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Quantification of NWFP in Joypur Forest Range (JFR) and Their Utility on Economic Aspects: A Review

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ABSTRACT

In present day, we are facing lots of problems regarding pollutions, resource crisis, water related issues, job scarcity, economic imbalances which are the product of fastest growing economy as well as rapid growth of urbanisation and industrialisation. This review paper aims to evaluate the amount of NWFP and its economic aspects in the JFR. NWFPs are vital elements of forest ecosystems, supporting local livelihoods and the regional economy through the provision of diverse resources, including medicinal plants, fruits, nuts, resins, and fuel wood. This paper discusses the economic services provided by Non-Wood Forest Products (NWFPs) with regards to income generation, rural employment, and the possibility of sustainable forest management practices for development. This study highlights the necessity for integrated strategies to safeguard and enhance NWFPs as an invaluable asset for both regional societies and the national economy. The study also conducted a thorough literature search, field surveys and data on NWFPs diversity, availability and consumption pattern in JFR. The volume and value of different types of NWFPs is reviewed, and their significance to the livelihood economy of neighboring communities is emphasized. They indicate that NWFPs possess high economic value, but their realization remains suboptimal owing to both management constraints and trade systems that are rarely organized. In conclusion, the review recommends strategies for enhancing the sustainable harvesting and marketing of NWFPs among local communities, such as capacity-building, awareness campaigns, and policy interventions to guarantee both ecological and economic sustainability in JFR.

Key Words: Industrialisation, JFR, NDVI, LULC, NWFP, SFMP

INTRODUCTION

Our ecosystems are being depleted at such a rapid pace that it is compromising their ability to regenerate, due to the unrestrained exploitation of nature and natural resources. Comprehensive evaluation of ethno-medicine is critical to understand these shifts and to formulate strategies for conservation of medicinal plants and sustainability of socio-ecological systems (6). The present study investigates the intimate association of forest resources with the livelihood of

