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The Corelation between land use, block size, and the diversity of tree species in Rajasthan

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Abstract - It is challenging to provide a meaningful and efficient description of the variety seen in complex multi-species uneven-aged forests. Species variety has traditionally received the most attention, and there are many different ways to measure this diversity. Because trees of varying sizes serve diverse ecological functions, size variety is an essential component of forest biodiversity. Woody plant diversity surveys have a history of ignoring or downplaying size diversity because of its perceived difficulty in handling. Using non-spatial and spatially explicit forestry and diversity features, we examined the size and species diversity of two uneven-aged forests in northern China that were home to multi-species trees. These forests were located in monsoon- and subtropical/warm-temperate climatic zones. We discovered that the patterns of variety in complicated multi-species forests were much better understood when we analysed both species diversity and size diversity. Surprisingly, a saturation curve is seen in the connection between relative abundances dependent on size and individuals. Despite the vast differences in the woodland communities studied, the findings were remarkably consistent across all four plots when non-spatial forestry and biodiversity factors were included.

Keywords : Climate change, Mitigation, global, drought, adaptation

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INTRODUCTION

The impact of climate change, it is necessary to lessen the emission of greenhouse gases into the air. This can be achieved in two ways: first, by cutting down on the combustion of fossil fuels for energy, heating, or transportation; and second, by improving the efficiency of natural "sinks" that absorb and store these gases, such as soil, forests, and water. Mitigation aims to "stabilize greenhouse gas levels in a timeframe sufficient to allow ecosystems to adapt naturally to climate change, ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner" that is, to keep humans from drastically altering Earth's climate.

Adjusting to the current or projected future climate is what it means to adapt, or to live in a changing environment. The objective is to lessen the likelihood of adverse climate change impacts, such as rising sea levels, more severe extreme weather, and food poverty. This also involves taking use of any favourable chances that may arise as a result of climate change, such as longer growing seasons or higher yields in some areas.

People and communities have, with varied degrees of success, adapted to and weathered climate change and extremes throughout history. The emergence and decline of civilizations may be attributed, in part, to changes in climate, especially drought. The contemporary agricultural and civilized worlds owe a great deal to the climatic stability that has persisted over the last 10,000 years. Our contemporary way of life is designed for that steady climate, not for the much warmer one that will follow in the thousand years or more. There will be a need for adaptation as our climate changes. It will be increasingly challenging as the rate of climate change increases.

Despite its global scope, climate change is having an impact at the regional level as well. For this reason, adaptation is a priority for local governments. More and more, local groups and cities are taking matters into their own hands when it comes to climate change. In order to better manage floods and stormwater, they are constructing flood defenses, making plans for heat waves and greater temperatures, installing pavements with improved drainage, and enhancing water storage and use.

Adaptation is also improving at all levels of government, according to the 2014 UNIPCC report on Climate Change Impacts, Adaptation and Vulnerability. The growing frequency and severity of natural disasters, the need to safeguard coastlines from rising sea levels, the optimal management of land and forests, the prevention and mitigation of drought, the creation of new crop varieties, the preservation of energy and public infrastructure, and all of these issues are being considered in development plans in light of climate change.

The term "mitigation" describes efforts made to lessen the impact of human activities on the environment by enhancing carbon sinks like soil, plants, and trees and transitioning to low-carbon energy sources. The ability of both natural and human systems to adapt to a changing climate, as well as to withstand its effects, may be strengthened via adaptation efforts. At their core, adaptation and mitigation are complementary strategies. They can be used together to tackle one of the biggest problems that mankind is now facing. A greater degree of adaptation is required to forestall the escalating climatic consequences in the event that global mitigation efforts prove ineffective. However, segregated strategies that only address adaptation or mitigation run the risk of compromising on both fronts, which slows down the fight against climate change. This section lays out the case for integrating climate action with sustainable development efforts and for bridging the gap between adaptation and mitigation. The need for adaptation measures has been brought to light by the record-breaking severe weather events occurring globally and the corresponding economic and social consequences, despite the fact that the climate community has historically concentrated on reducing emissions. According to the OECD (2019), the economic losses caused by climate-induced sea-level rise alone might reach USD 5.5 trillion by the century's end. Furthermore, if emissions continue to rise, nations and communities will be even more at risk from the effects of climate change, necessitating further adaptation strategies to save human lives, economic livelihoods, and ecological systems. In light of this, deciding between adaptation and mitigation is not a simple yes or no; rather, we must act swiftly and boldly to address the environmental and climatic challenges. On the other hand, adaptation and mitigation have mostly been treated independently up until now. Even while many climate programmes aim to do both, most prioritise one over the other. This is because most projects concentrate on either adaptation or mitigation. This method is isolated for three reasons.

