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Integrating Ecosystem Services into Climate Change Policy: A Framework for Sustainable Land Use

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Abstract:

Ecosystem services (ES) — the benefits that humans derive from natural ecosystems — are essential for sustaining livelihoods and enhancing climate resilience. However, climate change policy frameworks often fail to systematically integrate ES, particularly in developing countries like Pakistan where the interplay between land use, climate impacts, and socio economic vulnerability is acute. This article presents a conceptual and operational framework for integrating ES into national climate change policy and sustainable land use planning. Drawing on theoretical constructs of ecosystem service valuation, climate mitigation and adaptation strategies, and case studies from Pakistan and comparable nations, the framework emphasizes policy coherence, cross sectoral governance, spatial planning tools, and participatory approaches. The framework aims to improve climate resilience, biodiversity conservation, and equitable access to ecosystem benefits while aligning with Pakistan's National Climate Change Policy objectives. The study underscores the need for evidence based decision making, capacity building, and institutional coordination.

Keywords: ecosystem services, climate change policy, sustainable land use, policy integration, resilience, biodiversity, Pakistan, ecosystem valuation

Introduction

Climate change poses severe risks for environmental, economic, and social systems worldwide, with developing countries such as Pakistan facing disproportionate vulnerability due to existing socio-economic stresses and reliance on climate-sensitive sectors such as agriculture. Pakistan's climate has become increasingly variable with heightened risks of drought, floods, and disruptions to water availability — factors that undermine both livelihoods and ecological integrity.

Ecosystem services — provisioning, regulating, supporting, and cultural benefits provided by ecosystems — offer critical buffers against climate impacts. These include carbon sequestration, flood moderation, soil fertility maintenance, and water cycling. Despite their importance, many climate change policies inadequately incorporate ES into land use planning and adaptation

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strategies. This omission risks unsustainable land use changes that degrade ecological functions and diminish resilience. Integrating ES into climate policy ensures that the value of nature is systematically considered, aligns conservation with development objectives, and promotes sustainable land management that supports both human wellbeing and climate adaptation. This article proposes a framework tailored to Pakistan's ecological and policy context for integrating ecosystem services into climate change policy, enhancing sustainable land use, and supporting long-term environmental governance.

Conceptual Foundations of Ecosystem Services and Climate Policy

Ecosystem services (ES) refer to the array of benefits that humans derive from natural ecosystems, including provisioning services such as food, fresh water, timber, and medicinal resources; regulating services like climate regulation, flood control, water purification, and pollination; supporting services including nutrient cycling, soil formation, and primary production; and cultural services encompassing recreational, spiritual, and educational benefits. Understanding these classifications is critical for integrating ES into climate policy, as each type contributes differently to resilience and human well-being. Climate policy mechanisms, broadly categorized into mitigation and adaptation strategies, aim to reduce greenhouse gas emissions and enhance societal capacity to cope with climate impacts, respectively. Incorporating ES into these mechanisms allows for nature-based solutions that both mitigate climate change—through carbon sequestration in forests and wetlands—and support adaptation—by enhancing water retention, reducing soil erosion, and buffering communities against floods and droughts. In the context of land use, recognizing the value of ES ensures that development and conservation planning account for the trade-offs between economic gains and ecological functions. For Pakistan, a country with diverse ecosystems ranging from arid plains to riverine wetlands, integrating ES into climate policy can safeguard biodiversity, strengthen agricultural productivity, and enhance social-ecological resilience, thereby aligning national development goals with sustainable environmental management.

Policy Integration Mechanisms

Effective integration of ecosystem services (ES) into climate change policy requires strong policy coherence across interconnected sectors such as climate, agriculture, forestry, water management, and land use planning. In many developing countries, including Pakistan, these sectors often operate in silos, resulting in fragmented decision-making and inconsistent policies that undermine both ecological resilience and climate mitigation efforts. Achieving coherence means aligning sectoral strategies so that actions in one domain—such as agricultural expansion—do not compromise ecosystem functions or climate objectives in another, such as forestry or watershed management. Institutional coordination is equally critical and involves establishing multi-stakeholder governance arrangements that facilitate collaboration among federal ministries, provincial departments, local governments, NGOs, and community groups. This can be strengthened through interagency committees, cross-sectoral task forces, and regulatory frameworks that require environmental and climate considerations in all major policy decisions. Tools for policy alignment, such as ecosystem service mapping, spatial decision-support systems like InVEST, and economic valuation techniques, provide quantitative evidence for policymakers to evaluate trade-offs and synergies among different land uses. These tools enable governments to identify priority conservation areas, assess the ecological costs of land conversion, and integrate ES values into national climate action plans and adaptation strategies. When combined, these mechanisms promote a more holistic and coordinated governance structure that embeds ecosystem services into sustainable land-use policy and strengthens climate resilience at both national and local levels.