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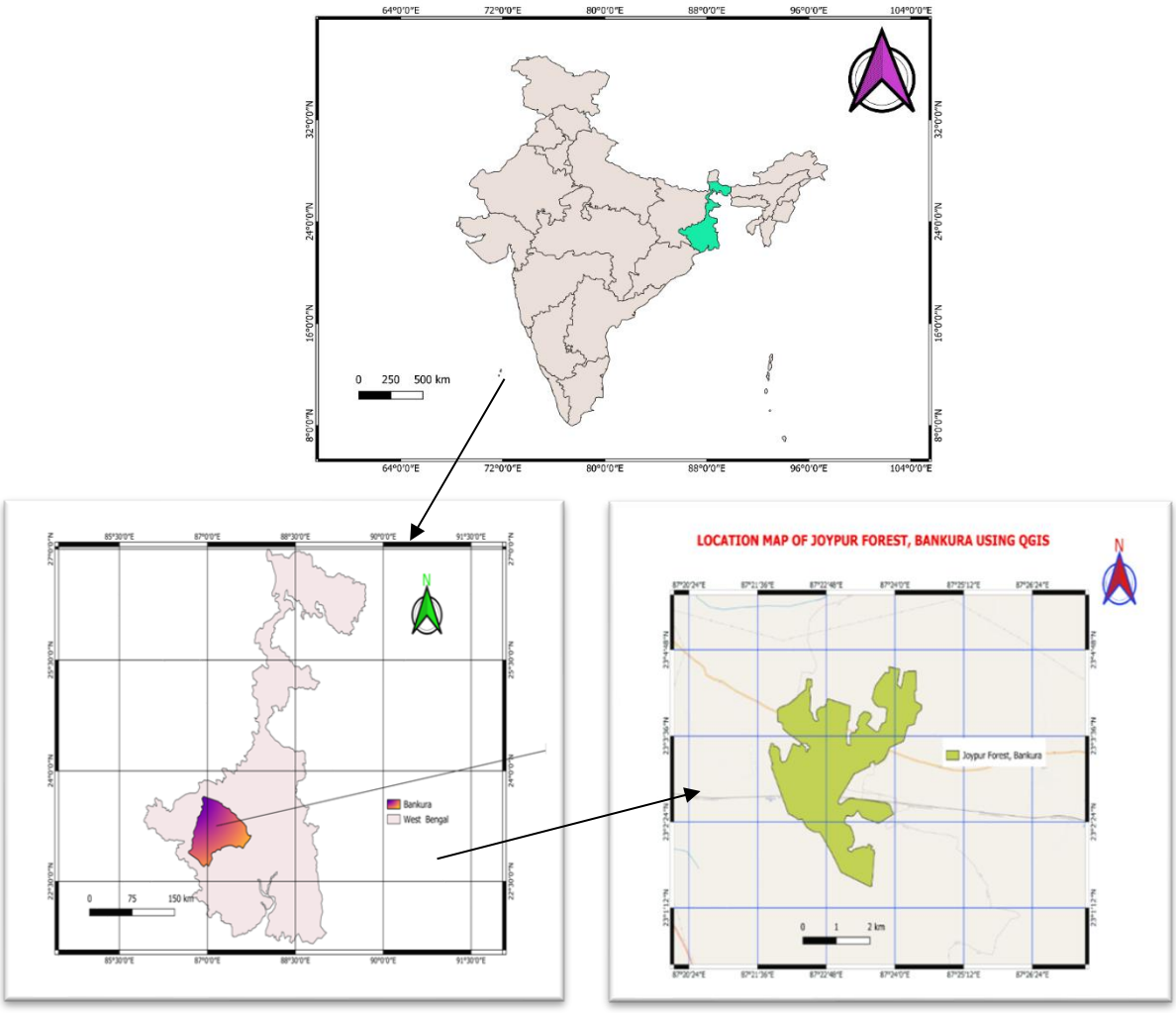
Santali community in the district in focus, specifically in Jaypur block. It also emphasizes the common knowledge and cultural practices used by the social group to manage and sustain forest resources (8). It calculates the use value of NTFP species to determine the multipurpose nature and importance, and participatory appraisal techniques and market surveys identify the collection methods, market dynamics, and economic potential. Commercialization patterns are explored through market channels, net returns and price spread models while with multiple regression models providing insight on elements affecting pricing and marketization. Results have shown that tribal people generally sell their products locally through middlemen, primarily due to a lack of knowledge of value addition, ineffective restoration practices and limited access to markets (3). The analysis found that higher education level of the head of household, social engagement, ownership of land and livestock, and availability of farm and non-farm income opportunities were all substantially associated with reduced dependence on forests (1).Here we study the resource dependence of 35 forest-dwelling families in the Bishnupur Forest Division in the Bankura District with regard to non-timber forest products (NTFPs) and livelihoods, specifically exploring modes of collection. These results demonstrate that half of these families depend on NTFPs for their daily lives. The majority of profits from NTFPs predominantly go to secondary and tertiary collectors/assets, indicating an insufficient return from forest resources to local communities. Therefore, economic welfare of residents in the area is highly reliant on collection of NTFPs and to trading it. The main characteristics of (10) of the collection have a direct influence on the policies of sustainable forest management (SFM) developed by the region. The average amount estimated of dark forest dwellers with low income that are willing to pay for reinvestment in forest protection measures is $9.62 per month. Even though it is a tiny donation in light of their budget, it demonstrates their devotion to a cause which is critical to their existence: forests (9) .There is major issues with the Global Forest Resources Assessment (GFRA) reports on Non-Wood Forest Products (NWFPs) that we unveil in the following analysis. Such reports regularly misstate NWFP quantities, contain inconsistencies and often lack information on quantities or values even where in-country studies can be found (5). This paper outlines different types of NWFP with some of the key species utilized in each. It focuses on a specific segment of the market and the contribution of these products to the economy of hilly regions, and their possible links with the socio-economic development of local communities (2). Peppara Wildlife Sanctuary is a traditional provider of different non-wood forest products (NWFP). In total, we established a list of these products through data collected during a given month as well as through assessment of seasonal shifts, availability, market demands and known channels with respect to trade (7). The present study is a report of identification and quantification of core habitat areas in Panchet Forest Division, Bankura District using the geospatial techniques corroborated with field verification. The main goals are to suggest concrete techniques to increase the surface of core habitat and to close the gaps between isolated patches to facilitate the functional connectivity of these habitats (4). The present study covers the close affinities between the forest resources and the Santali community in the Jaypur block of the district. It highlights the traditional knowledge and cultural practices of this particular social group, and stresses their role as to conserving and preserving the forest resources (8).

