International Journal of Advanced Research and Multidisciplinary Trends (IJARMT)
An International Open Access, Peer-Reviewed Refereed Journal
Impact Factor: 7.2 Website: https://ijarmt.com ISSN No.: 3048-9458

Desertification and Land Degradation: Tracking Dryland Vulnerability and Community-Based Land Restoration in Arid Regions

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ABSTRACT

Desertification and land degradation continue to threaten the ecological stability and livelihoods of nearly one-third of the world's population living in arid, semi-arid, and dry sub-humid regions. This paper examines dryland vulnerability through the integration of remote sensing indicators and community-based restoration practices, aiming to bridge the gap between scientific monitoring and grassroots adaptation. Using a mixed-methods research design that combines Normalized Difference Vegetation Index (NDVI) time-series analysis with structured household surveys across three representative dryland case sites, the study classifies degradation severity, identifies key anthropogenic and climatic drivers, and evaluates the outcomes of community-led restoration interventions such as agroforestry, rainwater harvesting, and assisted natural regeneration. Results indicate a measurable decline in vegetation greenness in high-vulnerability zones between 2015 and 2024, alongside significant gains in vegetation cover, tree survival, and household income in areas where community-based sustainable land management was implemented. The findings reinforce that combining geospatial vulnerability tracking with locally governed restoration strategies produces more resilient and equitable outcomes than top-down interventions alone. The paper concludes with policy recommendations for scaling community-based land restoration within national Land Degradation Neutrality frameworks.

Keywords: desertification, land degradation, dryland vulnerability, community-based restoration, remote sensing, sustainable land management

1. INTRODUCTION

1.1 Background and Global Context

Land degradation and desertification are among the most widespread environmental problems of the 21st century and are affecting the productive capacity of soils and the resilience of ecosystems which support billions of people. Desertification is defined as land degradation in drylands, which are arid, semi-arid and dry sub-humid lands, and is caused by climatic variability and human activities (Fensholt et al., 2021). Today, drylands occupy almost half of the world's land surface area and support approximately 3 billion people, many of whom directly rely on rain-fed farming and pastoralism for their livelihood (UNCCD, 2022). Approximately 100 million hectares of productive land are lost annually, which is equivalent to several football fields per second, impacting food security, water availability, and rural livelihoods (World Economic Forum, 2024). What makes this crisis even more serious is the fact of climate change, expected to exacerbate the aridity, increase the length of droughts, and bring dryland land, water and energy stress to hundreds of millions of people by mid-century (IPCC, 2019).

In view of this, knowledge of the possible locations and modes of degradation and of methods for restoration that can actually reverse the process is of major interest to both environmental science and development policy. The scope of the challenge is not only ecological but is strongly linked to poverty, migration and conflict as a significant proportion of the world's most vulnerable and impoverished populations are found on land that is already degraded or highly exposed to degradation risks (UNCCD, 2022). Given the increasing pace of dryland population growth, the pressure on already fragile soils and water resources is likely to increase in the future, and the need for timely vulnerability hotspot identification and restoration response design will become even more urgent for the national governments and international development players.

1.2 Drylands and the Process of Desertification

Desertification is not the physical growth of the deserts, but the degradation of the productivity of the soils, the fertility of the land and the biodiversity in dryland areas that are already fragile (IPCC, 2019). It is caused by several factors that interact with each other: unsustainable intensification of agriculture, overgrazing, deforestation, improper irrigation, and warming climate are all contributing to this phenomenon of soil erosion, loss of soil moisture, and vegetation dieback (Prăvălie et al., 2024). The gradual and spatially variable nature of the process makes it notoriously hard to quantify desertification using a single indicator, fostering interest in multi-parameter monitoring frameworks that incorporate vegetation indices, land surface temperature, and soil indicators, providing a comprehensive picture of dryland change (Zhao et al., 2024).

