Cultural and livelihood relationship between medicinal trees at-risk and indigenous people of Madhya Pradesh

Abhay Kumar Patil and Kaushalendra Kumar Jha

Correspondence

Abhay Kumar Patil and Kaushalendra Kumar Jha*

Technical Forestry, Indian Institute of Forest Management, Bhopal, Madhya Pradesh 246 003 India.

*Corresponding Author: jhakk1959@gmail.com

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Research

Abstract

Background: Indigenous communities depended on forest resources for food, shelter, health care and cultural need throughout the world. Such association existed in central India too where many medicinal trees are at risk due to their worrisome conservation status. Therefore, the study was taken to understand the dependency of indigenous people on medicinal trees at-risk (MTR) for livelihood, medicinal use, and their cultural need.

Methods: Qualitative methods of research (questionnaire survey, structured interview and focus group discussion) along with quantitative method (field survey: crop availability and regeneration status) were employed.

Results: Medicinal trees were the part of their culture as they used them in family functions and religious ceremonies. The MTR products were used for health care along with some livelihood options (sale of gums and resins), though with low dependency. Two cross culture use models showing people-MTR relationship could be developed using basic and published information: i. plant-ailment-community and ii. ailment-plant-community. Indigenous Traditional Knowledge (ITK) related to these trees was disappearing due to noninvolvement of youth in traditional occupation, reduced use and resources were on decline due to poor regeneration, climatic events-based (drought, flash flood) and natural (stem hollowness) damages.

Conclusion: Though the dependency was low, survival of MTR as well as ITK was in danger. For their conservation, a mechanism of shared management responsibility and revisit of *nistar* policy (free of cost use of forest resources) is suggested along with detail recording and promotion of ITK.

Keywords: Traditional knowledge; cross cultural model; tree damages; regeneration status; management

Background

About eighty percent of the world's developing population still depend on indigenous medicines, and a large population in remote and rural areas uses these medicines as their first line of defense against many ailments (Goleniowski et al. 2006), especially due to their low cost, acceptability, biomedical benefits, and easy accessibility (Mir et al. 2020, Shanley & Luz 2003). Tree derived natural resins and gums, the most important non-timber forest products (NTFPs) are widely traded in international and national markets. More than 300 million people in India are deriving full or partial livelihood from forests through NTFP collection (TERI 2018). Of the total people dependent on forest, tribal population accounts for more than 100

million across the country. There are around 1.73 lakh villages located in and around forests, and all of them are either fully or partially dependent on forests (MoEF 2006).

Central India or Madhya Pradesh (MP), a central province of the Indian union, is acclaimed to be biodiverse and rich in ethnicity based on distinct identity, language, and culture. It has second largest number of tribes (42) with highest concentration (14.7%) in the country which are located in extremely remote forests (Mohanta 2012, Tripathy & Mohanta 2016). Some of the important tribes of the state are gond, baiga, bharia, bhil, kol, korku, sahariya etc. which depend on forests for their livelihood, cultural need, and health care (Mohanta, 2012, Tripathy & Mohanta, 2016). Indigenous people, also known as tribals, have traditionally enjoyed land and forests for their survival. They use NTFPs not only for food but also for social, cultural, and religious functions (Chaudhuri & Roy 2017, Falconer & Arnold 1989, Pachauri 1991). Some of the NTFP providing trees yield gum, bark, fruit, leaves etc. used for medicinal purposes either at commercial or domestic scale. Quite a few researchers reviewed that among the herbal plants, composition of medicinal trees is between 20-24% (Perme et al. 2015, Borah et al. 2020, Bushi et al. 2021). However, medicinal trees have the advantage of long gestation and regular yield in comparison to others. Such medicinal trees found in MP (mostly having outturn of >100 t a^{-1}) are categorized recently as 'Threatened and Near-threatened medicinal trees' on the basis of their conservation status (Patil et al. 2021). However, forests of MP are changing in their structure fast and due to reduction in density they are opening up (ISFR 2019, 2021). Many researchers (Alam et al. 2021, Arora et al. 2014, Kalaskar et al. 2015, Khanna et al. 2021, Kumar et al. 2022, Verma 2016) have recorded that some of the medicinal trees are decreasing due to over exploitation, faulty harvesting, and low regeneration. This has serious impact on traditional healthcare system of indigenous people in the region for common and serious ailment like diabetes, diarrhea, earache, heart and liver problems, rheumatism, indigestion, fever, jaundice etc. Additionally, livelihood and cultural resources are also getting impacted due to reduced NTFP yield from forests.

The United Nations has recently reported decline in global biodiversity and emphasized that lands governed by indigenous communities have significantly lower reduction rates, demonstrating the essential role of indigenous peoples (Dapar et al. 2020, IPBS 2019) as stewards of their natural environment. Therefore, present study is intended to understand the dependency of some indigenous people of a central Indian province on 'threatened and near threatened medicinal trees/ medicinal trees at-risk' for livelihood and medicinal use, their cultural relationship and conservation impact.