STUDY AREA

Joypur Forest Range is an amazing, dense forest of Bankura district in West Bengal, India. It is located from latitude 23.12° to 23.25° N and longitude 87.10° to 87.25° E, in the northern part of the Bankura district, with great natural beauty and biodiversity. This forest is the home of tallest sal trees, rich bio-diversity, and a calm ambiance. The forests are composed mainly of sal trees and support some other plants. Various animals, including elephants, deer, foxes, and a plethora of birds, make it a good place for wild-life enthusiasts. The forest is a very popular destination among nature lovers, and tourists looking for tranquility. Nice walks and picnic spots are available within the forest. Significant number of historical terracotta temples in Bishnupur is the nearby attractions. The forest can be accessed from nearby towns such as Bishnupur and Bankura by road. With Bishnupur being the closest railway station, a day-trip here is all too convenient. The tranquil and pristine environment of Joypur Forest Range proves quite refreshing for visitors desiring to connect with nature.

Fig: 1. Showing the location map of Joypur Forest, Bankura District, West Bengal



MATERIALS & METHODS

Assessment of Non-Wood Forest Products and Medicinal Plants, which are to quantify as per the availability, use and their economic values. NWFPs are miscellaneous forest products, other

than woods, to comprise fruits, nuts, resins, and medicinal plants. These useful products will lead to the sustainability of Wildlife and Conservation Management efforts. An overview on quantification and use consists of: (1) Quantification; (2) Inventory and Assessment; (3) Direct Field Surveys: The use of direct inventory and field surveys to measure the quantities of NWFPs and medicinal plants in assorted forest area; (4) Remote Sensing: Use of satellite imagery/aerial surveys for the estimation of distribution and density of these plants; (5) Sampling Methods: Sample extraction from different locations to compute population size and distribution; (6) Data Collection: Harvest Data: An aggregate measure of the amounts harvested by local communities or industries. Market Surveys: Monitoring volume of sales and price in local and global market. Use Patterns: Patterns of use of these products for personal and commercial purposes; (7) Economic Valuation: Market Prices: Economic value deduction based on the current market prices of NWFPs and medicinal plants. Cost Benefits: Assessments done on the costs incurred during the harvesting and processing and the corresponding economic benefits thus derived; (8) Sustainability Metrics: Regeneration Rate: Ensuring the rate of plant regeneration post harvests is duly monitored. Ecological Impact: Assessment of the harvesting practice within the ecosystem.

DATA ANALYSIS

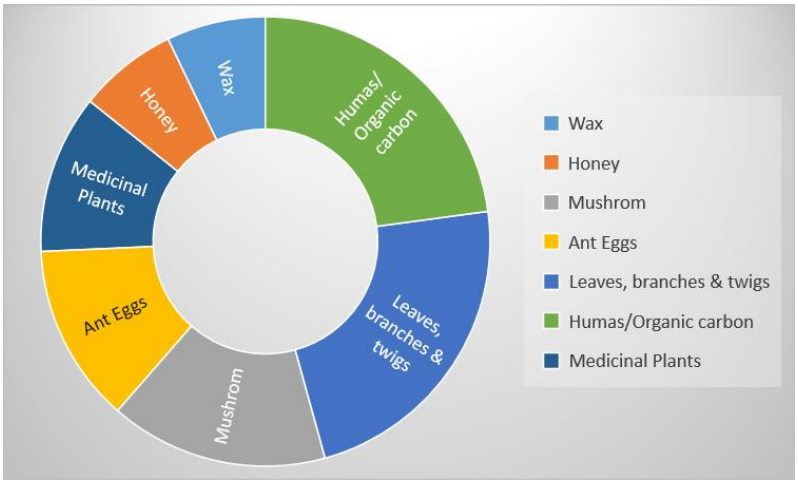
Before going into the field, we sit together to plan the roadmap so that we systematically collect the data. We are categories the entire study area into 4 broad blocks and 4 samples taken from each site into the block; 4 samples are taken from 4 study sites in each block. In total we are collecting data and sample from total of 16 sample sites from Joypur Forest Range (JFR), Bankura.