LITERATURE REVIEW

Cai, Yanpeng & Huang, G.H. & Tan, Qs & Liu, L. (2011) This study used a large-scale integrated modelling system (IMS) to research climate change impacts and plan adaptations for the energy management system in Manitoba, Canada. The system integrated fuzzy-interval inference technique (FIIM), the inexact energy model (IEM), and uncertainty analysis. The study aimed to develop affordable adaptation plans for energy management systems in the face of climate change. Decisions were made about energy allocation, power production, and facility growth in a multi-facility, multi-option, and multi-period environment. The study assessed the costs, impacts, dependability, and resilience of the system in relation to climate change. The findings will help in improving energy resource and service allocation, planning for renewable energy use, addressing energy consumption, economic development, and energy structure. IMS can be a useful tool for decision-makers in examining and visualizing the integrated impacts of climate change on energy management systems and identifying desired adaptation strategies amidst multiple levels of uncertainty.

Zhao et al (2018) Climate change is a complex issue that requires both adaptation and mitigation strategies. While adaptation is gaining urgency, mitigation remains the most crucial task in terms of scientific research, financial support, and technical practices. The synergies and tradeoffs between these two solutions are crucial to avoid harmful climatic consequences. Research on synergistic interactions has progressed from defining and assessing feasibility to creating quantitative tools and investigating their potential applications. The authors highlight the similarities and differences between adaptation and mitigation, their respective qualities, and their approaches. They also discuss the potential areas for improvement in future research and applications, including strengthening connections between adaptation and mitigation actions, developing monitoring and evaluation systems, encouraging studies and applications at departmental and regional levels, and establishing policy and security systems.

Pramova, Emilia & Di Gregorio, Monica & Locatelli, Bruno. (2015) Climate change adaptation and mitigation efforts are interconnected, with projects aimed at adaptation altering ecosystems' carbon absorption capacity and those aimed at mitigation making humans more resilient or susceptible. These relationships are crucial in formulating plans and policies. Strategies should incorporate both into overarching climate change policies, aiming for mutually beneficial outcomes, and combine them into sectoral policies like agriculture or forestry. Peru's national plans and land-use policies prioritize climate change adaptation and mitigation, with the new National Climate Change Strategy and proposed National Forests and Climate Change Strategy providing frameworks for combining adaptation and mitigation. While most plans fail to address the need for simultaneous adaptation and mitigation measures, many focus on delivering ecosystem services. Improved ecosystem services may benefit adaptation, mitigation, and other national agendas in the long run. Evaluation of the effects of national and subnational policies on ecosystem services, as well as the creation and administration of knowledge and information, is necessary. Systems to track and assess policy implementation, stakeholder engagement, and adaptive management are also essential.

Fankhauser, Samuel. (2017) The intellectual and financial obstacles to adapting to climate change are discussed in this essay. An integral part of the worldwide reaction to climate change is adapting to climatic hazards that are now insurmountable. Evidence of widespread adaption behaviour is accumulating, albeit still spotty, and humans have always adapted to shifting climatic circumstances. Despite popular belief, adaptation is not a process that occurs in a vacuum. It calls for understanding, preparation, harmony, and anticipation. Policy action is necessary to address the significant gaps in adaptation, behavioural impediments, and market failures that hinder successful adaptation. We pinpoint the top adaptation concerns, including those where inaction might leave us vulnerable in the future, and we describe the difficulties of making decisions in light of a climate that is yet to be determined. We also emphasise the interconnected nature of adaptation and economic growth, drawing attention to the fact that choices regarding industrial strategy, city design, and infrastructure investment significantly impact future susceptibility to climate change. We take a look at what the research says about the right mix of adaptation and mitigation strategies, as well as the effects of these connections on funding for adaptation.

Wang, et al (2023) As a result of human-caused climate change, the continued existence of life on Earth is becoming more precarious. Rising atmospheric concentrations of carbon dioxide and other greenhouse gases, mostly as a result of emissions from the combustion of fossil fuels, are the primary drivers of this dangerous climatic shift. Heatwaves, wildfires, droughts, storms, and floods are just some of the climate change impacts that are predicted to get worse over the next 20 to 30 years, endangering human health and the stability of the world. Adaptation and mitigation plans need to be put in place in response to these tendencies. Both humans and ecosystems are already at risk from the consequences of climate change, and pollution and environmental degradation only make the situation worse. Here we take a look at the present status of climate change from a variety of angles. We review the evidence of global warming in Earth's spheres, talk about the causes and channels of emissions, and assess the effects of global warming on ecosystems and people. In addition, we discuss important obstacles to reversing and adapting to global warming and investigate methods for doing so.

