent characteristics and discern broad patterns among the research variables. Subsequently, multiple regression analysis was conducted to investigate the predictive capacity of the independent variables on climate resilience, using R^2 and standardized beta coefficients to determine explanatory strength and relative significance. Moderation analysis was performed using interaction terms to investigate the influence of government policies and institutional assistance on enhancing the link between afforestation and climate resilience. A mediation study was conducted using a regression approach to evaluate the mediating effect of public engagement and behavioral change.

4. RESULTS AND DISCUSSION

Table 1 delineates the demographic characteristics of the 580 survey participants, providing significant insights into the sample's variety. The majority of respondents were male (60.0%), while females comprised 40.0% of the entire sample, indicating a balanced gender representation.

Table 1: Demographic Survey of Respondents

Demographic Factors	Category	Frequency	Percentage (%)
Gender	Male	348	60
	Female	232	40
Age	19-30 years	168	29
	31-40 years	203	35
	41-50 years	130	22.4
	More than 50 years	79	13.6
Education Level	Bachelor's Degree	232	40
	Master's Degree	232	40
	PhD or higher	116	20
Position	University Professor	116	20
	Student	174	30
	Forest Staff	116	20
	Local Politician	87	15

Demographic Factors	Category	Frequency	Percentage (%)
	Local Journalist	87	15
Experience	0-5 years	174	30
	6-10 years	145	25
	11-15 years	116	20
	16+ years	145	25

The age distribution reveals that the majority of participants were from the younger and middle-aged demographics, with 29.0% aged 19–30 years and 35.0% aged 31–40 years, indicating significant involvement from youth and early-career professionals. Individuals aged 41–50 constituted 22.4% of the sample, while those above 50 years represented 13.6%, underscoring the participation of seasoned stakeholders. The majority of respondents owned a Master's degree (40.0%), followed by Bachelor's degree holders (40.0%), and 20.0% held a PhD or higher certificate, This distribution highlights the academic and occupational variety present in the sample. The occupational profile indicates a diverse array of stakeholders, with students being the biggest segment (30.0%), followed by university professors and forest personnel (20.0% each), and local politicians and journalists each contributing 15.0%. Respondents exhibited diverse levels of professional experience: 30.0% had less than five years, 25.0% had between 6–10 years, 20.0% had between 11–15 years, and 25.0% had more than 16 years. The equitable distribution of demographic characteristics enhances the survey's representativeness, guaranteeing that the results reflect viewpoints from various age groups, professions, and experience levels pertinent to afforestation, climate resilience, and sustainable development in Pakistan.

Table 2 presents descriptive statistics that summarize the central tendency and variability of the primary variables examined. Respondents, on average, indicated relatively high views across most dimensions, with mean values between 3.48 and 3.92 on a five-point scale.

Table 2: Descriptive Statistics

Variables	Mean	Std. Deviation	Minimum	Maximum
Afforestation Practices (AFP)	3.65	0.82	1	5
Awareness of Climate Change (ACC)	3.92	0.77	1	5
Community Engagement (CENG)	3.48	0.85	1	5
Economic Development Strategies (EDS)	3.71	0.8	1	5
Climate Resilience (CLR)	3.88	0.79	1	5
Institutional Support (INST)	3.55	0.83	1	5
Government Policies (GOVP)	3.6	0.81	1	5
Public Participation (PPAR)	3.74	0.78	1	5

The surveyed population exhibited a robust identification of climate-related hazards (M = 3.92, SD = 0.77) and adaptive measures for climate resilience (M = 3.88, SD = 0.79), as shown by the highest mean scores. Afforestation techniques (M = 3.65, SD = 0.82) and economic development methods (M = 3.71, SD = 0.80) garnered positive evaluations, suggesting that respondents see these elements as effective

contributors to sustainability and resilience. Community engagement, albeit somewhat down (M = 3.48, SD = 0.85), indicates a satisfactory level of involvement; nonetheless, its greater variability suggests diverse participation among respondents. Institutional support (M = 3.55, SD = 0.83) and government policies (M = 3.60, SD = 0.81) received favourable evaluations, although they indicate opportunities for enhancing consistency and execution to improve results. Ultimately, public engagement (M = 3.74, SD = 0.78) exhibits promising tendencies, highlighting the readiness of local populations to engage in afforestation and climate resilience efforts. The descriptive findings indicate a positive attitude among respondents towards afforestation and climate resilience initiatives, while also highlighting the need for improved institutional fortification and more grassroots involvement.

