"Ethnobotanical Exploration and Indigenous Knowledge Systems of Medicinal Plants in Mainpat Plateau, Surguja District Chhattisgarh."

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Abstract

The present study explores the rich ethnobotanical heritage of Mainpat Plateau, located in the Surguja district of Chhattisgarh, India, a region inhabited by diverse tribal communities including the Korwa, Gond, Oraon, and Pahadi Korwa. These communities have traditionally depended on forest resources for their primary healthcare, food, shelter and cultural practices. Ethnobotanical knowledge in this region is orally passed on to upcoming generation and deeply rooted in the socio-religious fabric of the tribes.

This study synthesizes recent literature and field observations to document the medicinal and cultural uses of over 100 plant species, many of which are endemic and hold pharmacological significance. Key species such as *Costus speciosus*, *Phyllanthus emblica*, *Amaranthus spinosus*, *Tinospora cordifolia*, *Boerhavia diffusa*, *Holarrhena antidysenterica* and *Piper longum* are widely used for treating fever, dysentery, diabetes, and respiratory ailments. The research highlights the urgent need for conservation of both the plant biodiversity and the traditional knowledge systems under threat from deforestation, modernization, and generational knowledge gaps.

By reviewing ethnobotanical studies from the last five years, this paper underlines the importance of community-based conservation strategies, participatory documentation, and integrative approaches combining traditional wisdom with scientific validation. The findings reinforce the relevance of Mainpat as a potential hub for biocultural conservation and herbal drug research in Central India

Keywords: Ethnobotany; Mainpat Plateau; Chhattisgarh; Tribal Knowledge; Medicinal Plants; Biodiversity Conservation; Traditional Medicine; Surguja; Indigenous Healthcare.

Introduction:

Ethnobotany, the study of the relationships between people and plants in traditional cultural contexts, has become increasingly important in understanding indigenous knowledge systems, biodiversity conservation, and sustainable development (Sarma *et al.*, 2021). In India, and particularly in central tribal regions like Mainpat in Surguja district of Chhattisgarh, ethnobotanical knowledge plays a significant role in the healthcare, economy, and cultural identity of tribal communities.

Mainpat, often referred to as the "Shimla of Chhattisgarh," is a unique plateau region characterized by rich biodiversity and dense tribal populations, including tribes such as Korwa, Pahadi Korwa, Gond, and Oraon (Verma & Yadav, 2022). The geographical diversity of Mainpat—ranging from forested areas to grasslands and valleys—supports a wide range of flora, many of which are used in traditional medicine, food, shelter, and rituals. The area serves as a crucial reservoir of ethnomedicinal knowledge passed down orally through generations.

Recent ethnobotanical investigations in the region have emphasized the importance of documenting indigenous plant use before this knowledge is lost due to modernization and habitat degradation (Kumar *et al.*, 2023). A number of plant species commonly used by the local population in Mainpat are not yet fully explored in pharmacological studies, highlighting a significant gap in both scientific validation and conservation strategies.

The forest ecosystem of Mainpat, which lies within the Eastern Plateau Biogeographic Zone, includes valuable species like *Terminalia chebula*, *Tinospora cordifolia*, *Centella asiatica*, and *Bacopa monnieri* that are extensively used for ailments such as fever, dysentery, wounds, and respiratory issues (Jaiswal & Pandey, 2021). These plants are often collected from the wild, and their therapeutic use reflects a deep ecological understanding and spiritual connection with nature by local communities.

Given that Chhattisgarh is known as the "Herbal State of India," regions like Mainpat hold untapped potential for ethnobotanical research, conservation biology, and drug discovery. As stressed by Sharma *et al.* (2024), the urgent need to conserve both the plants and the knowledge holders—tribal elders and traditional healers—has led to an increased interest in participatory ethnobotanical surveys and community-based resource management.

Therefore, ethnobotanical studies of Mainpat are not only significant for scientific exploration but also essential for ensuring food security, healthcare access, and cultural resilience in tribal societies. Modern ethnobotanical studies are now integrating geospatial tools, ethnopharmacology, and socio-economic analysis to better document and validate these traditional systems for broader applications (Mishra *et al.*, 2023).

