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Integrated Management of Land, Water, and Forest Resources in Laljuri Cherra Micro Watershed: A Case Study of Hamsouhla Village

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Abstract:

This study explores the integrated management of land, water, and forest resources in Laljuri Cherra Watershed, located in the North District of Tripura. The research emphasizes community-level practices in resource utilization and conservation in Hamsouhla village, with a focus on understanding the interplay among ecological assets and rural livelihoods. Employing a qualitative and descriptive research approach, primary data were collected through field surveys, interviews, and participatory observation involving 42 households. The findings indicate that landholdings in the village are small and fragmented, with agriculture being the primary occupation practiced using traditional tools and techniques. Subsistence rice cultivation is widespread, supported by seasonal rainfall and rudimentary irrigation methods. Shifting cultivation is practiced by a significant portion of landless households, contributing to crop diversity but posing ecological concerns. Livestock and allied activities—such as piggery, poultry, and fishery—play an important supplementary role in livelihood generation, although constrained by infrastructural and financial limitations. Water availability is not a major constraint, but its management remains inadequate. Ring wells, ponds, and seasonal streams are the primary sources of water for domestic and agricultural use. However, the lack of piped supply and irrigation infrastructure renders the system vulnerable to seasonal fluctuations. Forest resources, both timber and non-timber, are extensively used for household needs, but community participation in forest management is negligible, with governance resting solely with the state. The study concludes that while traditional practices reflect environmental adaptability, the lack of integration among land, water, and forest management undermines the sustainability of the watershed. Despite the implementation of the Integrated Watershed Management Programme (IWMP), community participation remains limited. For sustainable watershed development, there is an urgent need to enhance participatory planning, inter-sectoral integration, and local capacity building in resource governance.

Keywords: Watershed Management, Land Use, Water Resources, Forest Dependency, Tribal Livelihoods, Sustainable Development, Tripura.

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1. Introduction

Watersheds have been examined from multiple perspectives, including the economic efficiency of water use, flood runoff, soil erosion, sedimentation, groundwater recharge, and socio-political dimensions (Dixon, 1992). However, understanding the interrelationship between land, water, forest, and people is equally critical in comprehensive watershed studies. Watershed management, therefore, extends beyond the narrow framework of cost-benefit analysis. It emphasizes a holistic approach, particularly focusing on ecological balance and sustainable livelihoods.

A key distinction between watershed development and conventional developmental programs lies in its community-based nature. Given the technical and spatial scale of interventions, watershed development often requires action that spans across individual households and even entire villages. While the importance of community participation is frequently acknowledged in academic and policy discussions, there remains a lack of in-depth theoretical and empirical analysis of the collective action processes involved. Watershed management is increasingly recognized as a holistic approach that goes beyond economic efficiency to include socio-ecological sustainability. It considers the interdependence of land, water, forest, and community action. Consequently, community participation in watershed management remains superficial in many policies, leading to limited success and adoption on the ground.

In this context, an Integrated Watershed Management Programme (IWMP) was implemented in the Laljuri Watershed between 2009–2014, with the objective of improving the socio-economic conditions of the local population through better management and utilization of natural resources. From the field investigation conducted in Hamsouhla para, 21.8% benefitted from the IWMP through their involvement in Self Help Groups (SHGs), aimed at supporting asset-less individuals. Among the beneficiaries, 8.72% took up fishery, 6.54% engaged in piggery, 2.18% pursued goat rearing, and 4.36 opted for poultry farming. Financial assistance was provided for the establishment and maintenance of these livelihood activities. However, access to fishery support was conditional upon land ownership, thereby excluding landless individuals from this specific option.

The Integrated Watershed Management Programme (IWMP) was implemented in Laljuri Cherra between 2009 and 2014 to improve livelihoods through participatory resource management. In Hamsouhla village, various livelihood activities supported by Self Help Groups (SHGs)—including fishery, piggery, poultry, and goat farming—highlight the role of watershed initiatives in transforming community engagement and resource use.