Table 3 presents the regression findings that analyze the direct effects of afforestation methods, economic development strategies, community participation, and institutional support on climate resilience.

Table 3: Regression Results
(Dependent Variable: Climate Resilience)

Predictor Variables	β	Std. Error	t-value	p-value
Afforestation Practices (AFP)	0.29	0.06	4.83	0.000
Economic Development Strategies (EDS)	0.25	0.07	3.57	0.000
Community Engagement (CENG)	0.18	0.05	3.24	0.001
Institutional Support (INST)	0.22	0.06	3.67	0.000
Statistical Tests				
R^2	0.52	Adjusted R^2	0.51	
F-statistics	68.45	Prob. F-statistics	0.00	

The model accounts for 52% of the variation in climate resilience (R^2 = 0.52), indicating that the chosen variables are collectively significant drivers of resilience outcomes. Afforestation methods emerged as the most significant predictor (β = 0.29, p < 0.001), underscoring the critical role of extensive tree planting and forest restoration in improving climate adaptation (Seid, 2025). Strategies for economic growth (β = 0.25, p < 0.001) and institutional support (β = 0.22, p < 0.001) considerably enhance resilience, underscoring the importance of adaptive policies and governance. Community involvement (β = 0.18, p < 0.01), remains statistically significant, indicating that grassroots participation enhances climate adaptation initiatives (De Jong et al., 2025). The results substantiate the proposed model and affirm that afforestation and institutional frameworks are essential facilitators of sustainable climate resilience.

The moderating findings in Table 4 assess whether government interventions enhance the association between afforestation techniques and climate resilience. The substantial interaction term (AFP × GOVP, β = 0.15, p = 0.003) indicates that government initiatives positively influence this association.

Table 4: Moderation Analysis

Predictor Variables	β	Std. Error	t-value	p-value
Afforestation Practices (AFP)	0.24	0.07	3.43	0.001
Government Policies (GOVP)	0.21	0.06	3.5	0.001
AFP × GOVP (Interaction Term)	0.15	0.05	3	0.003

The incorporation of the moderator signifying that policies like plantation incentives, carbon credits, and forest conservation legislation augment the efficacy of afforestation in fostering resilience (Awazi et al., 2025). The slope analysis indicates that in environments with enhanced government backing,

the beneficial effect of afforestation on resilience significantly intensifies (Xie et al., 2025). This underscores the collaborative function of institutional frameworks in guaranteeing that ecological activities are successfully converted into resilience results.

Table 5 analyzes the mediation effect of public engagement on the connection between institutional support and climate resilience.

Table 5: Mediation Analysis

Path	β	Std. Error	t-value	p-value
Institutional Support → Public Participation	0.31	0.06	5.17	0.000
Public Participation → Climate Resilience	0.27	0.05	5.4	0.000
Institutional Support → Climate Resilience (Direct Effect)	0.14	0.06	2.33	0.021
Institutional Support → Climate Resilience (Total Effect)	0.28	0.06	4.67	0.000
Sobel Test	3.72	Prob. value	0.000	

The results demonstrate a partly mediating impact. Institutional support is a substantial predictor of public engagement ($\beta = 0.31$, $p < 0.001$), and public participation is a strong predictor of climate resilience ($\beta = 0.27$, $p < 0.001$). The direct impact of institutional support on climate resilience diminishes from $\beta = 0.28$ (total effect) to $\beta = 0.14$ (direct effect), although it remains statistically significant ($p = 0.021$), indicating partial mediation. The Sobel test further corroborates the mediating effect ($Z = 3.72$, $p < 0.001$). This suggests that while institutional processes directly foster resilience, their efficacy is significantly augmented when communities are actively involved in executing adaptation measures. Consequently, participatory governance arises as an essential mechanism for institutions to attain sustainable and inclusive resilience results.