Tab: 1. Showing availability of NWFP in different study sites in Joypur forest, Bankura

Station	Wax	Honey	Mushroom	Ant Eggs	Leaves, branches & twigs	Humus/ Organic carbon	Medicinal Plants
Site 1	√	√	×	√	√	√	×
Site 2	×	×	√	×	√	√	×
Site 3	√	√	√	√	√	√	×
Site 4	×	×	√	√	√	√	√
Site 5	×	×	×	×	√	√	√
Site 6	×	×	×	√	√	√	×
Site 7	×	×	√	×	√	√	√
Site 8	×	×	√	√	√	√	√
Site 9	√	√	×	√	√	√	×
Site 10	√	√	√	×	√	√	√
Site 11	×	×	√	×	√	√	×

Site 12	×	×	×	√	√	√	√
Site 13	×	×	√	×	√	√	√
Site 14	×	×	×	√	√	√	×
Site 15	×	×	√	√	√	√	×
Site 16	√	√	×	×	√	√	√

Fig: 1 Showing availability % of NWFP in Joypur Forest in different sample site



The Joypur Forest Range situated in the Bankura district of West Bengal, India is a host to a very rich diversity with flora and fauna quite appropriate among them some good number of medicinal plants. The plant types are often employed into practice through traditional medicine systems, like Ayurveda, Unani, and Folk medicine. These plants not only have medicinal importance but also play their role in sustaining the local ecosystems and are endlessly catered to taking much more important dimensions of possible local economic growth, which includes:

Tab: 2 Medicinal Plants Found in Joypur Forest Range, Bankura and their utilities

Sl. No.	Common Local Name	Scientific Name	Uses
1	Aloe Vera	Aloe barbadensis miller	Other skin problems such burns and cuts as well as sunburn. To the intestinal health and for ailment in constipation.
2	Tulsi	Ocimum sanctum	It is used for the respiratory conditions, fever, and an adaptive mode for stress reduction.
3	Neem	Azadirachta indica	Conditions of skin like acne, eczema, and fungal infections.
4	Brahmi	Bacopa monnieri	To enhance memory, concentration, and cognitive abilities. This is additionally used for reducing anxiety and stress, and for promoting better mental clarity.

5	Ashwagandha	Withania somnifera	Reducing stress, improving energy levels, and boosting immunity. It is also used to enhance stamina and combat fatigue.
6	Giloy	Tinospora cordifolia	Treating fevers, respiratory infections, and in improving overall vitality and digestion.
7	Bael	Aegle marmelos	This is basically a remedy for most gastrointestinal conditions like indigestion, diarrhea, or constipation, among others. Antioxidant actions are also present in fruit.
8	Sarpagandha	Rauvolfia serpentina	Soothes high blood pressure and acts as a sedative. Helpful for anxiety and insomnia.
9	Turmeric	Curcuma longa	Relieve joint soreness, gut problems and also detox. It would be used externally for skin cases treatment.
10	Ginger	Zingiber officinale	Nausea, flatulence, and indigestion. It displays anti-inflammatory and antimicrobial properties as well.
11	Pipli	Piper longum	Recovering from coughs, asthma, bronchitis - treating such respiratory conditions. Indigestion and metabolism are improved by this remedy.
12	Moringa	Moringa oleifera	It boosts the immune system and thus helps in the treatment of malnutrition, treats conditions in skin, and also cures joint pain.
13	Curry Leaf	Murraya koenigii	Treat gastrointestinal ailments, revive tresses, and modify cholesterol levels. They are also used to cure diabetes cases and surface infections.
14	Sundari	Heritiera fomes	Treat of fever, wound, and an array of skin ailments. Known for its anti-inflammatory properties.
15	Chirayita	Swertia chirayita	Treat fevers, malaria, and liver disorders. The bitter herb is also used in traditional remedies to enhance digestion and treat intestinal worms.
16	Haritaki	Terminalia chebula	Constipation has well been cured, and with advanced digestion and better overall working of the gastrointestinal tract, these also boost immunity in the body.
17	Kalonji	Nigella sativa	Breathe easy with such conditions as asthma and bronchitis, and also solve digestive problems.