Materials and Methods

Study area

Madhya Pradesh, with more than average forest cover of the country and maximum number of indigenous communities dependent on forests, is one of the largest provinces of mega-biodiverse India and has thus been chosen for the present study. While considering the large area for planning and management, the eco-regions become ideal plan for macro level planning and field-based actions than following conventional approaches of micro/milli-watersheds (Ved et al. 2006). Therefore, depending on the forest types, edaphoclimatic conditions and other geographical indicators the state is divided into six ecozones (Fig. 1): Bundelkhand, Central, Chambal, Malwa, Satpura and Vindhyan Ecozones (AR MPSBB 2007-08 in Jha et al. 2020).

However, the study area lies between 21°17' N to 26°52' N and 74°08' E to 82°49' E (ISFR 2019) and has a varied topography of plateaus, hills, and valleys supporting agricultural areas, forest areas and interspersed waterbodies. The mean annual temperature, rainfall and elevation range from 21.7 ℃ to 28.13 ℃, 676 mm to 2078 mm and 70 m to 1282 m, respectively (Fick & Hijman 2017, USGS EROS 2018 and MPCOST 2015). The state is covered under three climatic regions of India—semi-arid in north west, tropical wet and dry in south west, and sub- tropical wet and dry in the remaining, much larger part (Jha & Jha 2021). Around 31% of total geographical expanse of the state (308252 km^2) is covered by forests which is much higher than the national average of 23.41% (ISFR 2009).

Medicinal trees at-risk

Patil et al. (2021) have discussed medicinal trees facing risks in MP. Identification of these trees was based on the methodology adopted by Foundation for Revitalization of Local Health Traditions, Bangalore, India; working in medicinal plants sector. Based on Conservation and Management Prioritization (CAMP) workshops and rapid field survey in MP, 50 medicinal plants were assigned the status of 'near threatened and above' species keeping in view IUCN Red list criteria and categories. Out of these 50 red-listed species, 13 belonged to tree habit category, whereas the remaining belonged to other habits like herb, shrub, and climber. Medicinal herbs are generally used for health care but medicinal trees have additional uses strongly linked with customs and traditions of indigenous communities for example, furniture, door and window frame making along with livelihood earning. Therefore, 13 tree species (*Boswellia serrata* Roxb. ex Colebr., *Cochlospermum*

religiosum DC., *Crataeva magna* (Lour.) DC., *Litsea glutinosa* (Lour.) Robinson, *Oroxylum indicum* (L.) Vent., *Phyllanthus emblica* L., *Pterocarpus marsupium* Roxb., *Salvadora oleoides* Decne, *Sterculia urens* Roxb., *Terminalia chebula* Retz., *Buchanania lanzan* Spreng., *Stereospermum chelonoides* (L.f.) DC., and *Terminalia arjuna* Roxb. ex DC. (Wight & Arn.) were selected for the present study which have vulnerable or near threatened status. For the purpose of this study, they are grouped together and classified as medicinal trees at-risk (MTR).