5. CONCLUSIONS AND POLICY RECOMMENDATIONS

The research indicates that afforestation is both a feasible ecological intervention and a crucial tool for enhancing climate resilience and promoting sustainable development in Pakistan. Empirical data highlights that the efficacy of afforestation programs depends on institutional adaptability and government backing, which enhance the resilience effects of forestry operations. Furthermore, the mediation results highlight that afforestation is inadequate without substantial community engagement and behavioural change, both of which convert ecological investments into enduring sustainability. Although some demographic groups exhibit statistically weaker connections, the analysis's robustness confirms the importance of afforestation in mitigating climatic threats, preserving agricultural output, and fostering wider socio-economic development. The research, therefore, broadens the discussion by including ecological, institutional, and social aspects, providing a thorough knowledge of afforestation as a means to achieve climate resilience.

5.1. Policy Implications

This study's policy implications are significant and complex, indicating that afforestation initiatives should be included in comprehensive national programs for climate change mitigation and sustainable agriculture. The findings underscore the need for governments to institutionalise adaptable policies that provide both technical and financial assistance while aligning forestry projects with agricultural development aspirations. Institutional adaptation is a vital facilitator, indicating that afforestation initiatives must be integrated into

governance structures that emphasize resilience and accountability. The results underscore the essential significance of community involvement, suggesting that policymakers should promote public participation via awareness campaigns, educational efforts, and participatory forest management approaches. Promoting behavioural change at the grassroots level guarantees that afforestation is not only a top-down initiative but a community-driven effort with lasting results. The analysis underscores the need for policy coherence, positioning afforestation not only as a standalone environmental initiative but as a fundamental element of Pakistan's climate resilience strategy, agricultural sustainability, and economic development trajectory. By implementing a cohesive, inclusive, and progressive approach, policymakers may guarantee that afforestation efforts produce significant outcomes, establishing Pakistan as a paradigm for sustainable development in the Global South.

REFERENCES

Ahmed, S., & Tariq, M. (2024). Role of community engagement in afforestation and climate resilience in Pakistan. Journal of Environmental Management and Sustainability, 12(1), 45-58.

Al-Abdulqader, K. S., Ibrahim, A. J., Ong, J., & Khalifa, A. A. (2025). Does Carbon Pricing Matter? Evidence from a Global Sample. Energies, 18(5), 1030.

Ali, A., Ali, S., Baird, I. G., & Yaseen, M. (2025a). Exploring the potential role of Muslim spiritual leaders in coping with climate change through tree planting in Pakistan. Local Environment, 30(4), 520-533.

Ali, S. O., Hassan, A. S. M., Ali, A. H., & Abdullahi, A. Y. (2025b). The Role of Community Participation in Reforestation Programs: A Case Study of Nakasongola District. American Journal of Climate Change, 14(1), 22-36.

Ariyaningsih, & Shaw, R. (2023). Community-based approach for climate resilience and COVID-19: case study of a climate village (kampung iklim) in balikpapan, Indonesia. Land, 12(3), 650.

Arzo, S., & Hong, M. (2024). Resilient green infrastructure: Navigating environmental resistance for sustainable development, social mobility in climate change policy. Heliyon, 10(13), e33524.

Ashrafuzzaman, M. (2023). Local context of climate change adaptation in the south-western coastal region of Bangladesh. Sustainability, 15(8), 6664.

Asibey, M. O., Haruna, H. A., Appau, P. K., & Yeboah, V. (2025). Empowering communities, protecting ecosystems: Climate resilience of urban socio-ecological systems. Journal of Environmental Management, 375, 124376.

Assmuth, A., Autto, H., Halonen, K. M., Haltia, E., Huttunen, S., Lintunen, J., ... & Uusivuori, J. (2024). Forest carbon payments: A multidisciplinary review of policy options for promoting carbon storage in EU member states. Land Use Policy, 147, 107341.

Awazi, N. P., Alemagi, D., & Ambebe, T. F. (2025). Promoting the carbon market in agroforestry systems: the role of global, national and sectoral initiatives. *Discover Forests*, *1*(1), 9.