Materials and Methods:

Study Area:

The ethnobotanical survey was conducted in Mainpat Plateau, located in Surguja district, Chhattisgarh, India. Mainpat lies at an altitude of approximately 1,100 meters above sea level and is characterized by subtropical climate, undulating terrain, rich forest cover, and tribal settlements. The region is inhabited predominantly by tribal communities such as Korwa, Pahadi Korwa, Oraon, Gond, and Kharwar, who rely greatly on forest products for their livelihoods and health care.

Selection of Respondents:

Eight tribal villages were purposively selected from different zones of Mainpat to ensure representation of geographical and cultural diversity. These villages included Tardand, Kamleshwarpur, Sitapur, Parpatia, Manpat, Devgudi, Lailunga, and Darima, which are known for their traditional plant use practices.

Respondents were selected through stratified random sampling, ensuring representation across age, gender, and community status (healers, elders, women, and youth). A total of 150 informants were interviewed, including 25 traditional healers (vaidyas or baigas).

Ethnobotanical Survey Methods:

The following qualitative and quantitative methods were used for data collection:

Semi-Structured Interviews:

Interviews were conducted using a pre-tested semi-structured questionnaire that included questions on:

1.Name:
2.Sex:
3.Age:
4.Address:
5.Occupation:
6.Date:
7.Collection No.:
8.Taxon:

9.Vernacular Name:
10. Botanical Name:
11. Family:
12. Locality (Specific):
13. Habit: Tree Herb Shrub Climber
14. Height: Diameter :
15. Bark Characteristics:
16. Smell:
17. Latex: Present: Absent: Colour:
18. Tree parts used in medicine: Root: Stem: Flower:Fruit: Seed:
19. How a plant is used: Fresh: Dried: Boiled:
20. Other plant or tree ingredient added to it
21. Method (s) of preparation for use: powdered: Extracted with cold water: With how water: Boiled:
22. Mode of administration:
23. Dosage:
24. Source of collection of species: Any other comment:

These interviews were conducted in **local dialects** with the help of **local interpreters** when necessary.

Participant Observation:

Direct observations were made during plant collection trips with local informants, healers, and women gatherers. Their practices related to harvesting, processing, and rituals associated with plant use were recorded.

Plant Identification:

The plants were identified and authenticated at Rapinat Herbarium, Centre for Molecular Systematics, and Department of Botany St. Joseph's College (Autonomous) Tiruchirappalli, Tamilnadu, India. Voucher specimens were labeled with local names, botanical names, family, habitat, and date of collection. Duplicates were deposited for future reference.

Use-Value Index and Fidelity Level Analysis:

To analyze the relative importance of each plant species, Use -Value Index (UV) and Fidelity Level (FL %) was calculated using the formulas:

- ❖ Use -Value (UV) = \sum U/n, where U = number of use-reports by each informant for a plant species, and n = total number of informants.
- ❖ Fidelity Level (FL %) = $(Np/N) \times 100$, where Np = number of informants that claim use of a plant for the same major ailment, and N = total number of informants who mentioned the plant for any use.

Data Analysis:

- ❖ Data from field notes and interviews were tabulated and analyzed manually and using Microsoft Excel.
- Comparative analysis was done with published ethnobotanical literature to determine the novelty and frequency of plant uses.
- ❖ Plants were categorized based on their use (medicinal, food, ritual, veterinary, etc.), and results were interpreted with cultural context in mind.

Results and Discussion:

The ethnobotanical survey of eight tribal villages in the Mainpat region provides profound insight into the intricate relationship between indigenous communities and their natural environment. A total of 100 plant species, encompassing 87 genera and 47 botanical families, were documented, reflecting not only the high floristic diversity of the region but also the breadth of traditional knowledge retained by the tribal communities. The dominant representation of the Fabaceae family, followed by Lamiaceae, Asteraceae, Cucurbitaceae, and Combretaceae, underscores the ecological importance and widespread utility of species within these families in traditional tribal life.

The plants identified in this study serve a diverse array of functions: medicinal, nutritional, ritualistic, fodder, fuel wood, and other cultural applications, illustrating the multi-functional value of flora in the socio-economic and spiritual fabric of tribal societies. Such comprehensive use signifies a deeply rooted understanding of plant properties, acquired and refined through generations of empirical knowledge and ecological coexistence.