2. Literature Review

a. Conceptual Foundations and Evolution

Watershed management has emerged as a multidisciplinary approach to the sustainable use and conservation of land, water, and forest resources. Initially focused on soil and water conservation, the concept evolved significantly after the Indian Council of Agricultural Research (ICAR) demonstrated its potential through model projects in different agro-climatic regions (Vaidyanathan, 2006). The Centre for Applied Systems Analysis in Development (CASAD) developed integrated tools like the Micro-Watershed Management System (MWMS) to assist in decision-making for semi-arid regions (Datta, 1995).

Watershed development provides a logical framework to organize development activities involving both structural and non-structural interventions, aiming to enhance water availability, reduce soil erosion, and improve productivity and livelihood outcomes (Sharma et al., 2005; Reddy, 2000).

Early works like Randall (1939) and Jeffrey and Goodell (1970) emphasized the importance of natural resource conservation and land management in municipal watersheds. Dixon (1992) provided a comprehensive framework for watershed analysis and management, advocating for integrated planning that considers both ecological systems and human dynamics. The symbolic and cultural aspects of resource use are also crucial, as highlighted by Cohen (1989) in his study on community identity and collective action.

In India, watershed development gained prominence in response to land degradation and rural poverty. Deshpande and Reddy (1991) and Singh (1991) explored the socio-economic impacts and people's participation in watershed programmes, revealing that effective outcomes are contingent upon community involvement. Kurian et al. (2003) and Kolavalli and Kerr (2002) further stressed the importance of participatory approaches, showing that top-down models often fail to address local needs. Case studies such as Jankar and Kulkarni (2013) and Panhalkar (2010) document the success of watershed projects in Maharashtra, highlighting improvements in agricultural productivity, water conservation, and local livelihoods. Similarly, Nicholas (2006) evaluated NWDPRA projects in Kerala, pointing to challenges in implementation and institutional coordination.

b. ***Community Participation and Institutional Mechanisms***

Community participation is widely acknowledged as essential for the success and sustainability of watershed programmes (Singh, 1991; Kolavalli & Kerr, 2002). The Joint Forest Management (JFM) and Irrigation Management Transfer (IMT) policies were promoted to facilitate integrated natural resource management at the local level (Kurian et al., 2003). Initiatives such as People's Organizations and Self Help Groups (SHGs)—supported by NGOs like BAIF—have proven instrumental in mobilizing communities, especially the marginalized (Sundaram, 2004).

However, challenges persist. Cohen (1989) and Rajasekaran (1997) point out that participatory models often overlook internal community dynamics and power asymmetries. Further, as GoI (1996) noted, projects tend to prioritize community lands over private fields, enabling unilateral bureaucratic action but often failing to yield long-term results.

c. ***Technological Interventions and Methodologies***

Technological innovations play a critical role in modern watershed management. Methods such as organic mulching, check dam construction, agri-silvi-horticultural systems, and poly-house farming are frequently employed in upper and middle catchments (Sharma et al., 2005).

Geospatial technologies, particularly GIS and remote sensing, have revolutionized watershed assessment and planning. Tim and Mallavaram (2003) emphasize the integration of Digital Elevation Models (DEMs), hydrographic datasets, and GPS-derived data in watershed analysis. GIS provides a spatially integrated platform to analyze drainage patterns, land use changes, and ecological processes, supporting informed decision-making and impact evaluation. The application of GIS and remote sensing in watershed monitoring and planning has been discussed by Ram and Kolarkar (1993) and Tim and Mallavaram (2003), offering tools for effective land use planning and impact assessment. Datta (1995) proposed a Decision Support System for micro-watershed management, underscoring the role of technology in resource governance. On the institutional front, Reddy (2000) and Vaidyanathan (2006) analysed the restructuring of watershed programmes, advocating for decentralized models and stronger local institutions. Government policy perspectives are documented in reports by GOI (1996) and programmatic evaluations by Sharma et al. (2005).

d. Socio-Economic and Policy Dimensions

The socio-economic impact of watershed programmes has been extensively documented. Studies by Deshpande & Reddy (1991) and Rajasekaran (1997) found improvements in agricultural productivity and income levels, though these benefits vary across regions and social groups. Vaidyanathan (2006) argues that Panchayati Raj Institutions (PRIs) should be central in programme implementation, yet their role is often marginalized or symbolic.