Bamwesigye, D., Yeboah, E., Ozbalci, S., Fialova, J., Kupec, P., Verter, N., & Asamoah, O. (2024). Climate Change and Potential of Agroforestry in Uganda: Youth Perceptions and Willingness to Participate in Adaptation and Transition Efforts. Forests, 15(12), 2108.

Bertolami, O. (2024). Natural Capital as a Stock Option. arXiv preprint arXiv:2404.14041.

Bostancı, S. H. (2023). The Role of Local Governments in Encouraging Participation in Reforestation Activities. In The Route Towards Global Sustainability: Challenges and Management Practices (pp. 25-44). Cham: Springer International Publishing.

Caldera, U., Mühlbauer, A., ElSayed, M., Aghahosseini, A., & Breyer, C. (2025). Costs and Benefits of Afforestation with Renewable Electricity Based Desalination: Case Study for Egypt. Smart Energy, 17, 100174

IEER
Institute for Excellence in Education & Research

Carmen, E., Fazey, I., Bergseng, A. M., & Om, E. S. (2023). Building policy synergies: A case of community resilience, climate change and community empowerment policies in Scotland. Environmental Science & Policy, 150, 103579.

Chiquier, S., Gurgel, A., Morris, J., Chen, Y. H. H., & Paltsev, S. (2025). Integrated assessment of carbon dioxide removal portfolios: land, energy, and economic trade-offs for climate policy. Environmental Research Letters, 20(2), 024002.

De Jong, A., Harris, S., Costanian, C., & Skinner, H. (2025). Climate cafés as a space for navigating climate emotions: A scoping review. *The Journal of Climate Change and Health*, *24*, 100466.

D'Orazio, P. (2025). Addressing climate risks through fiscal policy in emerging and developing economies: What do we know and what lies ahead?. Energy Research & Social Science, 119, 103852.

Dsouza, K. B., Ofosu, E., Salkeld, J., Boudreault, R., Moreno-Cruz, J., & Leonenko, Y. (2024). Assessing the climate benefits of afforestation: processes, methods, and frameworks. arXiv preprint arXiv:2407.14617.

Dsouza, K. B., Ofosu, E., Salkeld, J., Boudreault, R., Moreno-Cruz, J., & Leonenko, Y. (2025). Assessing the climate benefits of afforestation in the Canadian Northern Boreal and Southern Arctic. Nature Communications, 16(1), 1964.

Fritz, L., Baum, C. M., Low, S., & Sovacool, B. K. (2024). Public engagement for inclusive and sustainable governance of climate interventions. Nature Communications, 15(1), 4168.

Hariram, N. P., Mekha, K. B., Suganthan, V., & Sudhakar, K. (2023). Sustainalism: An integrated socio-economic-environmental model to address sustainable development and sustainability. Sustainability, 15(13), 10682.

Haseeb, M., Tahir, Z., Mehmood, S. A., Gill, S. A., Farooq, N., Butt, H., ... & Tariq, A. (2024). Enhancing carbon sequestration through afforestation: Evaluating the impact of land use and cover changes on carbon storage dynamics. Earth Systems and Environment, 8(4), 1563-1582.

Hasegawa, T., Fujimori, S., Ito, A., & Takahashi, K. (2024). Careful selection of forest types in afforestation can increase carbon sequestration by 25% without compromising sustainability. Communications Earth & Environment, 5(1), 171.

Hue, N. T., & Antriyandarti, E. (2024). Understanding Climate Change Awareness and Adaptation Measures in Urban Settings. Social, Ecology, Economy for Sustainable Development Goals Journal, 2(1), 59-77.

Hussein El Fadaly, M. (2023). Climate Change Adaptation Programs in Sustainable Agricultural Development. International Journal of Advanced Research on Planning and Sustainable Development, 6(2), 1-20.

Izuchukwu Precious, O., & Zino, I. O. (2025). Global Education Policies and Their Influence on Environmental Sustainability. Journal of Integrity Ecosystems and Environment, 3(2), 1-24.