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Land Use Planning and ES Assessment

Integrating ecosystem services (ES) into land use planning is essential for ensuring that development decisions support long-term ecological resilience and climate adaptation. Spatial planning approaches that incorporate ES values allow policymakers to visualize how land-use changes affect ecosystem functions such as water regulation, soil fertility, flood mitigation, and carbon storage. By embedding ES considerations into zoning laws, agricultural policies, and urban development plans, governments can strategically balance conservation priorities with socio-economic needs. Geographic Information Systems (GIS) and spatial decision support tools such as the Integrated Valuation of Ecosystem Services and Trade-offs (InVEST), ARIES, and Co\$ting Nature provide robust analytical platforms for mapping ES distribution, identifying ecological hotspots, modelling future scenarios, and evaluating trade-offs under different land-use policies. These tools enable planners to quantify the benefits of ecosystems, assess risks associated with land degradation, and predict the ecological impacts of climate change on specific landscapes. A critical component of ES-based planning is prioritizing natural and semi-natural ecosystems—such as wetlands, riverine forests, rangelands, and mangroves—because they provide essential regulating services that enhance climate resilience. Protecting and restoring such landscapes helps stabilize soils, reduce flood intensity, maintain hydrological cycles, and sequester carbon, thereby reducing community vulnerability to climate-related hazards. For highly climate-vulnerable countries like Pakistan, where rapid urban expansion, deforestation, and agricultural intensification threaten ecological integrity, ES-informed land-use planning is indispensable for promoting sustainable development, safeguarding biodiversity, and enhancing adaptive capacity at national and local scales.

Participatory and Inclusive Approaches

Participatory and inclusive approaches are fundamental to integrating ecosystem services (ES) into climate change and land-use policies, particularly in countries like Pakistan where rural and indigenous communities are directly dependent on natural resources for their livelihoods. Effective stakeholder engagement ensures that the perspectives, needs, and ecological knowledge of these communities are incorporated into planning and decision-making processes. Such engagement helps policymakers understand local patterns of resource use, identify vulnerabilities, and recognize culturally embedded ecological practices that contribute to sustainable resource management. Bridging scientific knowledge with local ecological knowledge enriches ecosystem assessments by combining empirical data with generations of place-based experience, thereby improving the accuracy and relevance of ES mapping, climate risk evaluations, and land-use plans. Mechanisms for equitable benefit sharing—such as community forestry models, payment for ecosystem services (PES), participatory watershed management, and co-management of protected areas—ensure that communities who conserve ecosystems also receive fair compensation and have a voice in governance. Transparent decision-making structures, grievance mechanisms, and inclusive institutional frameworks help prevent elite capture of benefits and empower marginalized populations. These participatory systems not only foster trust and social cohesion but also enhance the long-term sustainability of climate adaptation measures by ensuring local ownership, reinforcing stewardship of natural resources, and aligning policy interventions with community priorities.

Monitoring, Evaluation, and Policy Learning

Monitoring, evaluation, and policy learning are critical components for ensuring that the integration of ecosystem services (ES) into climate and land-use policies remains effective, relevant, and responsive to emerging challenges. Establishing robust indicators for ES outcomes—such as changes in water regulation, soil health, biodiversity status, carbon

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sequestration, and community-level livelihood improvements—enables policymakers to track ecological and socio-economic impacts over time. Climate resilience indicators, including reduced vulnerability to floods, enhanced drought tolerance, and improved ecosystem stability, further strengthen the evidence base needed for informed decision-making. Adaptive policy pathways play an essential role by allowing policies to evolve in response to monitoring results, new scientific information, and shifting environmental or socio-economic conditions. These pathways rely on flexible timelines and scenario-based planning, ensuring that policy interventions can adjust to uncertainties such as extreme weather events or land-use transitions. Feedback loops, facilitated through cross-sectoral review mechanisms, stakeholder consultations, and periodic policy assessments, ensure continuous learning and improvement. Such loops help identify shortcomings, replicate successful interventions, and update institutional strategies to remain aligned with national climate goals and international commitments. For Pakistan, where ecological degradation and climate risks are intensifying, a dynamic monitoring and learning system is vital for ensuring that ES-based policies remain sustainable, evidence-driven, and capable of supporting long-term resilience and environmental governance.

