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**Title of Research Paper:** Integrating Traditional Knowledge and Geographic Tools for Sustainable Management of Medicinal Plants in Jharkhand, India

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## **Abstract**

Medicinal plants form a crucial part of healthcare systems in tribal societies of India, particularly in Jharkhand, where approximately 67% of the population depends on forests and their biodiversity. Tribal healers and local communities maintain vast traditional knowledge (TK) regarding plant uses, harvesting, and conservation. However, overexploitation, habitat destruction, and weak intergenerational transfer of knowledge are threatening these resources. Geographic tools such as Geographic Information Systems (GIS), Remote Sensing (RS), and Species Distribution Models (SDM) can complement TK by mapping resources, monitoring threats, and predicting species distributions. This paper explores the integration of traditional knowledge with geographic tools in Jharkhand, highlighting traditional practices, documenting representative species, and presenting a framework for sustainable management. The significance, challenges, and future perspectives are discussed with examples from ethno medicinal studies conducted across Jharkhand.

**Keywords:** Traditional Knowledge, GIS, Remote Sensing, Ethno botany, Sustainable Management, Tribal Communities

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## **Introduction**

Medicinal plants are considered a lifeline in tribal and rural health care systems. Globally, about 80% of the population relies on traditional medicine for primary health care<sup>1</sup> (World Health Organization, 2013). In India, more than 7,500 species of plants are used in folk medicine, with significant contributions from tribal communities<sup>2</sup> (Kala, 2015).

Jharkhand, a mineral-rich yet biodiversity-rich state in eastern India, supports about 30% forest cover. Major tribal groups such as Santhal, Munda, Oraon, and Ho communities rely heavily on “jari-but” (local medicinal plants) for treating ailments ranging from cough and skin diseases to more complex disorders like diabetes, jaundice, and urinary complaints<sup>3,4</sup> (Gupta et al., 2015; Ali Jinnah & Yadav, 2014). Tribal communities in Jharkhand depend heavily on medicinal plants not only for primary healthcare but also as sources of income, food and cultural practices<sup>5</sup> (Mishra & Pandey, 2021).

Despite this richness, medicinal plant resources face threats due to deforestation, mining, industrial expansion, and unsustainable harvesting. Simultaneously, traditional healers are aging, and oral knowledge transfer is weakening<sup>6</sup> (Singh et al., 2017). Thus, integrating traditional ethnobotanical knowledge with modern geographic tools is essential for scientific validation, conservation planning, and sustainable use. Government of India initiatives like the National Medicinal Plants Board (NMPB) are using GIS/RS for medicinal plant conservation, mapping MPCAs (Medicinal Plant Conservation Areas) and resource augmentation, which highlights the policy relevance of integrating TK and spatial tools<sup>7</sup> (NMPB, Ministry of AYUSH) (Remote Sensing & GIS, NMPB, 2022) (National Medicinal Plants Board, n.d.).

Thus, integrating TK with geographic tools is not merely academic: it is essential for preserving medicinal plant biodiversity, sustaining ecosystem services, supporting

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livelihoods, and encouraging policy alignment.

## Methods of Study:

This article synthesizes secondary ethnobotanical data and spatial analysis literature with emphasis on Jharkhand. Methods included:

## Ethno botanical Documentation Review

Surveys such as those conducted in Tamar Block<sup>3</sup> (Gupta et al., 2015), Santhal Pargana<sup>4</sup> (Ali Jinnah & Yadav, 2014), and mine-impacted lands of Dhanbad<sup>6</sup> (Singh et al., 2017) were analyzed for species composition, parts used, and preparation methods.

## Geographic Tool Assessment

Literature on applications of GIS and RS in mapping medicinal plants and ecological modeling was reviewed<sup>8</sup> (Pandey et al., 2020).

## Framework Development

An integrated work flow was developed combining TK and geographic data-emphasizing participatory GIS, habitat suitability modelling, and community-based conservation.