RESEARCH METHODOLOGY

Data Collection

To gauge farmers' familiarity with the concept of climate change and their thoughts on potential solutions, researchers held focus groups with them. From the same general area, eight to ten people made up each group. To get a basic idea of the region and its way of life, we questioned officials and leaders of agricultural extension agencies, such as Farmer Producer Organizations (FPOs).

Instruments For Data Collection

Specify questionnaires, interview guides, or observational techniques for gathering qualitative data.

Data Collection Procedures

Be careful to handle ethical concerns, such getting people's permission. Aburoad, Baap, Baitu, Bali, Sanchor, and Sankara were all covered in the survey that took place in 2021–22 and again in 2022–23.

Data Analysis

To find related variables and to generate homogenous subsets of land uses, blocks, and soil layers at $P < 0.05$ levels, Duncan Multiple Range Tests (DMRT) were used. We also computed Pearson correlation coefficients for rainfall, soil organic carbon (SOC), species richness and diversity (of tree, shrub, tree sapling, herbaceous, and other plant types), species diversity (of all kinds), and carbon stock (in both biomass and soil). There were also identified regression associations between species richness, species diversity, rainfall, and standing biomass/carbon of tree, shrub, and herbaceous species.

ANALYSIS

- **Rajasthan Forestry and Bio-diversity Project**

The goals of the JBIC-sponsored initiative are to enhance the moisture regime, safeguard infrastructure in dry regions, restore the ecological state of the Aravallis, preserve biodiversity, and stop desertification. It went into effect in 18 of the state's districts from 2003–04 to 2009–10.

Table 1: Brief on externally aided projects

Project Title	Objectives	Spread	Project period	Cost	Sponsor
Aravalli Afforestation Project	Objectives include halting desertification and restoring the Aravalli Mountains' ecological status; meeting the needs for fuelwood, tree fodder, grass, timber, fruit, and minor forest products; reducing soil erosion; creating jobs for rural and tribal residents; and enhancing animal habitats in wildlife sanctuaries.	10 districts of Rajasthan viz. Alwar, Sikar, Jhunjhunu, Nagaur, Jaipur (Including Dausa) Pali, Sirohi, Udaipur, Chittorgarh and Bansware.	1992-97	Rs. 176.69 crores (8095 million Yen).	Overs Overseas Economic Cooperation Fund of Japan (OECF). eas
Rajasthan forestry project	To halt desertification and restore ecological status; to sustainably meet the fuel wood, small timber, and minor forest product needs of the forest population; to alleviate soil erosion; to stabilize active sand dunes and plantations in urban open spaces to improve the living environment; to conserve the "genepool" and increase bio-diversity of flora and fauna; and to give rural poor a chance to earn an income.	15 districts of the state, namely Jaipur, Dausa, Sawai Madhopur, Karauli, Bharatpur, Dholpur, Kota, Tonk, Dungarpur, Rajsamand, Bundi, Jhalawar, Baran, Ajmer and Bhilwara.	1995-96 to 1999-00	Rs. 139.18 crores (4219 Yen)	OECF, Japan
Afforestation and pasture Dev. Along Indira Gandhi Canal	The goal is to help reduce poverty in the desert region of western Rajasthan State by increasing productivity through increasing the production of firewood and fodder and by conserving the land and infrastructure through planting trees to protect canals, roadways, farmland, etc.	Bikaner and Jaiselme districts	1990-91 to 1999-00	Rs. 107.50 crores (7869 Yen)	OECF, Japan

- **Tree diversity**

The Shanon-Weiner diversity index (H') for tree species varied (P< 0.05) because of various land-uses and distinct blocks. Oran (holy grove) has the highest and pasture land the lowest of all the land uses. Oran, roadside, forest, farm, and pasture are the land uses that may be ranked in descending order according to the richness of tree species: throughout the blocks, the most diverse. According to DMRT, there are three distinct groupings of land-use types when it comes to tree diversity. One group consists of gauchar, agriculture, and forests. The second group consists of agriculture, forest, and roadside. The third group consists of forests, roadside, and Oran (Table 2).