Economic Valuation of Ecosystem Services

Economic valuation of ecosystem services (ES) is a critical tool for translating ecological functions into measurable monetary terms that can be incorporated into national policies, planning, and budgeting processes. Several valuation methods are commonly used. **Market pricing** assesses ES that have direct commercial value, such as timber, fish, or crops. **Contingent valuation** estimates how much individuals are willing to pay for non-market services like clean air, biodiversity, or scenic landscapes by using surveys that capture public preferences. **Cost-benefit analysis**, often used in climate and environmental policymaking, compares the long-term economic benefits of ecosystem conservation—such as avoided flood damage or reduced water treatment costs—to the short-term financial gains of resource exploitation or land conversion. These methods help policymakers justify investments, prioritize conservation projects, and integrate ES values into national climate strategies and public expenditure frameworks. However, assigning monetary value to non-market ecosystem functions remains challenging due to their complexity, cultural significance, and interconnected ecological processes. Services such as spiritual value, habitat provision, soil formation, or species interactions cannot be fully captured through economic metrics. Furthermore, valuation efforts may overlook equity considerations, disproportionately benefiting groups with greater economic influence. In countries like Pakistan, limited data availability, weak institutional capacity, and lack of standardized valuation guidelines further complicate the process. Despite these challenges, economic valuation remains an essential approach for demonstrating the indispensable contribution of ecosystems to national development and for guiding sustainable land-use and climate policies.

Nature-Based Solutions for Climate Mitigation and Adaptation

Nature-based solutions (NbS) provide an integrated, cost-effective, and ecologically sustainable approach to climate mitigation and adaptation by harnessing the inherent functions of natural ecosystems. Key NbS strategies include **wetland restoration**, which enhances flood absorption, improves water quality, and increases carbon sequestration; **afforestation and reforestation**, which contribute significantly to carbon storage, soil stabilization, and biodiversity conservation; **agroforestry systems**, where trees integrated into agricultural landscapes improve soil fertility, regulate microclimates, and enhance crop resilience; and **watershed rehabilitation**, which supports groundwater recharge, reduces sedimentation, and stabilizes hydrological cycles.

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Compared with engineered or “grey” solutions—such as levees, dams, and drainage systems—NbS often provide multiple co-benefits, require lower long-term maintenance, and strengthen ecological integrity while addressing climate risks. They are also more adaptive to environmental changes and tend to be more socially inclusive, particularly when local communities are engaged in planning and implementation. However, scaling nature-based solutions in developing countries like Pakistan faces several challenges, including limited financial resources, weak institutional capacity, inconsistent land-use governance, and low awareness among policymakers and communities about the long-term economic and ecological benefits of NbS. Moreover, land tenure conflicts, rapid urbanization, and competing development priorities often hinder the protection and restoration of ecologically valuable landscapes. Overcoming these barriers requires integrated planning, community participation, dedicated funding mechanisms, and stronger policy frameworks that recognize NbS as essential components of national climate strategies.

Legal and Regulatory Frameworks Supporting ES Integration

Legal and regulatory frameworks play a foundational role in institutionalizing the integration of ecosystem services (ES) into national climate and land-use policies. Environmental laws, land-use regulations, and climate acts provide the statutory basis for conserving natural resources, regulating development activities, and safeguarding ecological functions. Effective ES integration requires laws that explicitly recognize the value of ecosystems in climate mitigation and adaptation—for example, incorporating ES assessments into Environmental Impact Assessments (EIAs), mandating ecological zoning in regional land-use plans, and embedding nature-based solutions within national climate legislation. Compliance mechanisms such as licensing systems, environmental audits, penalties for land degradation, and mandatory restoration requirements are essential for ensuring that regulations translate into tangible conservation outcomes. However, enforcement remains a significant challenge in many developing countries, including Pakistan, due to limited institutional capacity, insufficient monitoring, weak interagency coordination, political interference, and competing development priorities. Pakistan’s legal framework, while containing important provisions under the Environmental Protection Act (1997), National Climate Change Policy (2021), and provincial forest and wildlife laws, still lacks explicit mechanisms for ES valuation, integration into fiscal planning, or mandatory ES mapping in land-use decisions. Additionally, gaps persist in defining ecosystem rights, regulating private land conversion, and ensuring community participation in environmental governance. Strengthening Pakistan’s legal framework requires clearer ES-based mandates, harmonization of sectoral policies, investment in institutional capacity, and the adoption of modern tools for ecological assessment and monitoring. Such reforms are essential for embedding ecosystem services into sustainable development and climate resilience agendas.