Moreover, successful watershed projects are typically those that combine technical soundness with community ownership, and are tailored to local socio-ecological conditions (Kolavalli & Kerr, 1999). However, the divergence between technocratic solutions and farmer preferences—such as in the case of vegetative barriers versus boundary bunds—illustrates the need for adaptive and context-sensitive approaches.

e. Livelihood and Environmental Linkages

Watershed management is increasingly linked to livelihood security and sustainable agriculture. Sharma et al. (2005) and Sivanappan (2008) argue that proper water and land management practices can significantly enhance agricultural productivity. Studies like Bahuguna et al. (1994) and Sundaram et al. (2004) have shown that integrating forest, water, and agricultural resource management is essential for ecological balance and poverty reduction. Lefkowitz (2004) and Rajasekaran (1997) emphasized the role of community-based planning and local knowledge in ensuring the long-term sustainability of watershed interventions.

The literature strongly supports an integrated, participatory, and technology-enabled approach to watershed management. While policy and institutional frameworks exist, their effectiveness depends on local engagement, proper implementation, and continuous monitoring. Future strategies must balance ecological conservation with socio-economic development to achieve holistic watershed management.

The literature strongly supports a shift toward integrated, participatory, and technology-driven watershed management. While policy frameworks and technical solutions are in place, the success of these programmes depends heavily on community empowerment, local institutions, and adaptive planning. Moving forward, a balanced approach that addresses both ecological integrity and socio-economic equity will be vital to the long-term sustainability of watershed interventions.

3. Objectives

1. To assess the patterns of land, water, and forest resource utilization and their interrelationship in the context of integrated watershed management in Laljuri Cherra Micro Watershed.
2. To examine the extent and effectiveness of community participation in resource management activities under the Integrated Watershed Management Programme (IWMP), with a focus on livelihood generation and sustainable practices.

4. Materials and Methods

4.1. Study area

The present study is conducted in the Laljuri Cherra Watershed, located in the North District of Tripura (24°05′21″N to 24°08′53″ N Latitudes to 92°11′44″E to 92°16′46″E Longitudes) , in north-eastern India. As illustrated in the location map, the watershed lies within the physiographic boundaries of Tripura and is a tributary of the Deo river basin system of the region. The watershed area is characterized by diverse land use and land cover features, including agricultural land, forests, jhum (shifting) cultivation areas, water bodies, plantations, and human settlements.

The Land Use and Land Cover (LULC) map of the Laljuri Watershed reveals a predominantly forested landscape, interspersed with patches of cultivated crop land and jhum cultivation. Water bodies and seasonal rivers flow through the watershed, forming the primary sources of irrigation and domestic water supply. The presence of linear road networks and scattered settlements, especially in the central and southwestern portions, reflects the rural and agrarian nature of the local economy.

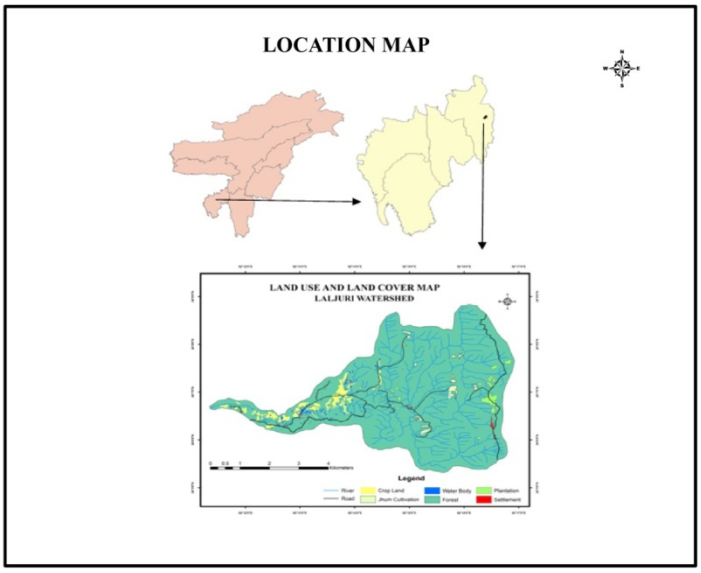

Figure 1. Location map of the study area, Author's Construct.