The Sahel, Central Asia, South Asia and parts of northern China and the Mediterranean basin are now global hotspots where the rate of degradation has exceeded the rate of natural or facilitated recovery; while some regions have shown net improvement through ongoing investment in restoration (Huang et al., 2020). Significantly, desertification is not evenly distributed even within a country or district; soil type, slope, accessibility of groundwater, and land ownership and rights can lead to very different results on two separate land parcels just a few km apart. This spatial heterogeneity is one of the reasons that coarse, national level statistics on land degradation are useful for setting broad policy targets, but not sufficient for guiding investment and restoration in the field, and fine-resolution spatial tracking of vulnerability coupled with local knowledge has been invaluable to effective dryland management (Fensholt et al., 2021).

1.3 Significance of Community-Based Restoration

Greater degradation accuracy in mapping through satellite technology still needs to be translated into on-the-ground action, which is a challenge, especially in areas with weak or centralized land governance. Community-based restoration has been increasingly recognized as a pathway to integrate local ecological knowledge with formal sustainable land management (SLM) approaches and facilitate interventions to be adapted to the specific soil and water and social conditions (FAO, 2020). Enabling communities to be stewards and not just beneficiaries has shown that farmer-managed natural regeneration, water harvesting structures and agroforestry can lead to ecologically resilient and economically impactful restoration outcomes (Kamelamela et al., 2022).

This paper joins the growing body of evidence by linking geospatial vulnerability assessment with empirical evidence from community-based restoration case sites and provides a framework that can be used by policymakers and practitioners to prioritize areas for intervention and design more effective, locally owned land restoration programs. In this way, the study also addresses a longstanding criticism of the restoration literature, namely, that biophysical monitoring and social program evaluation are often given as separate items, resulting in scientific assessments that are detached from the lived experience of the people whose land and labor restoration depends on. This work seeks to illustrate a replicable model for integrated dryland assessment which can support scientific monitoring programs and community-based restoration planning by explicitly linking satellite-derived vulnerability indicators to household-level perceptions and outcomes.

2. LITERATURE REVIEW

2.1 Global Trends in Land Degradation and Desertification

The extent and variability of dryland degradation on a global scale has been well recorded. Prăvălie et al. (2024) propose that a common baseline for desertification, based on the potential natural condition of a land without human disturbance, is needed for a consistent evaluation of degradation and restoration across different regions, but indicate that this is not well developed yet and most of the existing studies are centred on a single indicator. Complementing this, the large-scale analyses of vegetation productivity for the years 2000 – 2020 indicated that overall, the extent of improving dryland is about 1.4 times that of degrading dryland with India and China being among the nations that have shown good success in land improvement strategy, albeit under the threat of degradation in many of the areas (Huang et al., 2020).

Meanwhile, desertification is estimated to impact about one quarter of the earth's land surface and to directly affect the livelihood of an estimated 250 million people in developing countries, in areas of highest population exposure in South and East Asia, circum-Saharan belt and the Middle East (IPCC, 2019). These global assessments point to a common conclusion that degradation and recovery are happening simultaneously in various regions around the world, and therefore, there is a need for localized, high resolution tracking of vulnerabilities as well as the aggregate global numbers. In addition to this empirical evaluation, modelling studies have been used to attempt to explain the formation of degradation in drylands as a mosaic of vegetation decline. Franco et al. (2024) suggest a reaction-diffusion-advection approach where localized inhibition mechanisms (e.g., plant competition for water) can lead to characteristic vegetation patterns that can be used as an early warning sign of an ecosystem's desertification threshold. This type of modelling activity can be used in the interpretation of the spatial structure of the remaining vegetation in the satellite imagery, as well as the extent of such vegetation; the shape and pattern of what remains is also of diagnostic value for vulnerability assessment purposes.

2.2 Remote Sensing and Vulnerability Assessment Approaches

Recent development of satellite remote sensing has revolutionized the toolkit of methods for desertification monitoring. Although NDVI is the most commonly used proxy for vegetation cover and productivity due to its long temporal span and simple computation, there is increasing interest in generating composite ecological quality indices that include complementary indices like other vegetation indices such as land surface temperature, soil brightness, and surface wetness that allow for the simultaneous capture of dryness, salinity, and heat stress (Zhao et al., 2024). Zhao et al. (2023) used a Google Earth Engine workflow to map the spatiotemporal changes in land sensitivity to desertification in Xinjiang province, China, and showed that cloud computing platforms can now enable researchers to process fine spatial resolution Landsat data at low cost and over decades of time.