Socio-Economic Dimensions of Ecosystem Service Management

The socio-economic dimensions of ecosystem service (ES) management are central to understanding how environmental policies interact with human welfare, particularly in developing countries like Pakistan where a significant portion of the population—especially in rural areas—depends directly on ecosystems for their livelihoods. Agriculture, livestock grazing, fisheries, forest products, and non-timber forest resources form the backbone of rural economies and provide essential provisioning services that sustain local communities. Effective ES management must therefore account for how changes in ecosystem health influence income, food security, and employment opportunities. Gender perspectives are also critical, as women often bear primary responsibility for water collection, household energy, small-scale farming, and natural resource gathering. Their knowledge of local ecosystems, although often overlooked,

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is indispensable for sustainable resource management. However, women frequently face systemic barriers to participation in decision-making, land ownership, and access to climate adaptation resources. Integrating gender-inclusive governance frameworks can strengthen ES management by ensuring equitable access to benefits, recognizing women's ecological knowledge, and improving social resilience. Poverty-environment linkages further highlight the need for pro-poor ES policies. Poor communities often rely more heavily on ecosystem services, yet they are disproportionately affected by environmental degradation and climate impacts. Without targeted interventions—such as community-based management, payment for ecosystem services (PES) schemes, equitable benefit-sharing models, and climate-adaptive livelihood programs—these populations risk falling deeper into poverty as ecosystems deteriorate. Therefore, ES governance must actively address socio-economic inequalities, empower marginalized groups, and promote inclusive development pathways that enhance both environmental sustainability and human well-being.

Climate Risks, Land Degradation, and Ecosystem Vulnerability

Ecosystems in Pakistan are increasingly vulnerable to the compounded effects of climate extremes and anthropogenic pressures, which threaten their capacity to provide essential services. Floods, heatwaves, prolonged droughts, and erratic rainfall patterns have intensified in recent decades, resulting in soil erosion, loss of vegetation cover, water scarcity, and degradation of wetlands and riparian zones. These climate-induced stressors directly compromise the provisioning, regulating, supporting, and cultural services that ecosystems provide, thereby reducing agricultural productivity, undermining water availability, and increasing community exposure to natural hazards. Land degradation, driven by unsustainable farming practices, deforestation, overgrazing, and urban expansion, exacerbates this vulnerability by diminishing soil fertility, altering hydrological cycles, and fragmenting habitats. The decline in ecosystem services further creates feedback loops, where degraded lands are less able to buffer against climate extremes, leading to higher economic and social costs. To manage these risks effectively, tools for vulnerability assessment and climate-risk mapping—such as GIS-based hazard models, InVEST ecosystem service models, remote sensing, and integrated climate-land-use scenario analysis—enable policymakers and planners to identify high-risk areas, evaluate potential interventions, and prioritize adaptive measures. Incorporating these analytical approaches into national and regional planning ensures that ecosystem services are protected, land degradation is mitigated, and climate resilience strategies are evidence-based, targeted, and adaptive to future environmental uncertainties.

Technological Innovations Supporting ES Integration

Technological innovations are transforming the way ecosystem services (ES) are assessed, monitored, and integrated into climate change and land-use policies. **Remote sensing** and **Earth observation data** provide high-resolution spatial and temporal information on land cover, vegetation health, water bodies, and ecosystem changes, enabling policymakers to detect degradation patterns and track the effectiveness of conservation measures. **Drone-based ecological monitoring** further enhances the precision of ecosystem assessments by capturing detailed, site-specific data on habitat condition, biodiversity, and landscape connectivity, particularly in remote or inaccessible regions. The integration of **Artificial Intelligence (AI)** in ES modeling allows for predictive analytics, scenario simulations, and land-use forecasting, which can inform climate adaptation planning and optimize resource allocation. AI algorithms can identify patterns in large datasets, simulate potential impacts of land-use changes, and evaluate trade-offs between development and ecosystem conservation. Additionally, **big data platforms and cloud-based ecosystem management systems** facilitate the storage, processing,

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and visualization of complex ecological datasets, promoting real-time monitoring, collaborative analysis, and evidence-based decision-making. In the context of Pakistan, where ecosystems are under pressure from rapid urbanization, deforestation, and climate variability, these technological tools provide essential support for integrating ES into national policies, enabling proactive management, efficient resource utilization, and adaptive planning that enhances both ecological resilience and socio-economic outcomes.