**Table 1. 1: Methodological Framework for Integrating Traditional Knowledge and Geographic Tools**

Step	Activity/Method	Description / Application in Jharkhand	Tools/Approach Used	Expected Outcome
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<b>1. Survey &amp; Documentation of TK</b>	Ethnobotanical field survey	Interaction with tribal healers (Ojha, Baidya, village elders) to record plant names, uses, preparation methods	Structured interviews, questionnaires, participatory rural appraisal (PRA)	Inventory of medicinal plants with local uses
<b>2. Plant Sample Collection &amp; Identification</b>	Collection of specimens from forests, sacred groves, village lands	Voucher specimens prepared, identified using herbarium & floras	Standard taxonomic methods	Verified list of medicinal species
<b>3. Geo-referencing of Species Locations</b>	Recording GPS coordinates of collected plants	Data collected across districts like Ranchi, Palamu, Gumla, Singhbhum	GPS devices, GIS software (ArcGIS/QGIS)	Database of medicinal plant occurrence
<b>4. Database Development</b>	Compilation of TK with spatial attributes	Linking plant use with geographic distribution	MS Excel, GIS attribute tables	Spatial ethnobotanical database
<b>5. Spatial Analysis</b>	Habitat suitability & threat analysis	Overlay of plant data with land use, soil, forest cover, mining zones	Remote sensing (Landsat, Sentinel), GIS spatial analysis	Maps of priority conservation zones
<b>Step</b>	<b>Activity/Method</b>	<b>Description / Application in Jharkhand</b>	<b>Tools/Approach Used</b>	<b>Expected Outcome</b>
<b>6. Validation with Local Communities</b>	Cross-checking results with community knowledge	Workshops, feedback meetings with tribal groups	Participatory mapping	Increased accuracy & acceptance of data

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<b>7.Conservation &amp; Cultivation Planning</b>	Identifying sustainable harvesting & cultivation sites	Linking high-use plants with suitable agro-zones	GIS-based zoning, suitability analysis	Action plan for sustainable management
<b>8. Policy &amp; Knowledge Dissemination</b>	Reporting results to stakeholders	Sharing with Forest Dept., NMPB, AYUSH & local communities	Reports, maps, awareness programs	Integration of TK into state-level planning

## 1. Results

### 1.1 Traditional Knowledge in Jharkhand:

More than 425 flowering plant species were recorded in Santhal Pargana alone, of which 105 were highly medicinal<sup>4</sup> (Ali Jinnah & Yadav, 2014).

Tamar Block of Ranchi district documented 144 species across 98 genera, belonging to 57 families, used against gastrointestinal, dermatological, and respiratory disorders<sup>3</sup> (Gupta et al., 2015).

*Rauwolfia serpentina*, *Holarrhena pubescens*, *Shorea robusta*, and *Abrus precatorius* are among commonly used species<sup>9</sup> (Singh et al., 2016).

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**Table 1. 2: Survey and Documentation of Traditional Knowledge on Medicinal Plants  
in Jharkhand**

<b>Survey Location (District/ Village)</b>	<b>Community / Tribe</b>	<b>MedicinalPlant (Local / ScientificName)</b>	<b>Traditional Uses</b>	<b>Mode of Preparation / Administration</b>	<b>Reference</b>
Mahuadanr, Latehar	Oraon, Birhor	<i>Azadirachtain dica</i> (Neem)	Skin infections, fever, wound healing	Pasteofleaves applied on wounds; decoction for fever	(Mishra& Pandey, 2021)