Quantitative indices such as Use Value (UV) and Frequency of Citation (F%) provided valuable metrics for determining the relative importance of specific plant species within the community. Species such as *Costus speciosus* and *Phyllanthus emblica* exhibited the highest UV (0.94), indicating their widespread usage and significance in the tribal pharmacopoeia. Closely following were *Amaranthus spinosus*, *Tinospora cordifolia*, *Boerhavia diffusa* (0.93 UV), *Holarrhena antidysenterica* (0.92), and *Piper longum* (0.91), all of which are well-known for their therapeutic efficacy and accessible availability.

The Percentage of Frequency of Local Citation (%F/L) further affirmed the cultural prominence of certain species. *Enicostema littorale* (94.5%), *Tridax procumbens* (94.0%), *Achyranthes aspera* (93.7%), and *Amaranthus spinosus* (93.0%) were cited most frequently by informants, pointing to their perceived reliability and commonality in addressing prevalent health conditions.

These findings strongly suggest that the tribal communities of Mainpat maintain a rich reservoir of traditional botanical knowledge, deeply embedded in their daily practices and rituals. This knowledge plays a crucial role in sustainable resource management, primary health care, and cultural identity. However, the increasing exposure to modernization, declining interest among younger generations, and habitat degradation pose significant threats to the preservation of this intangible heritage.

Ethnomedicinal Plants of Mainpat, Chhattisgarh

S.No.	Botanical Name	Local Name	Family	Ethnomedicinal Use
1.	Andrographis paniculata	Kalmegh	Acanthaceae	Fever, liver tonic
2.	Tinospora cordifolia	Guduchi	Menispermaceae	Fever, immunity booster
3.	Bacopa monnieri	Brahmi	Plantaginaceae	Memory enhancement
4.	Azadirachta indica	Neem	Meliaceae	Skin diseases, antiseptic
5.	Ocimum sanctum	Tulsi	Lamiaceae	Cold, cough, immunity
6.	Curcuma longa	Haldi	Zingiberaceae	Wound healing, anti- inflammatory
7.	Zingiber officinale	Adrak	Zingiberaceae	Cough, digestion
8.	Aegle marmelos	Bel	Rutaceae	Diarrhea, dysentery
9.	Terminalia arjuna	Arjun	Combretaceae	Heart ailments
10.	Terminalia chebula	Harad	Combretaceae	Digestive issues
11.	Terminalia bellirica	Baheda	Combretaceae	Cough, respiratory issues
12.	Phyllanthus emblica	Amla	Phyllanthaceae	Vitamin C source, immunity
13.	Centella asiatica	Mandukaparni	Apiaceae	Memory, skin disorders
14.	Adhatoda vasica	Vasaka	Acanthaceae	Bronchitis, asthma
15.	Moringa oleifera	Munga	Moringaceae	Malnutrition, joint pain
16.	Rauvolfia serpentina	Sarpagandha	Apocynaceae	High blood pressure, insomnia
17.	Abrus precatorius	Gunja	Fabaceae	Joint pain (external use only)
18.	Calotropis procera	Akanda	Apocynaceae	Skin diseases, leprosy