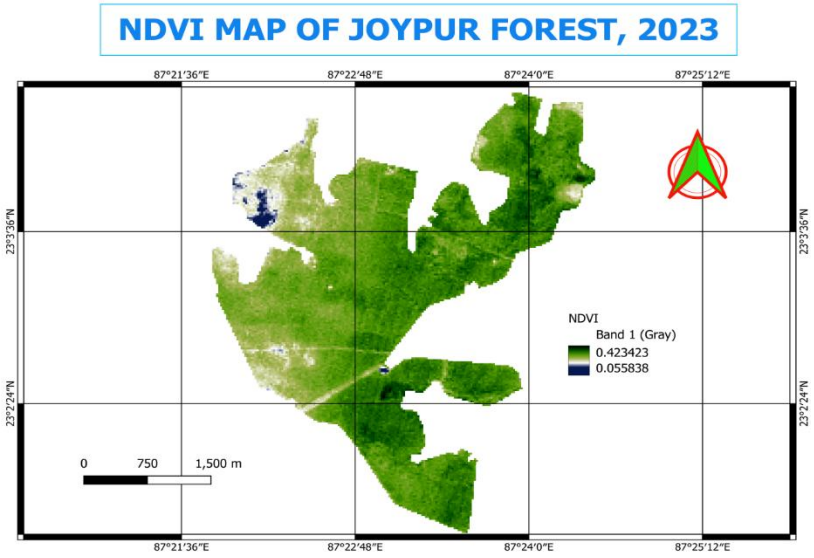
18	Ficus species	Ficus benghalensis, Ficus religiosa	There are a variety of diseases that can be cured. These include diabetes, respiratory illnesses, and infections of the skin.
19	Cinnamon	Cinnamomum verum	Sugar levels are regulated, and inflammation is reduced, alongside treating digestive disorders. Antimicrobial and antioxidant properties are also present.
20	Jatamansi	Nardostachys jatamansi	That's a treatment for nervous disorders, insomnia, and has improved mental clarity.
21	Saffron	Crocus sativus	It improves the mood, corrects the menstrual disorders, and nourishes the skin.
22	Shatavari	Asparagus racemosus	Aid in balancing hormonal levels, assist fertility, control menstruation, and help with lactation.
23	Wild Turmeric	Curcuma aromatica	Used for skincare and for its anti-inflammatory properties, this is often applied to curative wounds, bruises, and infections.
24	Bengal Quince	Aegle marmelos	It is used for the treatment of a digestive problem like diarrhea and also used in controlling blood sugar. Moreover, it can be a tonic for general health improvement.
25	Mahua	Madhuca longifolia	Tonic for the nervous system; also used for treatment purposes in skin diseases, fevers, and digestive disorders.

DATA INTERPRETATION

There are products from non-wood forests. They make the economy of rural communities dependent on forests. Examples of non-wood forest product sources in Joypur Forest in the Bankura District, West Bengal, include all forest products harvested without felling the trees: fruits, nuts, and medicinal plants, as well as bamboo, honey, and resins. They are used for subsistence and often also commercially; hence, their broad spectrum of economic, ecological, and cultural importance. Proceeds from trade in the NWFPs such as timber, tendu leaves, fruits, and herbs are available to local markets as well as regional or sometimes national markets. Such trading yields money to local markets and the state government by collection fees, taxes, and royalties levied on such specific forest products. Today, this constitutes an important aspect of the rural economy at Bankura because it creates revenues from collection, processing, and retail trade, among others, for the local population. The income generated from NWFPs often goes rather long in fulfilling the local needs and strengthens the local economy through petty micro-and informal trade networks. Its value has increased as the global demand for natural and herbal products continues to increase; thus, it assures a spotlight for the medicinal plants. Many of these plants are already being harvested not only for local use but are now going commercial for the flourishing Ayurvedic and wellness industry. Herbal medicines and health

supplements have a very significant local and national market. The forest houses many bees which produce wild honey and wax, a very valuable item. The honey of wild bees from Joypur forest has been collected, processed, and marketed in local and nearby regional markets. Seeds like karanj and sundari seeds that grow into the forest itself are ordinarily harvested for oil extraction or for use in medicines making. These products are consumed locally or commercially.