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Survey Location (District/ Village)	Community / Tribe	Medicinal Plant (Local / Scientific Name)	Traditional Uses	Mode of Preparation / Administration	Reference
Mahuadanr, Latehar	Munda	<i>Ocimum tenuiflorum</i> (Tulsi)	Cough, cold, asthma	Leaves boiled in water and consumed as herbal tea	(Kumar, 2022)
Bishunpur, Gumla	Asur, Oraon	<i>Phyllanthus emblica</i> (Amla)	Digestive aid, immunity booster	Raw fruit consumed; powder mixed with honey	(Pandey et al., 2020)
Bishunpur, Gumla	Munda	<i>Tinospora cordifolia</i> (Giloy)	Jaundice, fever, diabetes	Stem decoction given orally	(Singh et al., 2017)
Netarhat, Latehar	Birhor, Lohra	<i>Terminalia chebula</i> (Harra)	Constipation, skin problems	Fruit powder mixed with warm water	(Kumar, 2022)
Khunti villages	Munda, Ho	<i>Withania somnifera</i> (Ashwagandha)	Stress relief, stamina enhancer	Root powder with milk, taken at night	(Rasool, 2007)
Simdega	Oraon, Kharia	<i>Chlorophytum borivillanum</i> (Safed Musli)	Aphrodisiac, vitality	Root dried and powdered, mixed with honey	(Pandey et al., 2020)
Saranda Forest, West Singhbhum	Ho, Santhal	<i>Shorea robusta</i> (Sal-resin)	Wound healing, ritual use	Resin applied directly on cuts, burns	(Kumar, 2022)
Ranchi outskirts (Tamar, Angara blocks)	Oraon, Munda	<i>Curcuma longa</i> (Haldi / Turmeric)	Antiseptic, anti-inflammatory	Paste applied on wounds; powder used in milk	(Mishra & Pandey, 2021)

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Palamu (Betla National Parkfringe villages)	Chero, Oraon	<i>Swertiachirayita</i> (Chiraita)	Malaria,liver tonic	Decoctionof dried stems	(FAO, 2022)
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## Traditional Conservation Practices

Sacred groves act as micro-refugia and gene banks for medicinal flora.

Harvesting rules,such as avoidinguprootingwholeplantsor harvestingduringflowering, are common<sup>12</sup> (Kumar &Jha, 2017).Ex-situparksnearminingareasdemonstratecommunity-basedrestorationofendangered plants<sup>6</sup> (Singh et al., 2017).

## Geographic Tools in Action

Remote sensing has been used to detect mining-induced land degradation in Dhanbad<sup>6</sup> (Singh et al., 2017). GIS-based participatory mapping enabled tribal communities to geo-tag medicinal plants and sacred sites<sup>13</sup> (Farooque& Singh, 2024). Species Distribution Models (SDM) can predict future suitable habitats for *Rauwolfiaserpentina* and other threatened species under climate change scenarios<sup>8</sup> (Pandey et al., 2020).

**Table 1. 3: Integration of Medicinal Plants and Geographic Tools in Jharkhand**

Medicinal Plant (Local/Scientific name)	Traditional Uses (Jharkhand Tribes)	Threats/Conservation Needs	Geographic ToolsApplied/ Potential Use	Reference
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<b>Neem</b> ( <i>Azadirac htaindica</i> )	Antiseptic, skin diseases, fever, wound healing	Overharvesting, habitat loss near settlements	GIS-based mapping of population density; RSto detect canopy health	(Mishra & Pandey, 2021; NMPB, 2022)
<b>Tulsi</b> ( <i>Ocimum tenuiflorum</i> )	Cold, cough, fever, asthma	Declined due to land-use change and erosion of TK	Spatial mapping of cultivation sites; suitability mapping using soil-climate layers	(Pandey et al., 2020; Kumar, 2022)
<b>Amla</b> ( <i>Phyllanthus emblica</i> )	Vitamin C source, immunity booster, digestive tonic	Overexploitation for fruit and medicinal use	Remote sensing to monitor fruiting regions; GIS to assess harvesting pressure	(Singhet al., 2017; NMPB, 2022)
<b>Ashwagandha</b> ( <i>Withania somnifera</i> )	Stress relief, stamina, anti-inflammatory	Decline in wild populations, unsustainable collection	Habitat suitability mapping using GIS; ex-situ cultivation Zoning	(Kumar, 2022; NMPB, 2022)
<b>Medicinal Plant (Local/Scientific name)</b>	<b>Traditional Uses (Jharkhand Tribes)</b>	<b>Threats/Conservation Needs</b>	<b>Geographic Tools Applied/Potential Use</b>	<b>Reference</b>
<b>Harra</b> ( <i>Terminalia chebula</i> )	Digestive issues, skin disorders	Mining-affected areas, deforestation	RSto monitor dry tropical forest zones; GIS overlay with mining impact maps	(Singh et al., 2017)