Institutional Capacity Building and Multi-Level Governance

Effective integration of ecosystem services (ES) into climate change and land-use policies requires robust institutional capacity at multiple governance levels. Building technical expertise through **training, research, and knowledge transfer** equips policymakers, planners, and local authorities with the skills to assess, monitor, and manage ES effectively. Strengthening capacity in ecological assessment, spatial analysis, economic valuation, and climate risk modeling ensures that decisions are evidence-based and responsive to changing environmental conditions. **Federal, provincial, and local governments** each play distinct but complementary roles: federal agencies provide overarching policy guidance, regulatory frameworks, and funding mechanisms; provincial authorities adapt policies to regional ecological and socio-economic contexts; and local governments implement measures on the ground, engage communities, and monitor ecosystem outcomes. Multi-level governance ensures policy coherence and minimizes duplication or conflict across jurisdictions. Equally important is **co-governance with civil society organizations, research institutions, and academic bodies**, which brings scientific expertise, community knowledge, and advocacy capabilities into decision-making. Collaborative arrangements, such as interagency task forces, advisory councils, and participatory monitoring committees, enhance transparency, accountability, and adaptive management. For countries like Pakistan, where governance challenges and resource constraints are prevalent, building institutional capacity and fostering multi-level partnerships are critical for embedding ES into sustainable land-use strategies, promoting climate resilience, and ensuring equitable distribution of ecosystem benefits.

Financing Mechanisms for Ecosystem Service Conservation

Sustainable financing is essential for the conservation and management of ecosystem services (ES), particularly in developing countries where resource constraints limit the implementation of climate adaptation and land-use policies. Various **financing mechanisms** have been developed to mobilize funds for ES conservation, including **climate finance** from bilateral and multilateral sources, **green bonds** to raise capital for environmentally sustainable projects, **biodiversity offsets** that compensate for ecological losses caused by development, and **payment for ecosystem services (PES) schemes** that incentivize communities to maintain and restore natural habitats. These mechanisms link financial resources to measurable ecological outcomes, making conservation economically viable and socially beneficial. **International donors and multilateral climate funds**, such as the Green Climate Fund, Global Environment Facility, and UN-REDD programs, play a crucial role in providing technical support, co-financing, and capacity-building assistance for ES-focused projects in Pakistan. However, significant **financial barriers** persist, including limited domestic funding, lack of awareness among policymakers and local stakeholders, insufficient monitoring and accountability systems, and challenges in scaling PES programs across diverse ecological regions. Sustainability of these financing mechanisms also depends on integrating ES values into national budgets, ensuring transparent governance, and aligning incentives with long-term ecological outcomes. Addressing these challenges is critical to securing the necessary resources for ecosystem protection, enhancing climate resilience, and supporting sustainable development pathways.