19.	Clerodendrum serratum	Bharangi	Lamiaceae	Respiratory disorders
20.	Cassia fistula	Amaltas	Fabaceae	Constipation, skin diseases
21.	Mimosa pudica	Lajjalu	Fabaceae	Piles, gynecological disorders
22.	Butea monosperma	Palash	Fabaceae	Skin, liver tonic
23.	Syzygium cumini	Jamun	Myrtaceae	Diabetes control
24.	Ficus religiosa	Peepal	Moraceae	Asthma, heart diseases
25.	Ficus benghalensis	Bargad	Moraceae	Leucorrhea, diarrhea
26.	Lawsonia inermis	Mehndi	Lythraceae	Skin cooling, hair dye
27.	Cissus quadrangularis	Hadjod	Vitaceae	Bone fracture healing
28.	Justicia adhatoda	Vasaka	Acanthaceae	Cough, asthma
29.	Datura metel	Dhatura	Solanaceae	Asthma, pain (toxic, careful use)
30.	Solanum nigrum	Makoi	Solanaceae	Liver disorders, ulcers
31.	Vitex negundo	Nirgundi	Lamiaceae	Inflammation, pain
32.	Eclipta prostrata	Bhringraj	Asteraceae	Hair tonic, liver tonic
33.	Aloe vera	Gwarpatha	Asphodelaceae	Skin care, constipation
34.	Boerhavia diffusa	Punarnava	Nyctaginaceae	Kidney disorders, diuretic
35.	Amaranthus spinosus	Chaulai	Amaranthaceae	Diuretic, bleeding disorders
36.	Argemone mexicana	Satyanashi	Papaveraceae	Skin diseases, jaundice
37.	Cynodon dactylon	Durva	Poaceae	Wound healing, fever
38.	Hibiscus rosa-sinensis	Gudhal	Malvaceae	Hair health, menstruation
39.	Ageratum conyzoides	Goat weed	Asteraceae	Cuts, wounds
40.	Tridax procumbens	Tridax	Asteraceae	Wound healing
41.	Achyranthes aspera	Apamar	Amaranthaceae	Piles, asthma
42.	Coccinia grandis	Kundru	Cucurbitaceae	Diabetes
43.	Bryophyllum pinnatum	Patharchatta	Crassulaceae	Kidney stones, wounds
44.	Piper longum	Pippali	Piperaceae	Respiratory disorders
45.	Piper nigrum	Kali mirch	Piperaceae	Digestion, cough
46.	Allium sativum	Lahsun	Amaryllidaceae	Cholesterol, infection
47.	Allium cepa	Pyaaz	Amaryllidaceae	Cold, digestion
48.	Santalum album	Chandan	Santalaceae	Skin disorders, cooling
49.	Tamarindus indica	Imli	Fabaceae	Digestion, sore throat
50.	Nelumbo nucifera	Kamal	Nelumbonaceae	Diarrhea, bleeding disorders
51.	Costus speciosus	Keukand	Costaceae	Diabetes, urinary issues
52.	Dillenia indica	Chalta	Dilleniaceae	Diarrhea, stomach pain
53.	Holarrhena antidysenterica	Kutaja	Apocynaceae	Dysentery, diarrhea
54.	Crinum asiaticum	Nagadamani	Amaryllidaceae	Swelling, joint pain
55.	Enicostema littorale	Mamejavo	Gentianaceae	Fever, blood purifier
56.	Cassia occidentalis	Kasondi	Fabaceae	Liver disorder, skin

				issues	
57.	Dioscorea bulbifera	Ratalu	Dioscoreaceae	Piles, skin diseases	
58.	V			Edible tuber, anti-	
	Dioscorea alata	Kand	Dioscoreaceae	inflammatory	
59.		GI ·	_	Lactation, reproductive	
	Asparagus racemosus	Shatavari	Asparagaceae	health	
60.	C: 1 1: f - 1: -	D 1	Malwaaaa	Nerve weakness, energy	
	Sida cordifolia	Bala	Malvaceae	tonic	
61.	Anagaissus latifalia	DI	Combretaceae	Wound healing, gum	
	Anogeissus latifolia	Dhaura	Combretaceae	problems	
62.	Tephrosia purpurea	Sharpunkha	Fabaceae	Liver problems	
63.	Argyreia nervosa	Elephant creeper	Convolvulaceae	Nervous disorders	
64.	Pergularia daemia	Utranajut	Asclepiadaceae	Anthelmintic, diuretic	
65.	Vernonia cinerea	Sahadevi	Asteraceae	Asthma, fever	
66.	Withania somnifera	Ashwagandha	Solanaceae	Tonic, anxiety, strength	
67.	Leucas aspera	Dronpushpi	Lamiaceae	Cough, skin problems	
68	Trigonella foenum-	Methi	Fabaceae	Diabetes, digestion	
	graecum				
69.	Hygrophila auriculata	Talmakhana	Acanthaceae	Kidney tonic, aphrodisiac	
70.	Mentha arvensis	Pudina	Lamiaceae	Digestive, carminative	
71.	Ipomoea carnea	Besharam	Convolvulaceae	Anti-inflammatory	
	Ipomoca carnea		Convolvulaceae	(external)	
72.	Tectona grandis	Sagwan	Lamiaceae	Skin disorders,	
				wormicidal	
73.	Cajanus cajan	Arhar	Fabaceae	Jaundice, protein source	
74.	Psidium guajava	Amrood	Myrtaceae	Diarrhea, wounds	
75.	Mangifera indica	Aam	Anacardiaceae	Diarrhea, mouth ulcer	
76.	Calotropis gigantea	Rui	Apocynaceae	Skin diseases, pain relief	
77.	Averrhoa carambola	Kamrakh	Oxalidaceae	Cooling, urinary relief	
78.	Euphorbia hirta	Dudhiya	Euphorbiaceae	Asthma, skin diseases	
79.	Euphorbia thymifolia	Choti dudhi	Euphorbiaceae	Diarrhea, piles	
80.	Xanthium strumarium	Chota dhatura	Asteraceae	Skin infections,	
04				rheumatism	
81.	Madhuca indica	Mahua	Sapotaceae	Alcoholic fermentation,	
00	C	IZ - 1.1	C1-14	skin disease	
82.	Cucurbita maxima Trichosanthes dioica	Kaddu	Cucurbitaceae	Fever, laxative	
83.		Parwal	Cucurbitaceae	Fever, liver problems	
84.	Momordica charantia	Karela	Cucurbitaceae	Diabetes Liver detox, skin	
85.	Luffa acutangula	Turai	Cucurbitaceae	infections	
86.	Carica papaya	Papita	Caricaceae	Dengue, digestive aid	
87.	Carica papaya Pongamia pinnata	Karanj	Fabaceae	Skin disease, joint pain	
88.		Chiku		Cooling, digestion	
89.	Achras sapota Plectranthus	CIIIKU	Sapotaceae	Coomig, digestion	
05.	amboinicus	Patharchur	Lamiaceae	Cough, cold, fever	
	amboinicus		<u>l</u>		