Fig: 2 NDVI Map showing the vegetation density on Joypur Forest



NDVI:

NDVI (Normalized Difference Vegetation Index) is a detail colour index used for assessing or monitoring vegetation, health and cover, usually by remote sensing. It evaluates vegetation by satellite or aerial imagery based on the difference in infrared (which vegetation reflects strongly) and visible light (absorbed by vegetation).

Formula:

The NDVI is calculated using the following formula:

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)}$$

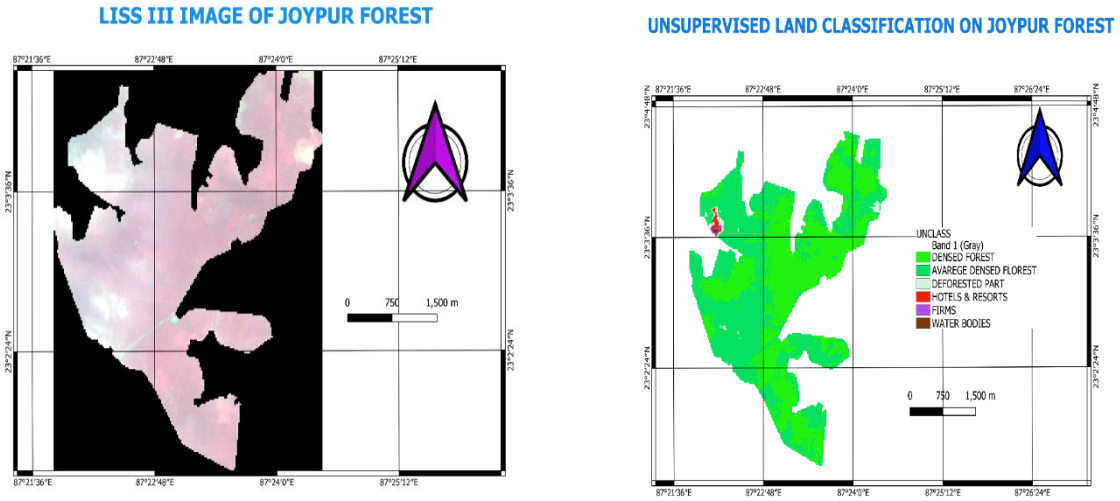
Where:

- **NIR (Near-Infrared)**: The reflectance in the near-infrared band of the electromagnetic spectrum (usually around 0.7–1.1 µm).
- **RED**: The reflectance in the red band of the electromagnetic spectrum (usually around 0.6–0.7 µm).

NDVI Values:

- +1 indicates dense, healthy vegetation.
- 0 indicates bare soil or non-vegetated surfaces.
- Negative values indicate water bodies, snow, or clouds.

Fig: 3 LULC Map on Joypur Forest to Show the Land Classification and its changes



The given image is an NDVI map for Joypur Forest in 2023. NDVI is widely applied to estimate vegetation health, density, and productivity. From the given image, following are the key observations.

The green channel, having dimensions of1448×2048seems to contain intensity values of grayscale, likely associated with NDVI. The range of values spans from 0 to 255, which is typical for 8-bit images.

Scale Grayscale to NDVI Range: The legend shows that the NDVI values range between 0.0558 and 0.4234. I will scale the grayscale values to this range.

Compute NDVI Statistics: Compute the mean, median, and distribution of the NDVI values.

Classify Vegetation Density: Classify NDVI values into classes such as dense, moderate, sparse, and non-vegetated.

NDVI Analysis Results:

Mean NDVI: 0.387- This suggests that the vegetation is moderately healthy in the forest.

Median NDVI: 0.423 - This indicates that a large proportion of the area is covered with dense vegetation.

Minimum NDVI: 0.056 - This value represents areas with sparse vegetation, bare soil, or water bodies.

Maximum NDVI: 0.423 - This value represents the regions with the densest vegetation.

LULC:

In an unsupervised context, Maximum Likelihood distributes a pixel to a class, based on the likelihood of assignment of the pixel to one or other classes given spectral signatures of its record.