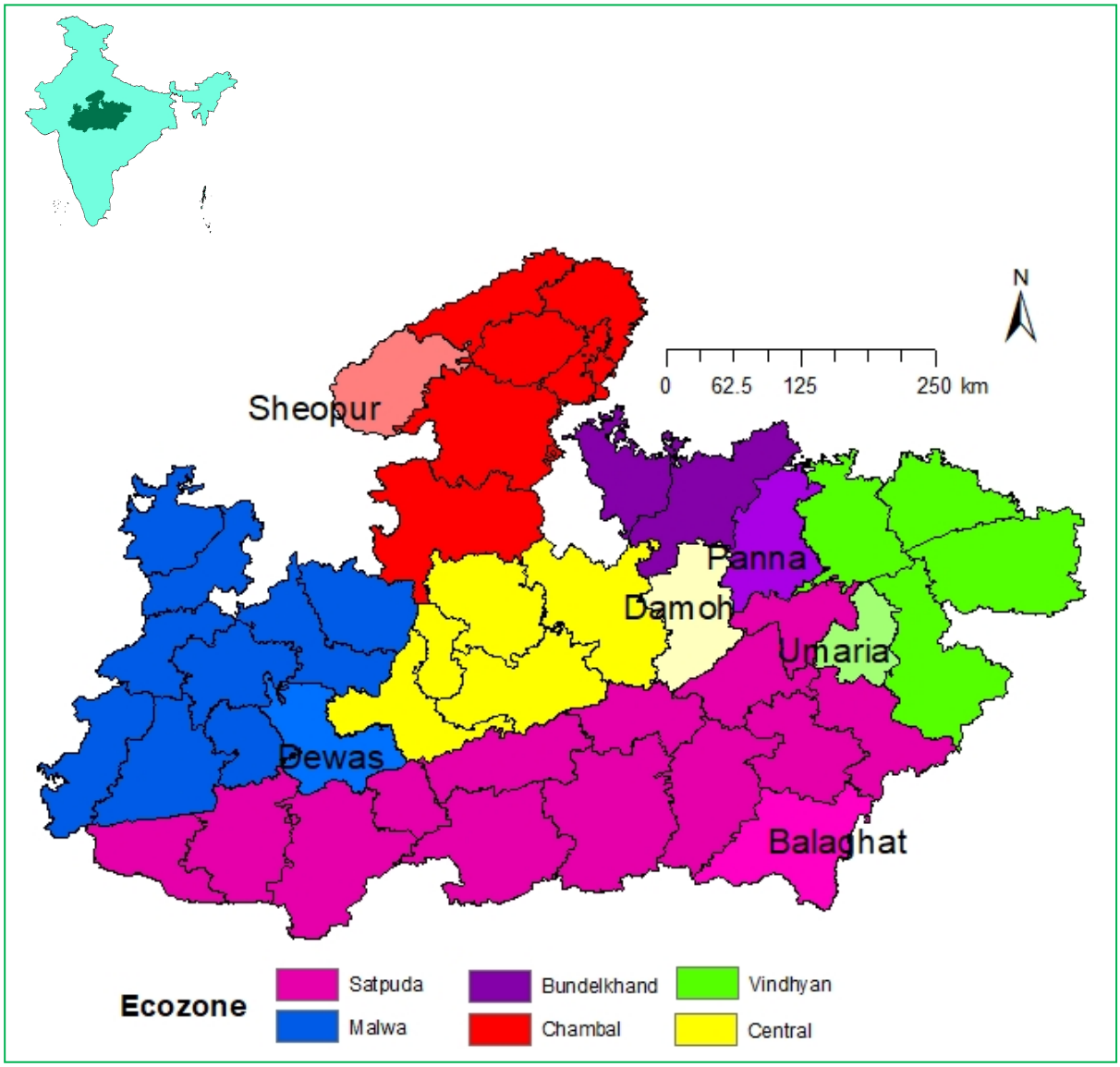

Figure 1. Location of the study area: Madhya Pradesh which is divided into six ecozones. Each ecozone is represented by lighter polygons labeled by their names (district/forest division) where survey had been conducted in and around the compartments of different ranges.

Tools, sampling, and survey

Though single tool research is not uncommon (questionnaire survey in Piña-Covarrubias et al. 2022 and interviews in Mattalia et al. 2021), social science research, generally, is conducted with the help of qualitative tools like questionnaire survey, semi-structured interviews, and FGD to exploit the advantages of all these methods together (Adams & Cox 2008). Nowadays, quantitative approaches to explore the social issues are increasingly incorporated (Valbuena 2022). We used questionnaire survey and FGD to extract the information which could not be quantified for example, villagers' perception about status of resources in the forests and observed factors for damages, medicinal and cultural use of resources. To supplement the qualitative findings, some quantitative research like field survey about regeneration and tree availability was also done as adopted in earlier works (Hong & Saizen 2019).

The state (MP) was divided into ecozones for various types of surveys (forest survey, stakeholder survey and socio-economic survey). One district or forest division (FD) was selected from each ecozone which was having the highest forest cover and a few indigenous communities. Thus, selected FDs were Panna (South) in Bundelkhand, Damoh in Central, Sheopur in Chambal, Dewas in Malwa, Balaghat (North) in Satpura and Umaria in Vindhyan ecozones. One compartment (working unit of the FD) each having good population of MTR was purposely selected in all the ranges (execution unit of the FD) of these divisions (supervision unit of the FD) with the help of incumbent forest staff to minimize the resource investment.

Quadrat survey

The field surveys were carried out to study the regeneration status of MTR by the trained beat guards of the respective FD. Pictorial guides of the 13 MTR were distributed to identify the trees in the field (supplementary materials as annexure 1). A set of written instructions in Hindi (local language) was also provided to them for carrying out the forest surveys uniformly. The quadrat (10m by 10m) method was adopted to record the regeneration status of the MTR by counting the number of saplings of the MTR of varied height, such as <15 cm, between 15 to 50 cm, 50 to 150 cm, and > 150 cm and up to 15cm girth at breast height (137 cm from ground) as regeneration standard.

Socio-economic survey

Socio-economic surveys were carried out to collect data to study the degree of dependence of local communities on the MTR for their health, livelihood, and other socio-cultural requirements. For this purpose, a village (preferably less than 200 house-holds in size) near the selected forest compartments was selected. In each one of these villages one structured focus group discussion (FGD: Supplementary material annexure 2) was carried out with people (many of whom were senior citizens) having good knowledge of the village and surrounding forest areas. In the same villages, schedule-based household survey of ten households per village was carried out (Supplementary materials annexure 3).