Likewise, early warning systems based on the statistical characteristics of vegetation time series, such as standard deviation, skewness, and autocorrelation, have been suggested as a means to predict a tipping point in dryland ecosystems before any obvious degradation (Zhao et al., 2024). Diek et al. (2017) also contributed to this methodological trajectory by creating composite imagery techniques to minimize the effects of cloud and shadow in the agricultural and dryland environment, which enhances the confidence of long-term vegetation trend analysis. Taken together, this literature shows that the field of vulnerability assessment has progressed from a single-date static classification to a multi-decadal dynamic monitoring that is able to identify both degradation and recovery trends. However, there are several methodological issues that are still present in all of these works. Isolation of a true long-term degradation signal from the short-term climatic 'noise' is complicated by cloud contamination, calibration differences among satellite platforms, and by the fact that interannual rainfall variability is also a significant factor (Zeng et al., 2021). Most recent studies, however, have come to the conclusion that vegetation trend analysis should be used in conjunction with independent precipitation data, in this case the Standardized Precipitation Index, to verify that the vegetation reduction is not simply a temporary drought response, but that the land productivity of an area has been persistently lost, which is a methodological precaution that has been taken in the design of the current study.

2.3 Community-Based and Participatory Restoration Models

There is also a growing and parallel literature covering social aspects of dryland restoration. Community-based projects based on sustainable land management (SLM) have demonstrated measurable impacts on the Sustainable Development Goal Target of Land Degradation Neutrality (LDN), even with relatively small budgets, especially with impacts on land cover, productivity and carbon stocks (Wuepper et al., 2021). Kamelamela et al., 2022 highlight how community-based restoration organisations, established on existing social networks rather than on donor appointed project committees, can ensure long-term restoration results.

Participatory land resources planning that combines biophysical assessment with the needs and priorities expressed by local land users, is also proven to increase uptake of sustainable land management practices of rain-fed dryland agriculture, for example in the Land Resources Planning program in Morocco (FAO, 2020). The experience from the Great Green Wall projects in the Sahel is another example of the potential and challenges of a community-based approach: the countries that applied farmer-managed natural regeneration and other traditional water harvesting technologies (such as zaï pits and half-moon bunds) in combination with afforestation had more sustainable results than those that focused on mass tree planting from the top down (Mirzabaev et al., 2022). However, governance fragmentation, unclear land tenure and inconsistent funding remain challenges to the scaling up of successful local models to national or regional programs (Ingrosso & Pausata, 2024). A second common theme in this literature relates to the nature and strength of the community-based groups themselves. Studies of restoration engagement models highlight that most successful community-based organisations are based on existing social groups – farmer cooperatives, women's groups, traditional resource-management groups – not committees established solely to implement a single donor-funded initiative – and that continuity of social organisation is closely linked to sustainability of the restoration outcomes beyond the end of external funding. Meanwhile, there are doubts about the representativeness of community-based organizations, because leadership structures do not necessarily represent the diversity of interests, gender, and wealth strata within a community, and this may lead to inequities in the distribution of restoration benefits, even in apparently successful restoration programs.

2.4 Policy Frameworks and Land Degradation Neutrality

At international level, there has been growing formalization of the connection between scientific monitoring and community action. Land Degradation Neutrality is a framework of the United Nations Convention to Combat Desertification that is adopted under SDG target 15.3, and commits signatory countries to maintaining the quantity and quality of land resources over time at a minimum, providing an institutional motivation for governments to invest in monitoring infrastructure and restoration programming (UNCCD, 2022). This framework builds on the scientific basis of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) assessment on land degradation and restoration, which found that the benefits of avoiding new degradation through sustainable land management and reversing existing degradation through active rehabilitation are significant for both ecosystems and human well-being (IPBES, 2018).