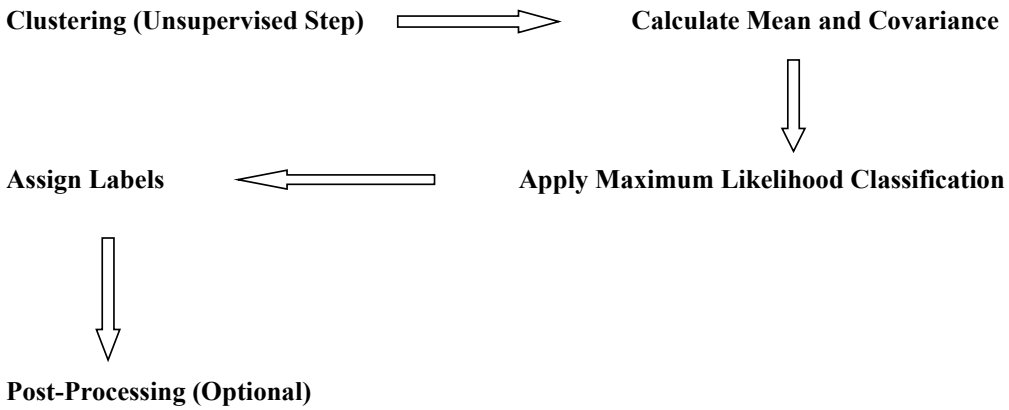
The general formula for Maximum Likelihood is:

$$P(Ci|x) = \frac{1}{(2\pi)^{n/2}|\Sigma_i|^{1/2}} \exp(-1/2(x-\mu_i)^T\Sigma_i^{-1}(x-\mu_i))$$

Where:

- P(Ci|x)P(C_i | x)P(Ci|x) = The probability that the pixel xxx belongs to class CiC_iCi.
- nnn = The number of spectral bands used (e.g., Red, Green, Blue, NIR).
- μi\mu_iμi = The mean vector of the class CiC_iCi in the feature space (for all bands).
- Σi\Sigma_iΣi = The covariance matrix for the class CiC_iCi, representing the variance and correlation between bands in the class.
- xxx = The spectral values (pixel values) of the pixel being classified across the bands.
- Σi−1\Sigma_i^{-1}Σi−1 = The inverse of the covariance matrix for class CiC_iCi.

Steps to Apply MLC in an Unsupervised Classification:



The given image represents a Land Use Land Cover (LULC) Map of Joypur Forest, where different kinds of land use categories have been depicted by colour.

Dense Forest- Dark Green: It consists of the densest portions of vegetation.

Average Dense Forest- Light Green: They are moderately vegetated ones.

Deforested Part- White: These have been cleared of vegetation.

Hotels & Resorts- Red: Built-up or tourist/ hospitality areas

Firms- Purple: This is for industrial or commercial purposes.

Water Bodies (Brown): Rivers, lakes, or other water resources.

Dense forest cover, the forest is generally in good condition but face possible pressure. There are patches of deforestation. This is mainly along built-up areas such as hotels, resorts, and firms. This may indicate that anthropogenic activities are responsible for land use changes.

Deforestation Trends: White areas (deforested areas) are usually adjacent to red zones (hotels and resorts) and purple zones (firms). This is a spatial correlation between human infrastructure and the loss of forests. Fragmentation could occur if this continues to happen, leading to an impact on biodiversity.

Effects of Built-Up Areas (Red and Purple Zones)

Hotels & Resorts (Red): Likely to cater to tourism, contributing to local economy but potentially exerting pressure on surrounding forest through land clearing, waste generation, and water resource consumption. Firms (Purple): Industrial zones could lead to pollution (air, water, and soil) and disrupt local wildlife habitats.

Conservation and Water Resources (Brown Zone)

Water bodies are scarce, mainly around the northern forest boundary. The scarcity of water could make the ecosystem vulnerable to climate change and human activities. Forest areas around water bodies should be conserved to ensure ecological balance.