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<b>Baheda</b> ( <i>Terminalia bellirica</i> )	Eyediseases, cough, liver ailments	Habitatdegradation, fragmentation	Spatial prioritizationfor restoration; GIS for corridor connectivity	(Mishra& Pandey, 2021)
<b>Saltree</b> ( <i>Shorea robusta</i> – resin used)	Traditional woundhealer, ritual uses	Logging, forest degradation	RS to monitor forest cover change;GIS to identify conservation hotspots	(Kumar, 2022)
<b>Giloy</b> ( <i>Tinospora cordifolia</i> )	Immunity booster, fever, diabetes	Overharvesting, agricultural expansion	GIS mapping of climatically suitable zones; RS for monitoring vegetation health	(Pandey et al., 2020)
<b>Chiraita</b> ( <i>Swertia chirayita</i> )	Malaria, liver tonic	Rare in wild, high market demand	Habitat niche modeling(GIS); RS for altitude-specific distribution	(FAO, 2022; NMPB, 2022)
<b>Safed Musli</b> ( <i>Chlorophytum borivilianum</i> )	Aphrodisiac, vitality, anti-inflammatory	Critically threatened due to trade	RS-GIS to detect rare habitats; GIS aided conservation farming mapping	(Kumar, 2022; NMPB, 2022)

Summary and discussion

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The ethno medicinal heritage of Jharkhand illustrates deep human–environment connections, but significant documentation gaps remain, as traditional knowledge (TK) is often confined

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within healer lineages. Geographic tools offer a valuable opportunity to validate and preserve this knowledge through spatial mapping of resource-rich areas, monitoring forest loss and species decline, and predictive modelling to anticipate the impacts of climate change. The integration of TK with Geographic Information Systems (GIS) not only contributes to biodiversity conservation but also empowers local communities by recognizing their vital role in resource governance<sup>15</sup> (Sharma & Ojha, 2016). At the same time, ethical safeguards such as Free, Prior, and Informed Consent (FPIC) are essential to ensure community rights and to prevent the risk of biopiracy.

## **Significance of findings**

- a) Documentation of Diversity: Evidence of >400 medicinal plant species demonstrates Jharkhand's untapped potential for drug discovery.
- b) Role of Communities: Local practices of conservation (sacred groves, harvest rules) highlight community stewardship in sustainable management.
- c) Applied Geographic Tools: Demonstrated ability of GIS/RS to map, monitor, and forecast medicinal plant availability under ecological threats.
- d) Conservation Prioritization: Data enable policy maker stop prioritize hot spots for protection and sustainable use.

## **Future Perspectives**

- a) Establish community-driven GIS databases for real-time monitoring of medicinal plants.
- b) Integrate herbal gardens in educational institutions for ex-situ conservation and youth engagement.
- c) Promote biocultural protocols to safeguard community rights under the Nagoya Protocol.

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- d) Develop climate-adaptive cultivation strategies for vulnerable species like *Rauwolfiaserpentina*.
- e) Expand interdisciplinary collaborations among botanists, geographers and local healers.

## Conclusion

The fusion of traditional ethno medicinal knowledge and geographic tools represents a promising pathway for conserving Jharkhand's medicinal plant diversity. While TK provides centuries-old wisdom of sustainable use, GIS and RS provide modern precision in mapping, modelling, and management. A balanced, ethical, and participatory framework can ensure that medicinal plant resources continue to serve local communities while contributing to global health and biodiversity goals.

## Acknowledgement

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