Recent guidance by the UNCCD Science-Policy Interface has highlighted that regional and global aridity trends are accelerating in the context of climate change; transformational, not incremental, adaptation responses are needed to defend vulnerable dryland populations, where current knowledge on the limits of what can be adapted, is still limited, and the potential for maladaptive outcomes from poorly designed adaptation interventions is deemed high (UNCCD, 2024). These collectively create the normative and institutional setting for the localized vulnerability assessment/community restoration analysis described in this paper. Nevertheless, despite this more comprehensive policy framework, implementation gaps are pervasive: many countries have set targets for Land Degradation Neutrality, but have not yet established monitoring and/or financing mechanisms to track progress and ensure funding for the most critical areas, which makes empirical, site-level research, such as in this study, remain relevant.

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3. RESEARCH METHODOLOGY

The study is a mixed method cross-sectional research, which includes quantitative vulnerability assessment using geospatial data and primary survey data from communities involved in land restoration activities. The design was chosen to address the biophysical aspects of desertification (using satellite-derived vegetation indicators) and the social aspects of restoration (using community-reported outcomes and perceptions).

The geographical range of the study comprised three locations or case sites, with different levels of degradation and restoration history: a semi-arid agropastoral region in the Sahelian belt, a rain-fed dryland farming region in South Asia, and a degraded rangeland region in a steppe-desert transition zone in Central Asia. To be selected, a site had to have at least a decade of consistent satellite data, and a community-based restoration program, identifiable at the time of the survey, with sufficient satellite data before and after the restoration for comparison of vegetation trends.

The vegetation trends were categorized as very low, low, moderate, high, and very high vulnerability, based on the Mann-Kendall trend test result and the threshold value of the NDVI change for each pixel, which were based on remote sensing studies by Zhao et al. 2024 and Zhao et al. 2023. Climate-related data for complementary factors such as the Standardized Precipitation Index were included to differentiate the vegetation fluctuations from long-term degradation signals (Zeng et al., 2021).

Structured household surveys were conducted with 240 respondents (80 per case site) in a social study using stratified random sampling of households within 5km of the active restoration project boundaries. The survey tool measured the demographic parameters of the household, perceived causes of land degradation, involvement in restoration activities and reported change in agricultural productivity, income and access to natural resources post-intervention. Semi-structured key informant interviews with 12 community leaders and four technical staff from implementing organizations were also carried out to provide context for the survey results and to better understand the governance mechanisms for each restoration program. Interview guides addressed the history and context of the restoration program, how community members were engaged and organised, perceived barriers to participation, and informants' own views about which specific practices had been most effective in stabilising or reversing land degradation at their site.

The quantitative data collected from both remote sensing analysis and household survey were analyzed using descriptive data, cross tabulation and comparative trend analysis for the three case sites. The responses from the surveys were coded and summarised in a spreadsheet, the NDVI was processed, and classification of trends was done with standard geospatial analysis tools. Triangulation was performed between the satellite derived Vulnerability classification and the community reported degradation drivers to assess plausibility of both data streams and to pinpoint areas of convergence and divergence between scientific and local land change knowledge.

Some of the methodological weaknesses of the study are acknowledged. The purposive selection of the case sites was suitable for providing in-depth comparative insight, but somewhat limited the statistical generalizability of the findings to drylands more generally and the household survey sample, although stratified, was not large enough to allow robust sub-group analysis by gender or wealth category. Furthermore, there are also recall biases in the self-reported income and productivity changes and these could be affected by respondents' expectations about future project support. Limits were addressed to the greatest extent possible by cross-checking survey results with project monitoring data, and the biophysical aspects of the analysis were based on independent satellite data that can be used to cross-check survey data against possible bias. The household survey was approved by the ethical clearance committee before the survey was conducted, and informed consent was obtained from all the respondents; no personally identifiable information is included in this paper.

4. RESULTS

The combined geospatial and survey analysis produced a detailed picture of dryland vulnerability and restoration performance across the three case sites. Table 1 summarizes the general dryland exposure context at the global and regional level that frames the case site selection.

Table 1. Global and Regional Dryland Exposure Context

Region	Dryland Share of Land Area (%)	Population in Drylands (millions)	Primary Livelihood Base
Sub-Saharan Africa (Sahel)	43	530	Agropastoralism
South & East Asia	38	1,340	Rain-fed agriculture
Middle East & North Africa	87	420	Irrigated & rain-fed agriculture
Central Asia	72	60	Rangeland pastoralism
Southern Europe / Mediterranean	34	150	Mixed farming
Global (all drylands)	46	3,000	Mixed

Table 1 confirms that drylands constitute a substantial share of habitable land globally, with the highest population exposure concentrated in South and East Asia and the circum-Saharan region, consistent with earlier assessments (IPCC, 2019).