The watershed has been identified as a priority area for integrated watershed development due to its ecological sensitivity, socio-economic dependency on natural resources, and vulnerability to soil erosion and seasonal water scarcity. The study area includes Hamsouhla village, which falls within the watershed boundary and has been a beneficiary of the Integrated Watershed Management Programme (IWMP) during the 2009–2014 implementation phase.

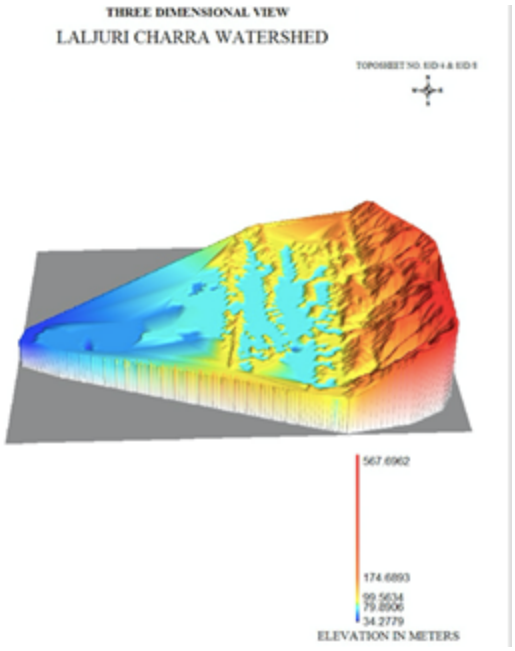

Figure 2: DEM of Laljuri Cherra Micro Watershed

4.2. Data Sources

Primary data were collected through:

Structured household surveys using pre-tested schedules, covering aspects of land use, water access and conservation, forest product dependence, and associated management practices; Key informant interviews with local leaders, watershed committee members, and IWMP beneficiaries to capture insights into policy implementation and collective action; Participatory Rural Appraisal (PRA) tools, including resource mapping and seasonal calendars, were employed to identify local perceptions and usage patterns; Focus group discussions with elders and women's groups were held to explore socio-cultural dimensions of resource use.

Secondary data were sourced from:

Topographical sheets (Survey of India) and satellite imagery for base map preparation, Government reports, IWMP records, and documentation from the Department of Rural Development and Forests, Academic literature, journals, and previous research studies.

4.3. Data Analysis and Interpretation

Quantitative data were analysed using descriptive statistics (percentages, averages, frequency distributions) to determine landholding patterns, water source dependency, crop yields, and livestock ownership. Cross-tabulations were used to explore relationships between variables such as landholding size and resource dependency.

Spatial analysis was carried out using GIS-based cartographic methods, with thematic maps prepared to represent land use, water access points, and forest utilization zones. Qualitative data were thematically analysed to identify patterns in community perception, participation levels, and institutional dynamics.

This combination of biophysical features and human activity makes the Laljuri Cherra Watershed a critical unit for studying the interplay between land, water, and forest resources, as well as the role of community participation in sustainable natural resource management.

5. Results and Discussion

5.1. Land Use and Agricultural Practices

The landholding pattern in Hamsouhla village reflects significant fragmentation, with nearly half (45.23%) of households owning less than 1 acre of total land. The majority (71.42%) of households possess less than 1 acre of homestead land, limiting scope for expansion of agricultural or allied activities. Horticulture in the Laljuri Cherra Micro Watershed primarily takes the form of homestead cultivation, with most households maintaining a small number of fruit trees around their homes. The species grown are typically low-maintenance and suited to the region’s seasonal climate, providing fruits at different times of the year. The predominant horticultural crops include jackfruit (85.71%), mango (52.38%), banana (47.61%), guava (35.71%), and papaya (28.57%). A smaller percentage of households grow tamarind (19.04%), areca nut (16.66%), and coconut (9.52%). These figures suggest that jackfruit is the most widely grown crop, likely due to its ease of maintenance, adaptability, and high yield, followed by mango and banana. Despite favourable environmental conditions for horticultural development, the overall scale and commercial viability of horticulture remain underutilized. Key constraints include lack of financial resources and inputs, poor access to markets and transportation, limited extension services and technology support, inadequate awareness and training. These issues hinder the scaling-up of horticulture as a livelihood strategy. Additionally, the absence of organized marketing channels and processing units discourages surplus production and income generation. Thus, while homestead horticulture contributes to

household nutrition and seasonal income, its role in sustainable livelihoods and economic diversification remains limited.