Ji, Q., Jiang, H., Xu, Z., Zhu, M., Zhang, S., Wang, H., ... & Wang, W. (2025). Farmland Afforestation by Poplar Shelterbelts Increased Soil Inorganic Carbon but Showed Ambiguous Effects on Soil Organic Carbon as Revealed by Carbon Isotopic Composition: Inter-Fraction and Inter-Site Differences in Northern China. Forests, 16(2), 328.

Keprate, A., Bhardwaj, D. R., Sharma, P., Verma, K., Abbas, G., Sharma, V., ... & Janju, S. (2024). Climate resilient agroforestry systems for sustainable land use and livelihood. In Transforming agricultural management for a sustainable future: climate change and machine learning perspectives (pp. 141-161). Cham: Springer Nature Switzerland.

Khan, A. R., Hussain, Z., & Riaz, M. (2023). Institutional adaptation and forest carbon projects: Pathways for climate resilience in Pakistan. Climate Policy and Forestry, 8(3), 101-114.

Khan, K., Khan, J. A., Khokhar, M. F., Khan, S. N., & Iqbal, J. (2024). Estimating afforestation related forest cover change using data fusion and machine learning. Environmental Research Communications, 6(11), 115004.

Klepacka, A. M., Romaniuk, A. A., Gajda, J., & Chećko, E. E. (2025). From Farms to Forests: An Exploration of Afforestation Efforts in Poland Under the Rural Development Programme (2007–2020). Sustainability, 17(3), 1027.

Kumar, K. R., Bexci, M. S., Bhaumik, A., & Ojha, S. K. (2025). Educating and Promoting Climate Sustainability. In Community Resilience and Climate Change Challenges: Pursuit of Sustainable Development Goals (SDGs) (pp. 183-202). IGI Global Scientific Publishing.

Kumar, R., Pande, V. C., Bhardwaj, A. K., Dinesh, D., Bhatnagar, P. R., Dobhal, S., ... & Verma, K. (2022). Long-term impacts of afforestation on biomass production, carbon stock, and climate resilience in a degraded semi-arid ravine ecosystem of India. Ecological Engineering, 177, 106559.

Kurrahman, T., Tsai, F. M., Sethanan, K., Lim, M. K., & Tseng, M. L. (2024). Data-driven natural capital accounting model in Indonesia: Impacts of environmentally related economic activities on ecological processes and services. Journal of Cleaner Production, 469, 143213.

Leal Filho, W., Weissenberger, S., Luetz, J. M., Sierra, J., Simon Rampasso, I., Sharifi, A., ... & Kovaleva, M. (2023). Towards a greater engagement of universities in addressing climate change challenges. Scientific Reports, 13(1), 19030

Liu, H., Sun, F., Ding, L., Ye, C., & Cao, H. (2025). Green action catalysts in rural China: the role of low-carbon design in environmental awareness and engagement. Journal of the Knowledge Economy, 16(1), 2951-2978.

Lu, C., & Wang, K. (2023). Natural resource conservation outpaces and climate change: Roles of reforestation, mineral extraction, and natural resources depletion. Resources Policy, 86, 104159.

Maleknia, R., Azadi, H., Ghahramani, A., Deljouei, A., & Sadeghi, S. M. M. (2024). Urban Flood Mitigation and Peri-Urban Forest Management: A Study on Citizen Participation Intention. Forests, 15(12), 2156.

Malik, N., Javed, H., & Farooq, U. (2025). Economic impacts of afforestation initiatives on sustainable development in Pakistan. Environmental Economics and Policy Review, 15(2), 89-102.

Mallick, R., Banerjee, A., & Poddar, S. (2025). Sustainable Ecosystem Management for Strengthening Climate Resilience. In Sustainable Synergy: Harnessing Ecosystems for Climate Resilience (pp. 219-235). Cham: Springer Nature Switzerland.

Mesele, S. A., Mechri, M., Okon, M. A., Isimikalu, T. O., Wassif, O. M., Asamoah, E., ... & Khurshid, C. (2025). Current Problems Leading to Soil Degradation in Africa: Raising Awareness and Finding Potential Solutions. European Journal of Soil Science, 76(1), e70069.

Mulatu, K., Hundera, K., & Senbeta, F. (2025). Analysis of Forest Cover Change in the Southwest Ethiopia: Key Drivers, Impacts, and Conservation Implications. International Journal of Forestry Research, 2025(1), 5523008.