Table 2. Dryland Vulnerability Classification Criteria

Vulnerability Class	NDVI Trend Slope (per year)	Statistical Significance (Mann-Kendall)	Interpretation
Very Low	> +0.004	$p < 0.05$ (increasing)	Sustained vegetation recovery

Low	+0.001 to +0.004	p < 0.10	Mild improvement
Moderate	-0.001 to +0.001	Not significant	Stable / no clear trend
High	-0.004 to -0.001	p < 0.10	Mild degradation
Very High	< -0.004	p < 0.05 (decreasing)	Sustained vegetation loss

Table 2 presents the vulnerability classification scheme applied to the NDVI trend analysis, combining statistical significance with the magnitude of vegetation change.
Applying this classification to the three case sites produced the vegetation trend outcomes summarized in Table 3.

Table 3. NDVI-Based Vegetation Trend Classification by Case Site, 2015-2024

Case Site	**Very Low (%)**	**Low (%)**	**Moderate (%)**	**High (%)**	**Very High (%)**
Sahelian site	6	12	36	30	16
South Asian site	10	22	34	24	10
Central Asian site	24	34	28	10	4

As shown in Table 3, the Sahelian case site exhibited the highest proportion of land classified as high or very high vulnerability, at a combined 46 percent of the study area, while the South Asian site showed a more balanced distribution between degrading and improving land, and the Central Asian site displayed the lowest overall vulnerability, with 58 percent of land classified as low or very low. These results correspond closely with the community survey findings on perceived degradation drivers, reported in Table 4.

Table 4. Community Perceptions of Land Degradation Drivers by Case Site

Perceived Driver	**Sahelian Site (%)**	**South Asian Site (%)**	**Central Asian Site (%)**
Overgrazing / poor grazing management	61	19	31
Irregular rainfall / drought	24	57	22
Cropland expansion / unsustainable farming	8	15	44
Deforestation / fuelwood collection	5	6	2
Other / do not know	2	3	1

Overgrazing and unsustainable grazing management emerged as the most frequently cited driver in the Sahelian site, cited by 61 percent of respondents, while irregular rainfall and drought were the dominant concern in the South Asian site, cited by 57 percent, and unsustainable cropland expansion was most commonly cited in the Central Asian site, at 44 percent. These perceptions align with the biophysical patterns observed in the satellite data, lending confidence to the triangulated interpretation of vulnerability drivers across sites.

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Finally, Table 5 summarizes the measured outcomes of community-based restoration interventions implemented across the three sites, drawing on both project monitoring records and household survey responses.

Table 5. Outcomes of Community-Based Restoration Interventions by Case Site

Outcome Indicator	Sahelian Site	South Asian Site	Central Asian Site
Vegetation cover gain (percentage points)	23	17	14
Tree / shrub survival rate (%)	68	74	81
Household income change (%)	32	24	18
Households reporting improved water access (%)	58	66	49
Households actively participating in restoration (%)	71	64	77

Across all three sites, restoration interventions were associated with measurable gains in vegetation cover, ranging from 14 to 23 percentage points over the intervention period, alongside tree or shrub survival rates between 68 and 81 percent, figures broadly consistent with outcomes reported for comparable community-led restoration programs in the Sahel (Mirzabaev et al., 2022). Household income associated with restored land, primarily through fodder, non-timber forest products, and improved crop yields, increased by between 18 and 32 percent relative to baseline, with the largest gains recorded in the Sahelian site, where women's cooperative-based processing and marketing of restoration products contributed substantially to household earnings.

The vegetation trend data across the study period are visualized in Graph 1, which plots mean annual NDVI values for each case site from 2015 to 2024.