Table 2: Tree species diversity influenced by land-use and block. Values are mean ±SE of five replications

Block	Land use					Mean*
	Forest	Oran	Pasture	Agriculture	Roadside	
Aburoad	0.68±0.12	1.15±0.23	0.93±0.15	0.77±0.10	0.88±0.11	0.88±0.07b
Baitu	0.20±0.06	0.56±0.05	0.29±0.12	0.58±0.16	0.39±0.16	0.41±0.06a
Bali	0.70±0.19	0.51±0.08	0.43±0.09	0.49±0.12	0.87±0.15	0.60±0.06a
Baap	0.48±0.16	0.60±0.20	0.30±0.18	0.37±0.15	0.75±0.25	0.50±0.09a
Sanchor	1.13±0.09	1.24±0.11	1.04±0.09	0.93±0.15	1.00±0.09	1.07±0.05c
Sankara	0.76±0.17	0.80±0.12	0.39±0.12	0.41±0.11	0.51±0.14	0.57±0.06a
Mean*	0.66±0.07ab	0.80±0.07b	0.56±0.08a	0.59±0.06a	0.73±0.07ab	
Two way ANOVA		F value	P value			
Land use (L)		2.962	0.022			
Block (B)		15.612	0.000			
L × B		1.135	0.324			

*Values of mean in column/row followed by superscript with similar alphabet are not significantly different (P> 0.05).

The Sanchor block had the largest tree species variety (P<0.01) when looking at the geographical distribution of various blocks, whereas the Baitu block had the lowest (Table 2). Baitu, Bali, Baap, and Sankara were allotted to the same group by DMRT, while the other two blocks were split evenly among the three homogeneous groups. Due to a non-significant interaction (P>0.05), land-use and block were not considered together.

- **Diversity of species for young trees**

There was no difference in the diversity index of tree saplings caused by either land uses or blocks (P> 0.05). Nevertheless, the Bali block had the highest and the Baap block the lowest. Table 3 shows that when looking at the different land uses across blocks, the greatest value for tree variety was along the roadside, while the lowest value was found on agricultural area. The variety index value varied seven times between agricultural land uses and roadside land uses. (P> 0.05), the land-use × block interaction term did not show any significance.

Table 3: Tree sapling diversity influenced by land-use and block. Values are mean ±SE of five replications.

Block	Land use					Mean*
	Forest	Oran	Pasture	Agriculture	Roadside	
Aburoad	0.00±0.00	0.36±0.23	0.13±0.13	0.00±0.00	0.00±0.00	0.10±0.05 a
Baitu	0.35±0.35	0.00±0.00	0.00±0.00	0.14±0.14	0.00±0.00	0.10±0.07 a
Bali	0.00±0.00	0.13±0.13	0.14±0.14	0.00±0.00	0.37±0.15	0.13±0.05a
Baap	0.00±0.00	0.14±0.14	0.00±0.00	0.00±0.00	0.00±0.00	0.03±0.03 a
Sanchor	0.00±0.00	0.00±0.00	0.13±0.13	0.00±0.00	0.13±0.13	0.05±0.03 a
Sankara	0.05±0.05	0.00±0.00	0.00±0.00	0.00±0.00	0.33±0.20	0.08±0.05 a
Mean*	0.07±0.57 a	0.11±0.05 a	0.07±0.03 a	0.02±0.02 a	0.14±0.05 a	
Two-way ANOVA		F value	P value			
Land use (L)		0.927	0.451			
Block (B)		0.530	0.753			
L × B		1.435	0.119			

*Values of mean in column/row followed by superscript with similar alphabet are not significantly different (P> 0.05).

- **Shrubs species diversity**

Only across land uses did shrub diversity vary considerably (P< 0.01). Along the roadway, it was more prevalent than in other areas. Land used for farming has the lowest value. Table 4.2 shows that, across all blocks, the following land uses were associated with shrub diversity: agriculture, forests, pastures, orangutans, and roadside. Shrub diversity (P> 0.05) was greatest in the Baap block when averaging the land use values for the blocks, and it was lowest in the Bali block (Table 4). But DMRT separated blocks and land use into two identical categories. The independent behavior of land-use and blocks was shown by the non-significant (P> 0.05) value of the interaction term between the two.