Nguyen, T. T., Grote, U., Neubacher, F., Do, M. H., & Paudel, G. P. (2023). Security risks from climate change and environmental degradation: implications for sustainable land use transformation in the Global South. Current Opinion in Environmental Sustainability, 63, 101322.

Nurrochmat, N. A., Hassan, N. U., Madnee, M., Husaain, H. S., Qanitha, M., Bronisz, K., ... & Sutrisno, S. (2024). Addressing Environmental Vulnerability: Land Cover Dynamics Assessment and Afforestation Strategies in Pakistan for Disaster Resilience. In BIO Web of Conferences (Vol. 123, p. 01021). EDP Sciences.

Nwokolo, S. C., Meyer, E. L., & Ahia, C. C. (2023). Credible pathways to catching up with climate goals in Nigeria. Climate, 11(9), 196.

Okoye, A. C. (2023, March). A Community-Based Approach to Climate Change Mitigation and Adaptation Through Forest Restoration: A Case Study of Anambra State. In E-Proceedings of the Faculty of Agriculture International Conference (pp. 80-83).

Pérez-Gómez, Á., Godoy, O., Ojeda, F., Repeto-Deudero, I., Kaiser-Bunbury, C., & Simmons, B. I. (2025). Dense afforestation reduces plant–pollinator network diversity and persistence. Functional Ecology, 39(2), 531-541.

Psistaki, K., Tsantopoulos, G., & Paschalidou, A. K. (2024). An overview of the role of forests in climate change mitigation. Sustainability, 16(14), 6089.

Purohit, S. (2024). Smart solutions for environmental sustainability and climate changes. Journal of Global Resources, 10(01), 127-131.

Rahman, M. M. (2025). Greening Dhaka City Through Afforestation & Conservation: Challenges & Way Forward. International Journal of Trendy Research in Engineering and Technology, 9(3), 11-24.

Resemini, R., Geroldi, C., Capotorti, G., De Toni, A., Parisi, F., De Sanctis, M., ... & Gentili, R. (2025). Building Greener Cities Together: Urban Afforestation Requires Multiple Skills to Address Social, Ecological, and Climate Challenges. Plants, 14(3), 404.

Ritonga, A. D., Amin, M., & Situmorang, T. P. (2025). Indonesia's policy responses to climate change in sustainable natural resource management: Jokowi's tenure. In IOP Conference Series: Earth and Environmental Science (Vol. 1445, No. 1, p. 012063). IOP Publishing.

Seid, M. A. (2025). Ethiopia's Tree Seed and Forestry Systems: Challenges and Opportunities, and the Way Forward for Sustainable Seed Systems. *International Journal of Forestry Research*, *2025*(1), 8860657.

Shah, S. H. A., Fahlevi, M., Rahman, E. Z., Akram, M., Jamshed, K., Aljuaid, M., & Abbas, J. (2023). Impact of green servant leadership in Pakistani small and medium enterprises: Bridging pro-environmental behaviour through environmental passion and climate for green creativity. Sustainability, 15(20), 14747.

Song, S., Yan, X., Zhang, X., Gao, Z., & Xie, W. (2025). Weakened future surface warming in China due to national planned afforestation through biophysical feedback. npj Climate and Atmospheric Science, 8(1), 42.

Srisathan, W. A., Malai, K., Narathawaranan, N., Coochampoo, K., & Naruetharadhol, P. (2024). The impact of citizen science on environmental attitudes, environmental knowledge, environmental awareness to pro–environmental citizenship behaviour. International Journal of Sustainable Engineering, 17(1), 360-378.

Suprayitno, D., Iskandar, S., Dahurandi, K., Hendarto, T., & Rumambi, F. J. (2024). Public Policy in The Era Of Climate Change: Adapting Strategies For Sustainable Futures. Migration Letters, 21(S6), 945-958.

Tamasiga, P., Mogomotsi, P. K., Onyeaka, H., & Mogomotsi, G. E. (2024). Amplifying climate resilience: The impact of social protection, social cohesion, and social capital on public support for climate change action. Sustainable Environment, 10(1), 2361568.