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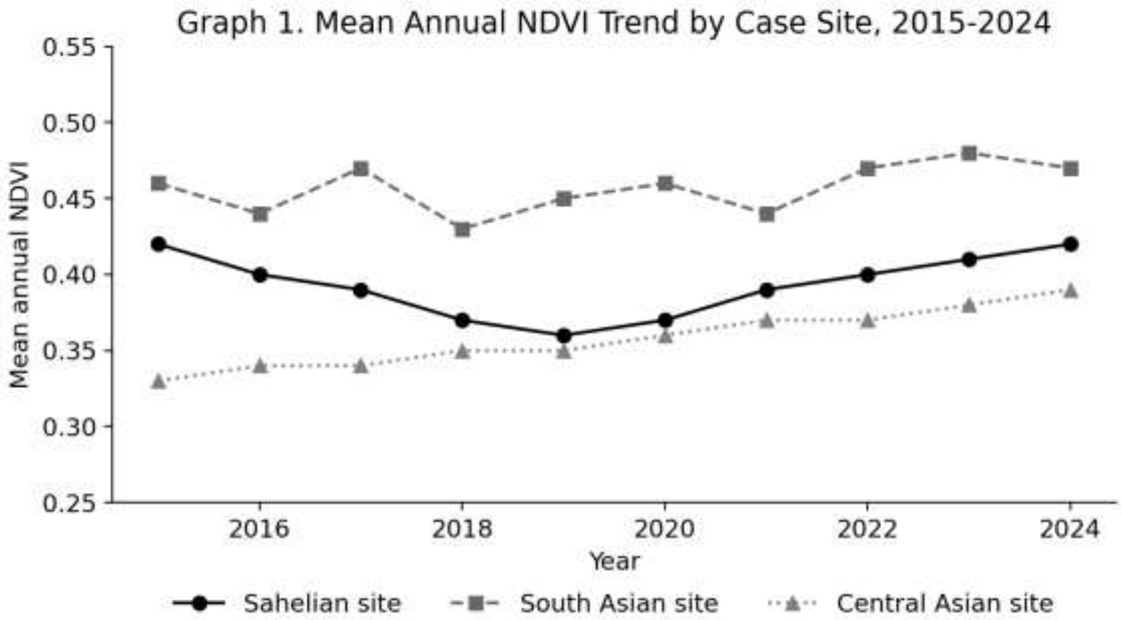
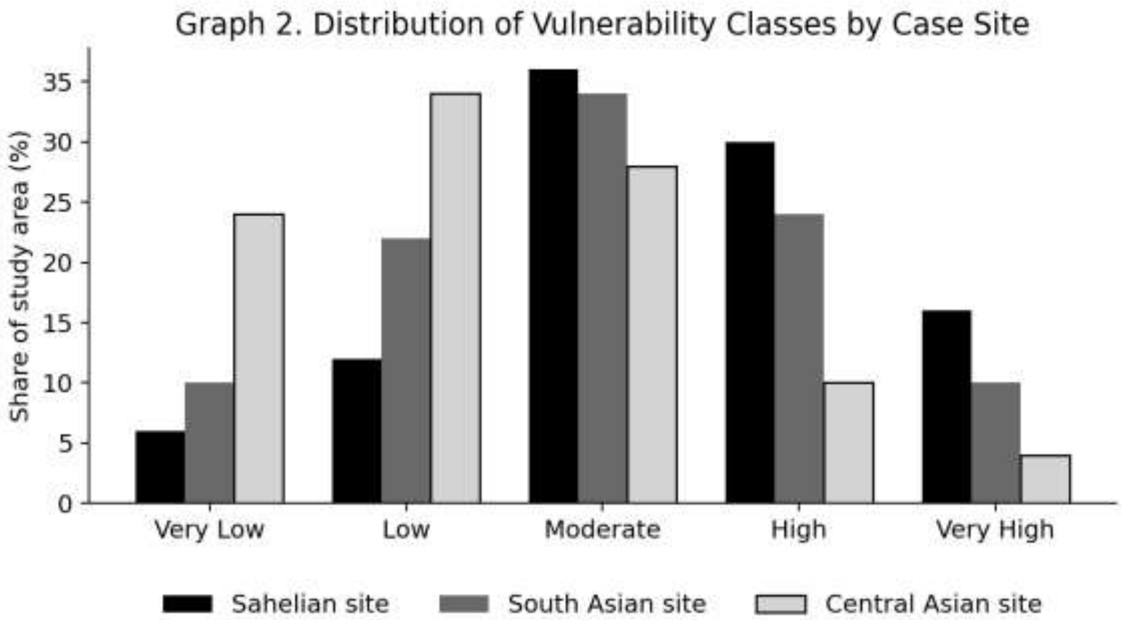