MAJOR FINDINGS AND RECOMMENDATIONS

The quantification of Non-Wood Forest Products (NWFPs) and medicinal plants found in the Joypur Forest Range (JFR) is meaningful in terms of understanding the socio-economic and ecological roles that these NWFPs play. NWFPs, which include among others the fruits, seeds, resins, gums, honey, or itself as medicinal plants, are vital for livelihood sustenance of the people these local communities have, especially the rural and forest-dependent. So, such study broken down and its relevance to the local aspects:

1. Survey and Inventory of NWFP and Medicinal Plants

Quantification of Non-Timber Forest Products: This step will have to identify and catalog the various NWFPs available within the Joypur Forest Range through botanical surveys, engagement with local populations, and the use of forest management data. Important species include those yielding: edible fruits and nuts, resins and gums, fibers and leaves for craftwork, medicinal herbs and plants. Medicinal Plants: Many forest plants are used for medicinal purposes and have formed part of the systems of traditional medicine for centuries. Documentation and quantification of such species would include: identification of the most harvested medicinal plants, their abundance in different forest zones, understanding how and on which scale they have been harvested.

2. Utility to Local Communities

The uses of NWFP and medicinal plants to local communities within the Joypur Forest Range

have several dimensions: Economic Aspects: NWFPs contribute much to the economy of these forest-dependent populations. It is a source of income by selling them in local or urban markets. Livelihood support: It qualifies for the sustenance of rural households in seasons off from farming. Employment generation: Harvesting and processing NWFPs generate employment, especially for women and marginalized communities. Health and Traditional Medicine: Medicinal plants are essential inputs of traditional medicine in rural areas where modern health services are not comprehensive. Most of the households derive remedies for common ailments from these plants. Cultural importance: The use of medicinal plants goes back into the local traditions and cultures. Food Security: The NWFPs offer an added nutritional material to local communities, thus serving as food during hard times. Sustainable Development: NWFPs are harvested in a sustainable manner, which means they could be made ecologically friendly to manage forest resources in the environmentally sound way of avoiding deforestation and degradation.

3. Challenges in NWFP and Medicinal Plant Utilization

Overharvesting: Practices of extraction over great limits may threaten supplies of both NWFPs and medicinal plants, as well as perhaps make ecosystems unbalanced. Change in Climate: Variation in rainfall and temperature may be caused by the changes in both the physical as well as environmental factors in forest products. Market Access: Such a group really has difficulty accessing fair markets for its products and is dependent on agents who bring down the profit margin.

4. Sustainable Management Practices

Community Participation: Community-based forest resource planning and management will make sure that these resources are used judiciously and have long-term benefits. Training and Capacity Building: Awareness creation and training of local communities on sustainable harvesting methods and processing will improve the value and longevity of NWFP. Biodiversity Conservation: Protection from over-exploitation of some critical areas in the Joypur Forest Range can help save medicinal and other species of NWFPs.

5. Recommendations for Policy and Development

Enhance local economies by promoting NWFP-based industries e.g. herbal occupier products, food supplements, and access to markets for local collectors and producers, developing infrastructure networks. Promoting researchers for lesser known medicinal plants and their possible uses for locally or even for pharmaceutical applications on a larger scale. Capacity building and awareness programs can be taken for local communities to understand the importance of sustainable harvesting and forest conservation. Such research can bring forth benefits to local communities in socio-economic development and maintain ecological balance in the Joypur Forest Range.

CONCLUSIONS

The significant role Non-Wood Forest Products (NWFPs) play in the case of social and economic fabric of the Joypur Forest Range (JFR). Through a comprehensive analysis and going through various references, it has exploring that various NWFPs are found in the region.

So, it becomes evident that these useful resources actually contribute substantially to the subsistence of vicinal population segments, offering both indirect ecological services and direct economic benefits. The rich range of products, including fibers, medicinal plants, resins, and fruits, not only supports local dwellers but also encourages new sustainable forest management practices. However, the need for improved and scientific data for the quantification and sustainable harvesting of NWFPs is very crucial for ensuring long-term fruitful results. Additionally, integrating NWFPs into common economic strata and policy-making could pushing to their full potential while protecting rich biodiversity and promoting ecological sustainability in that region. Moving forward, there is an essential need for further field research on the market dynamics, value chains, supply chain, and the socio-economic impacts of NWFPs in the JFR to encompass their contribution to the local economy while ensuring their environmental conservation and management.

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