Agriculture remains the primary occupation, predominantly characterized by subsistence farming, with rice as the staple crop cultivated once annually using traditional tools and methods. There is no mechanization or use of chemical inputs. Labour exchange practices such as *"yauggu kshilaimo"* demonstrate community cooperation in the face of labour shortages.

Table 1: Distribution of Households by Homestead land owned, Agricultural Landholding Size, and Crop yield.

Homestead Land Owned (in Acre)	Households (%)
Less Than 1	71.42
1 To 2	28.57
Agricultural Land (in Acre)	
1 to 2	28.57
3	14.28
4	11.9
Without Agri. Land	45.23
Rice Yield (kg/ha)	
Upto 300	2.38
400-600	19.04
700-900	21.42
More than 900	11.90
Without Agricultural Land	45.23

Source: Author's Field Survey, 2014

Shifting cultivation is practiced by 33.33% of the households, primarily among landless farmers. Although it involves a more diverse range of crops—such as cereals, spices, and oilseeds—it remains ecologically sensitive and requires monitoring for long-term sustainability. Agricultural yield remains modest, with most households producing between 300–700 kg of rice annually, barely sufficient for year-round consumption.

A significant 45.23% of households are landless, while only 11.9% possess larger agricultural land (4 acres). This clearly indicates a high level of land scarcity in the village.

This mirrors the landholding pattern, indicating that only landholding households produce rice, with over 50% producing modest yields (300–700 kg), suggesting subsistence-level farming. Households with larger landholdings (3–4 acres) tend to fall within the 700–900 kg/ha or above category, suggesting a positive correlation between land size and yield levels. However, yield variation within smaller holdings suggests influence of other factors such as access to water, labour, and farming practices. Resource dependency, particularly on land and water, increases with the size of landholding—but disparities remain due to infrastructural limitations, traditional practices, and lack of irrigation inputs.

5.2. Livestock and Allied Activities

Livestock rearing acts as a secondary livelihood, particularly piggery (73.81%) and poultry (80.95%), owing to their low maintenance requirements. Goat rearing and cattle husbandry are less common, the latter due to higher costs and space constraints. Pisciculture is limited to households with access to ponds (26.19%). These allied activities play a critical role in supplementing food and income security, though they remain underutilized due to resource constraints and limited technical support.

5.3. Water Resources and Management

Despite the availability of surface and groundwater resources, water management in the village remains rudimentary. Drinking water is sourced primarily from ring wells (80.95%), with the rest relying on earthen wells constructed through joint community effort. There was no piped water supply. Bathing and washing practices involve a mix of ring wells, ponds, and streams.

Irrigation is heavily monsoon-dependent, with only 38.09% of households supplementing rainwater with pond water via manually dug channels. Another 16.66% of households rely solely on rainfall, leading to irrigation vulnerability during dry spells. Water conservation occurs mainly through traditional earthen and natural ponds, which also support pisciculture. The absence of modern irrigation infrastructure and water-saving technologies hampers agricultural productivity.

Table 2: Household Distribution by Water Usage Purpose in Laljuri Cherra Micro Watershed

Bathing and Washing	Households (%)
Ring Well	52.38
Earthen Well	0
Stream	7.14
Pond	40.47
Source Of Drinking Water Source:	
Ring Well	80.95
Earthen Well	19.04
Irrigation Source	
Rainwater	16.66
Rainwater and Pond	38.09
Shifting Cultivator	33.33
Without Agriculture Land	11.9

Source: Author's Field Survey, 2014

Conservation and Government Intervention

Traditional Water Conservation practices such as man-made and natural ponds are the primary form of rainwater harvesting in the village. These ponds also support aquaculture, contributing to both food and livelihood security.From the institutional perspective, the State Government has played a significant role in water resource management. A total of 33 water harvesting structures (IWMP, Laljuri Block) have been constructed within the watershed, where the older dilapidated structures have been repaired, indicating efforts toward maintenance and sustainability. However, these infrastructures are not evenly distributed, resulting in localized access gaps and underutilization in certain areas.