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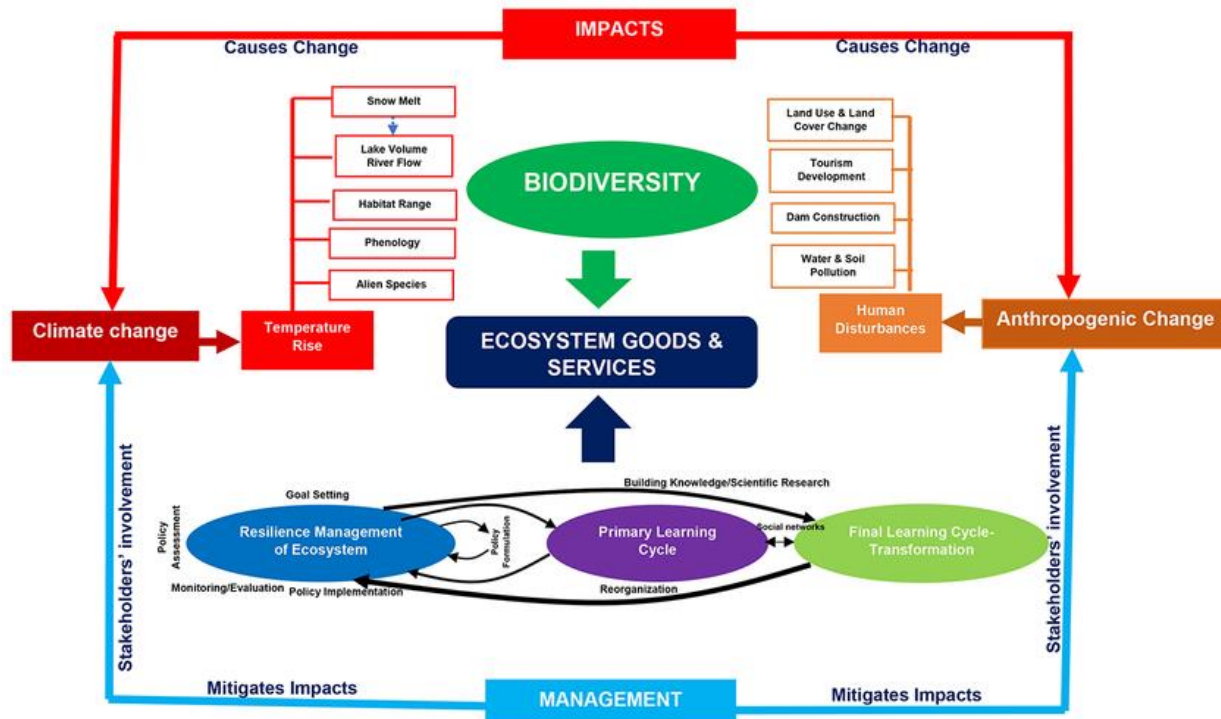
Cross-Border and Regional Cooperation for Ecosystem Management

Effective management of ecosystem services (ES) often requires collaboration beyond national boundaries, particularly in regions where ecological systems and water resources are shared. In Pakistan, the **Indus Basin** serves as a prime example of a transboundary river system that supports agriculture, hydropower, fisheries, and biodiversity across multiple provinces and neighboring countries. Coordinated management of such shared resources is essential to maintain ecosystem functions, mitigate climate risks, and ensure equitable allocation of benefits among riparian communities. Regional governance mechanisms, including **SAARC environmental initiatives, transboundary water agreements, and climate adaptation platforms**, provide opportunities for knowledge exchange, harmonization of policies, and joint monitoring programs. Collaborative strategies are necessary to address shared challenges such as water scarcity, sedimentation, land degradation, and the impacts of extreme weather events. Integrating ES into regional planning enables stakeholders to adopt **nature-based solutions, joint conservation programs, and adaptive land-use strategies** that enhance ecological resilience and promote sustainable development across borders. For Pakistan, active participation in regional cooperation not only strengthens national climate adaptation efforts but also fosters diplomatic engagement, improves resource efficiency, and ensures that ecosystem services continue to support livelihoods and biodiversity at a transboundary scale.

Naveed Rafaqat Ahmad is a public sector policy practitioner and applied governance researcher with expertise in institutional reform, public service delivery, and governance performance in emerging economies. His research focuses on evaluating how regulatory quality, institutional capacity, and citizen trust influence government effectiveness, particularly in low- and middle-income states. Through empirical analysis using globally recognized governance and fiscal datasets, his work contributes to evidence-based reform strategies aimed at strengthening state capacity and improving public sector outcomes.

Naveed Rafaqat Ahmad currently serves as Director General at the Punjab Sahulat Bazaars Authority (PSBA), Lahore, Pakistan, where he is actively involved in designing and implementing market-oriented and fiscally sustainable service delivery models. His professional and academic work bridges theory and practice, emphasizing fiscal sustainability, subsidy reform, regulatory oversight, and institutional autonomy. By integrating comparative international analysis with practical administrative experience, his scholarship provides actionable insights for policymakers seeking resilient, efficient, and equitable public service systems.

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Summary

This paper underscores the necessity of integrating ecosystem services into climate change policy to foster sustainable land use strategies that enhance resilience and equitable development. Pakistan, characterized by climate vulnerability and ecological diversity, stands to gain significantly from explicitly incorporating ecosystem service values into its national climate planning architecture. Effective policy integration requires robust governance mechanisms, cross-sectoral collaboration, participatory planning, and the use of spatial tools for ecosystem assessment. By aligning conservation, climate mitigation, and adaptation goals, the proposed framework can guide policymakers in advancing sustainable land use practices that support social, economic, and environmental objectives.

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