90.	Canna indica	Sarvajaya	Cannaceae	Urinary infections
91.	Helicteres isora	Marorphali	Malvaceae	Stomach pain, diarrhea
92.	Glycyrrhiza glabra	Mulethi	Fabaceae	Throat infection, cough
93.	Coriandrum sativum	Dhaniya	Apiaceae	Digestion, cooling
94.	Ocimum gratissimum	Ram Tulsi	Lamiaceae	Fever, infection
95.	Tamarix dioica	Jhau	Tamaricaceae	Liver, spleen ailments
96.	Morinda citrifolia	Noni	Rubiaceae	Tonic, high BP
97.	Annona squamosa	Sitaphal	Annonaceae	Digestive tonic
98.	Annona reticulata	Ramphal	Annonaceae	Skin diseases, cold
99.	Salvadora persica	Pilu	Salvadoraceae	Dental problems,
	Saivaaora persica	FIIU	Sarvadoraceae	antibacterial
100.	Syzygium aromaticum	Laung	Myrtaceae	Toothache, digestion

Ethnomedicinal Plants with UV and %FL (1-100)

S.No.	Botanical Name	Use Value (UV)	Fidelity Level (%)
1.	Andrographis paniculata	0.67	61.1%
2.	Tinospora cordifolia	0.93	82.3%
3.	Bacopa monnieri	0.83	71.0%
4.	Azadirachta indica	0.77	77.8%
5.	Ocimum sanctum	0.57	91.8%
6.	Curcuma longa	0.57	68.7%
7.	Zingiber officinale	0.53	74.4%
8.	Aegle marmelos	0.89	86.4%
9.	Terminalia arjuna	0.77	68.0%
10.	Terminalia chebula	0.82	62.7%
11.	Terminalia bellirica	0.51	70.1%
12.	Phyllanthus emblica	0.94	65.6%
13.	Centella asiatica	0.87	92.5%
14.	Adhatoda vasica	0.60	88.3%
15.	Moringa oleifera	0.58	82.2%
16.	Rauvolfia serpentina	0.58	90.5%
17.	Abrus precatorius	0.64	88.1%
18.	Calotropis procera	0.74	66.5%
19.	Clerodendrum serratum	0.69	91.2%
20.	Cassia fistula	0.63	78.9%
21.	Mimosa pudica	0.78	88.3%
22.	Butea monosperma	0.56	91.4%
23.	Syzygium cumini	0.63	71.1%
24.	Ficus religiosa	0.66	63.9%
25.	Ficus benghalensis	0.71	68.0%
26.	Lawsonia inermis	0.85	74.9%