The findings reflect that while natural water resources are available, the infrastructure for water management remains inadequate and unevenly distributed. The monsoon-dependent irrigation system and absence of piped drinking water highlight the need for improved investment in decentralized water systems. Conservation structures and traditional pond systems show promise but require scaling and equitable distribution. For long-term sustainability, integrating governmental efforts with community-based water governance is essential

5.4. Forest Resource Use and Management

The entire village depends on forest resources, especially non-timber forest products (NTFPs), collected regularly by 45.23% of households. Timber collection is infrequent and used for subsistence purposes such as house-building and fencing. While 78.57% collect

forest products for household consumption, 21.42% engage in limited sale. However, market linkages for forest products are weak, restricting income generation.

Importantly, there is no community-level forest management. The villagers act as passive users, with forest governance entirely under the state government's jurisdiction, in collaboration with external institutions such as the Forest Stewardship Council (FSC). The absence of local participation in forest conservation raises concerns regarding long-term sustainability.

Table 3: Household Utilization Patterns of Forest Resources in the Laljuri Watershed

Forest items	Households (%)
Timber	76.19
Non-timber	100
Frequency of Collection	
Daily	21.42
Weekly	33.33
Seasonally	45.23
Purpose	
Household Consumption	78.57
For Sale & Consumption	21.42

Source: Author's Field Survey, 2014

5.5. Integration of Resource Management

While resource use practices show adaptation to environmental and socio-economic conditions, the lack of integration between land, water, and forest management is evident. For instance, deforestation and shifting cultivation contribute to soil erosion and reduced water retention. Similarly, the absence of vegetative buffers or soil conservation techniques undermines water quality and agricultural sustainability.

Though the Integrated Watershed Management Programme (IWMP) was implemented in the region (2009–2014), its impact appears limited, with only 10 households directly benefiting. The core principle of watershed-based planning—coordinated, resource-efficient, and community-participatory management—is yet to be fully realized in practice.

6. **Conclusion**

The study of the Laljuri Cherra Watershed reveals a close interdependence between the rural community and its natural resources, particularly land, water, and forests. Through a detailed assessment of resource availability, use, and management practices in Hamsouhla village, the study has brought to light the complexities of sustaining rural livelihoods in ecologically sensitive regions.

Agriculture, practiced mostly on small and fragmented landholdings, remains the primary occupation of the villagers. Traditional farming techniques, seasonal dependency on monsoon rains, and limited irrigation infrastructure collectively constrain agricultural productivity. While allied activities like piggery, poultry, and pisciculture offer supplementary income, their scale remains limited due to resource constraints and lack of institutional support.

Water, although not scarce in absolute terms, is inequitably accessed. Drinking water is sourced primarily from ring and earthen wells, but the absence of piped water and functional hand pumps underlines the need for improved infrastructure. Irrigation remains heavily monsoon-dependent, with very few households able to supplement rainwater with pond irrigation. Government-sponsored water harvesting structures exist, but their distribution is uneven, limiting their effectiveness in addressing seasonal shortages.

Forests play a vital role in the socio-economic life of the villagers, providing essential resources like fuelwood, fodder, and non-timber products. However, the absence of community-led forest management indicates a gap between resource dependence and stewardship. Forest governance remains primarily institutional, with minimal grassroots participation.

The study concludes that while the community has adapted to its environment through traditional and subsistence-level practices, the lack of integration across resource sectors, weak institutional linkages, and limited community engagement pose challenges to sustainable watershed management. Moving forward, a truly integrated approach—combining technological interventions, equitable infrastructure development, and participatory governance—is essential to enhance resilience, resource productivity, and ecological sustainability in the watershed.

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