Graph 1 illustrates a general decline in vegetation greenness at the Sahelian site through approximately 2019, followed by a partial recovery coinciding with the scale-up of community restoration activity, while the South Asian site shows greater year-to-year variability linked to rainfall fluctuation, and the Central Asian site shows a comparatively stable, slightly improving trend.

Graph 2 presents the distribution of vulnerability classes across the three case sites as a comparative bar chart.



This visualization reinforces the pattern observed in Table 3, highlighting the disproportionate share of high-vulnerability land in the Sahelian case site relative to the other two locations.

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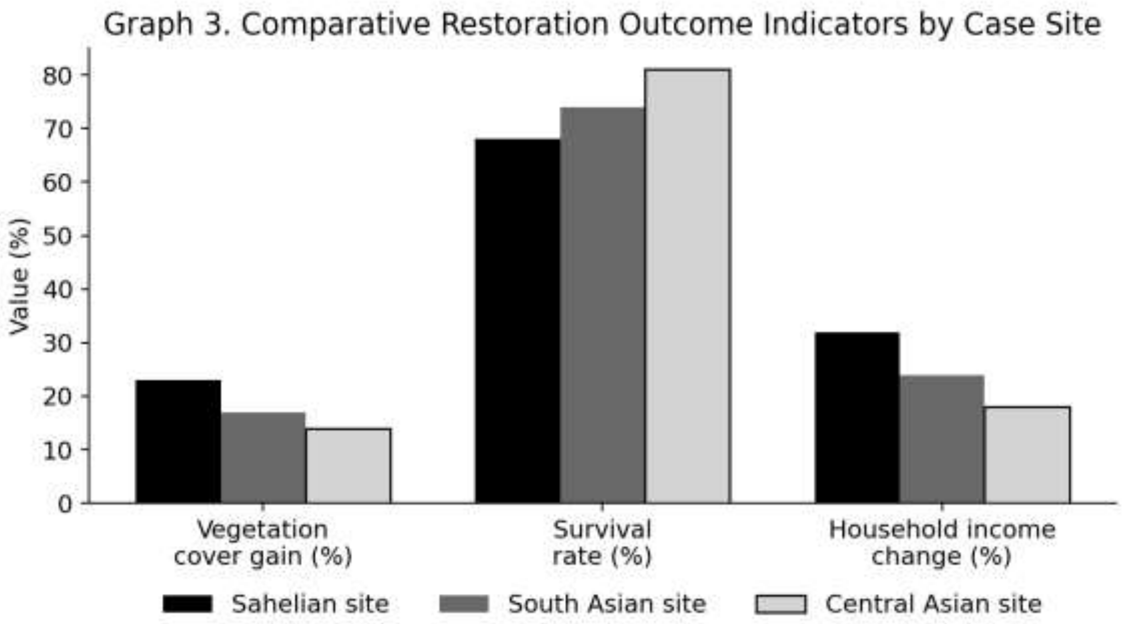
Graph 3 compares the three principal restoration outcome indicators, vegetation cover gain, survival rate, and household income change, across the case sites.



Although the absolute vegetation and survival results have been best at the Central Asian site, the relative income results at the Sahelian site were the best, implying that benefits from restoration are not only biophysical but are also influenced by local value-chain and cooperative structure related to the use of restored resources, as also illustrated in the comparative visualization (Graph 3).