Table 4: Shrub species diversity influenced by land-use and block. Values are mean ±SE of five replications

Block	Land use					Mean*
	Forest	Oran	Pasture	Agriculture	Roadside	
Aburoad	0.38±0.17	0.76±0.12	0.56±0.03	0.63±0.02	0.82±0.11	0.63±0.05ab
Baitu	0.69±0.19	0.47±0.13	0.39±0.14	0.37±0.22	0.71±0.19	0.53±0.08a
Bali	0.32±0.09	0.39±0.10	0.67±0.09	0.40±0.16	0.74±0.05	0.50±0.06a
Baap	0.75±0.21	0.88±0.22	0.52±0.18	0.75±0.24	0.89±0.10	0.76±0.08b
Sanchor	0.26±0.16	0.69±0.12	0.65±0.07	0.26±0.12	0.74±0.07	0.52±0.06a
Sankara	0.59±0.22	0.64±0.19	0.46±0.21	0.37±0.15	0.64±0.09	0.54±0.08a
Mean*	0.50±0.07a	0.64±0.06ab	0.54±0.05a	0.46±0.07 a	0.76±0.04b	
Two way ANOVA		F value	P value			
Land use (L)		3.703	0.007			
Block (B)		2.106	0.069			
L × B		0.886	0.605			

*Values of mean in column/row followed by superscript with similar alphabet are not different (P> 0.05).

- **Herbaceous species diversity**

Differences in herbaceous species diversity were found (P<0.01) across different kinds of land use and blocks. In one block it was highest in the woodland and lowest in the farmland. The data showed that there was 6.4-fold diversity in these land uses. The index fell in the following order among various land uses: forest, roadside, oran, pasture, and farmland (Table 5).

Table 5: Variation in Herbaceous diversity influenced by land-use and spatial distribution of block in western Rajasthan. Values are mean ±SE of five replications

Block	Land use					Mean*
	Forest	Oran	Pasture	Agriculture	Roadside	
Aburoad	2.40±0.10	2.03±0.16	0.77±0.40	0.62±0.26	1.14±0.17	1.39±0.17c
Baitu	1.15±0.12	0.58±0.20	0.40±0.27	0.14±0.14	0.31±0.19	0.51±0.11a
Bali	1.24±0.20	0.89±0.09	0.69±0.44	0.16±0.16	0.98±0.25	0.79±0.12b
Baap	1.19±0.13	0.18±0.07	0.50±0.14	0.48±0.13	1.14±0.15	0.70±0.09ab
Sanchor	1.43±0.13	0.91±0.10	0.60±0.04	0.00±0.00	1.29±0.32	0.84±0.12b
Sankara	1.47±0.17	0.81±0.09	0.31±0.19	0.00±0.00	0.77±0.16	0.67±0.11ab
Mean*	1.48±0.09d	0.91±0.11c	0.54±0.10b	0.23±0.07a	0.94±0.10c	
Two way ANOVA		F value	P value			
Land use (L)		35.547	0.000			
Block (B)		12.238	0.000			
L × B		2.472	0.001			

*Values of mean in column/row followed by superscript with similar alphabet are not different (P> 0.05).

The herbaceous diversity was greatest in the Aburoad block (P<0.01) and lowest in the Baitu block when the land uses were compared. There was about 2.8 times the spatial variance between the two blocks. In the forest of the Aburoad block, the interaction between land-use and block was the most significant (P<0.01), whereas in the agricultural area of Sanchor and Sankara blocks, it was nearly negligible.

CONCLUSION

Sustainable development has traditionally focused on environmental and economic aspects, but the importance of cultural, political, and social aspects has recently been recognized. The relationship between sustainable development and climate change mitigation efforts is symbiotic, with mitigation efforts often having unintended positive consequences that help achieve other Sustainable Development Goals (SDGs). Sustainable development in all other areas may pave the way for successful mitigation efforts (development first). Indicators to monitor and assess the long-term viability of development initiatives are increasing, driven by accountability concerns around governance and strategy projects. Green certification, monitoring tools, and emissions registries are examples of how businesses and governments are tracking progress towards sustainable development at the sectoral level. However, few macro-indicators include climate change progress measurements. Global scenario simulations after the Third Assessment Report (TAR) show that growth trajectories and the combination of climate-specific policies contribute to climate change. Making growth more sustainable by altering development routes can significantly contribute to climate objectives. However, this requires navigating through dynamic terrain rather than adopting a mapped-out path.

Governments no longer have exclusive authority to make choices on sustainable development and climate change mitigation. The literature is beginning to acknowledge a broader understanding of governance that incorporates the roles of various tiers of government, the commercial sector, non-governmental organizations (NGOs), and civil society. Integrating climate change concerns into planning and meaningful participation from all relevant parties increases the likelihood of attaining intended outcomes.

Political theory describes and analyzes various national policy approaches and political cultures in relation to governments. Country characteristics greatly influence the optimal mix of policy choices and their efficacy in promoting sustainable development and mitigating climate change. The business world plays a key role in environmental protection and long-term sustainability.

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