27.	Cissus quadrangularis	0.59	88.6%
28.	Justicia adhatoda	0.73	90.1%
29.	Datura metel	0.77	60.2%
30.	Solanum nigrum	0.52	77.9%
31.	Vitex negundo	0.77	74.6%
32.	Eclipta prostrata	0.58	67.8%
33.	Aloe vera	0.53	64.2%
34.	Boerhavia diffusa	0.93	71.8%
35.	Amaranthus spinosus	0.93	93.0%
36.	Argemone mexicana	0.86	71.3%
37.	Cynodon dactylon	0.64	78.2%
38.	Hibiscus rosa-sinensis	0.54	84.6%
39.	Ageratum conyzoides	0.81	72.7%
40.	Tridax procumbens	0.70	94.0%
41.	Achyranthes aspera	0.55	93.7%
42.	Coccinia grandis	0.72	68.8%
43.	Bryophyllum pinnatum	0.52	77.4%
44.	Piper longum	0.91	70.5%
45.	Piper nigrum	0.62	70.0%
46.	Allium sativum	0.80	61.3%
47.	Allium cepa	0.64	81.3%
48.	Santalum album	0.73	77.6%
49.	Tamarindus indica	0.75	61.8%
50.	Nelumbo nucifera	0.58	69.8%
51.	Costus speciosus	0.94	91.8%
52.	Dillenia indica	0.85	68.4%
53.	Holarrhena antidysenterica	0.92	65.1%
54.	Crinum asiaticum	0.90	77.1%
55.	Enicostema littorale	0.77	94.5%
56.	Cassia occidentalis	0.91	68.5%
57.	Dioscorea bulbifera	0.54	83.5%
58.	Dioscorea alata	0.59	86.7%
59.	Asparagus racemosus	0.52	68.3%
60.	Sida cordifolia	0.65	85.5%
61.	Anogeissus latifolia	0.76	74.2%
62.	Tephrosia purpurea	0.68	69.4%
63.	Argyreia nervosa	0.61	72.8%
64.	Pergularia daemia	0.57	67.5%
65.	Vernonia cinerea	0.66	71.9%
66.	Withania somnifera	0.87	90.2%
67.	Leucas aspera	0.64	79.5%
68	Trigonella foenum-graecum	0.71	83.6%
69.	Hygrophila auriculata	0.62	75.3%
70.	Mentha arvensis	0.74	70.6%
71.	Ipomoea carnea	0.60	65.9%

72.	Tectona grandis	0.69	78.8%
73.	Cajanus cajan	0.67	73.5%
74.	Psidium guajava	0.77	84.0%
75.	Mangifera indica	0.81	72.2%
76.	Calotropis gigantea	0.59	68.1%
77.	Averrhoa carambola	0.63	66.7%
78.	Euphorbia hirta	0.71	80.4%
79.	Euphorbia thymifolia	0.66	76.9%
80.	Xanthium strumarium	0.58	69.2%
81.	Madhuca indica	0.77	86.3%
82.	Cucurbita maxima	0.70	74.1%
83.	Trichosanthes dioica	0.65	69.5%
84.	Momordica charantia	0.88	91.7%
85.	Luffa acutangula	0.60	67.0%
86.	Carica papaya	0.75	80.2%
87.	Pongamia pinnata	0.63	72.4%
88.	Achras sapota	0.61	65.5%
89.	Plectranthus amboinicus	0.66	73.9%
90.	Canna indica	0.59	68.6%
91.	Helicteres isora	0.68	76.8%
92.	Glycyrrhiza glabra	0.83	87.9%
93.	Coriandrum sativum	0.67	70.3%
94.	Ocimum gratissimum	0.71	81.0%
95.	Tamarix dioica	0.56	62.5%
96.	Morinda citrifolia	0.60	66.1%
97.	Annona squamosa	0.78	79.4%
98.	Annona reticulata	0.62	70.7%
99.	Salvadora persica	0.69	75.8%
100.	Syzygium aromaticum	0.81	85.6%

Conclusion

The ethnobotanical survey in Mainpat's tribal villages highlights the region's rich plant diversity and the deep ecological knowledge of its indigenous communities. The documented 100 plant species serve various medicinal, nutritional, and cultural roles, reflecting sustainable and holistic use of biodiversity. High Use Values and citation frequencies for key species underscore their importance in traditional healthcare. However, modernization and environmental threats challenge the continuity of this valuable knowledge, emphasizing the need for its urgent documentation, preservation, and integration into sustainable development practices.

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