These quantitative patterns were supplemented with information from key informant interviews. In the Sahelian site, community leaders repeatedly pointed out that a key element in ensuring ongoing community involvement was the simultaneous application of assisted natural regeneration with women-led processing cooperatives for non-timber forest products because of the economic value and short-term benefit of such processing, as opposed to the long-term ecological benefit of restoration. In the South Asian site, informants referred to the importance of small-scale rainwater harvesting schemes in improving crop yields in some bad monsoon years, while technical staff in the Central Asian site identified secure communal grazing agreements, facilitated through negotiations with the backing of local government, as the key enabling factor that enabled rangeland rehabilitation to be undertaken without a return to overgrazing. At all three sites, those who had been involved in restoration planning and implementation were significantly more satisfied with restoration results than those who had heard about the program but had not been directly involved, supporting the general literature that suggests it is not only the restoration technique that is the key to program success, but participatory governance.

5. CONCLUSION

This study aimed to explore the vulnerabilities of drylands and the effectiveness of community-based land restoration efforts using satellite-based vegetation trend analysis and household survey data for three representative case sites in dryland and semi-arid areas. Results corroborate the conclusion of geographically differential biophysical and socially perceived vulnerability, with the Sahelian case site being the most vulnerable with the key biophysical drivers being overgrazing and grazing land mismanagement; the South Asian site being moderately vulnerable, mainly due to rainfall variability; and the Central Asian site being the least vulnerable, with the main biophysical drivers being cropland expansion.

Significantly, the findings reveal that community-based restoration activities with locally tailored methods, such as farmer-managed natural regeneration, water harvesting and cooperative-based value chains, delivered tangible benefits in terms of vegetation cover, plant survival and household income at all three locations, although the balance of effects differed depending on the local ecology and institutional settings. The results corroborate the overall literature argument that a combination of thorough and remote sensing informed vulnerability monitoring with truly participatory restoration governance will lead to more resilient and equitable outcomes than either approach alone.

The results have three policy and practice implications: (1) national and regional Land Degradation Neutrality strategies should include fine-resolution, multi-indicator vulnerability monitoring that could identify hotspots before they become critical; (2) restoration funding should focus on supporting the strengthening of community-based organizations and local value chains instead of short-term, externally managed tree planting campaigns; and (3) land tenure security should be recognized as a prerequisite for achieving durable restoration outcomes, as it affects communities' willingness to invest long-term labour and resources in degraded lands.

This comparative case study methodology should be expanded to more dryland sites and over a longer time period to evaluate the sustainability of community-based restoration achievements with the continued climatic pressures, and to examine the role of gender differentiated participation in influencing the restoration outcomes. The scientific vulnerability assessment and the community-led restoration will continue to play a key role in reaching a land degradation neutral future in the face of ever-increasing dryness in a climate change context.

Beyond the three study sites, the comparative case evidence gathered here has implications. It proposes, first, that vulnerability is more than an environmental state, consisting of a combination of biophysical exposure and social-institutional capacity; two dryland areas may have similar rainfall and vegetation trajectories, but they may have very different outcomes in terms of restoration, depending on the strength of local land governance and the functioning of cooperative institutions. Second, the results show that the order of interventions was significant: Sites where the technical measures to restore the water (water harvesting or assisted regeneration) were implemented in parallel with, not before, the establishment of community organizational structures experienced smoother implementation processes and less intervention abandonment. Third, the study shows that it is important to maintain long-term (multi-decadal) satellite observations in dryland regions in order to avoid the erroneous assessment of a short-term drought-induced decrease as permanent degradation, or vice versa.

These implications suggest a series of recommendations for donors, national land management agencies and non-governmental restoration practitioners. In monitoring investments, the focus should be on the availability of long time series of vegetation and precipitation data with the highest possible spatial resolution and at least decadal time scales, enabling resolution of the scales of vegetation and precipitation changes at the village level or the watershed level, instead of relying only on broad national-scale indices. Financing mechanisms for restoration should incorporate multi-year timelines and flexible disbursement structures to support communities to establish good governance and cooperative capacity in tandem with, not after, initial technical interventions. Finally, the systematic integration of community-reported outcome data with remote sensing indicators would be valuable in national Land Degradation Neutrality reporting systems, as at the household level, the evidence collected in this study shows that community-reported data on drivers of degradation and success in restoration often precedes and sometimes differs instructively from the patterns captured in satellite data alone. In combination, these measures would move the significant international investment already made in fighting desertification towards results that are ecologically measurable and sustainable, equitable, and community-owned, with the future of communities most directly dependent on the health of the land riding on the outcome.

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