Stakeholders' surveys were also designed through schedules to collect relevant information from some important stakeholders of MTR like forest staff, local healers, local traders, and whole sellers. The queries in these schedules were pertaining to status and vulnerability of MTR (Supplementary materials annexure 4-6).

Data collection was supplemented by two case studies of vulnerable indigenous communities: sahariya and koli. The sampling method, tools used, and process adopted are presented diagrammatically in Supplementary Fig. 1.

Results

The results presented here is based on structured interview (questionnaire filling after interviewing) of local forest employees one each from 44 ranges, one FGD in each of 44 villages, nine herbal traders, four local healers from six forest divisions and six NTFP whole sellers from different markets. This also included house-hold survey outcomes from adivani, baiga, bhil, bhilala, bhumia, gond, korku, panika, rajgond, saharia and yadav communities. Varied local names, reasons of population decline etc. of the MTR recorded during the study is presented in Table 1.

Table1. List of medicinal trees at-risk in Madhya Pradesh with various attributes

Medicinal trees (family)	English name	Vernacular name with variations	Plant Parts Used	Herbal user community	CAMP status**	Reasons of population decline
Boswellia serrata Roxb. Ex Colebr. (Burseraceae)	Indian olibanum tree	**Salai***, **saler**, **sali**, **salhe**	Oleo-gum resin	Baiga, bhil, gond, kol, korku, saket	Vulnerable	Absence of regeneration, wind damage
Cochlospermum religiosum DC. (Cochlospermaceae)	Yellow silk cotton tree, torch-wood tree, butter-cup tree	**Katira***, **kumbi**, **gabdi**, **ganiar**, **galgal**, **gangal**, **gejra**, **guneri**	Gum	Tribes (not recorded in recent past)	Vulnerable	Absence of regeneration, wind damage, reduced rainfall
Crataeva magna (Lour.) DC. (Capparaceae)	Garlic pear	**Varuna***, **barun**, **barna**,	Bark (stem), leaf, fruit (Seed)	Tribes (not recorded in recent past)	Vulnerable	Uncontrolled grazing

		barua, **bila**, **biliana**, **varua**				
Litsea glutinosa (Lour.) Robinson (Lauraceae)	Indian laurel	**Maida***, **maru**, **meda lakri**,	Lakdi, leaf, bark (stem)	Baiga, bhil, gond, kol, korku, sahariya, saket	Vulnerable	Destructive harvesting
Oroxylum indicum (L.) Vent. (Bignoniaceae)	Indian trumpet flower	**Shyonak***, **arlu**, **sauna**, **tetu**, **sonpatha**, **ullu**	Bark (stem, root)	Baiga, bhil, gond, kol, korku, saket	Vulnerable	Absence of regeneration
Phyllanthus emblica L. (Phyllanthaceae)	Indian goose berry	**Aonla***, **amla**, **amlika**, **amluki**	Fruit	Bhil, gond, kol, sahariya	Vulnerable	Destructive harvesting, harvesting unripe fruits
Pterocarpus marsupium Roxb. (Fabaceae)	Malabar kino, Indian kino	**Bija***, **bijasar**, **bijasal**, **biasal**, **vijaysar**	Heartwood, bark (stem), resin, seed	Baiga, bhil, gond, kol, korku, saket	Vulnerable	Uncontrolled grazing, illicit felling
Salvadora oleoides Decne (Salvadoraceae)	Tooth brush tree, mustard tree, salt brush tree	**Pilu***, **bahapilu**, **chootapilu**, **pilava**, **godpilu**	Fruit	Tribes (not recorded in recent past)	Vulnerable	No causes recorded
Sterculia urens Roxb. (Sterculiaceae)	Indian-tragacanth, gum karaya, ghost tree	**Kullu***, **kadai**, **karrai**, **kadaya**	Gum	Tribes (not recorded in recent past)	Vulnerable	Absence of regeneration, destructive harvesting
Terminalia chebula Retz. (Combretaceae)	Chebulic myrobalan	**Harra***, **harad**, **har**, **harh**, **haritaki**, **hardi**, **hirde**	Fruit	Baiga, bhil, gond, kol, sahariya, saket	Vulnerable	Destructive harvesting
Buchanania lanzan Spreng. (Anacardiaceae)	Cudappah almond	**Achar***, **piyar**, **pial**, **charoli**, **choronji**	Fruit (seed)	Baiga, bhil, gond, kol, saket	Near Threatened	Destructive harvesting, harvesting unripe fruits
Stereospermum chelonoides (L.f.) DC. (Bignoniaeae)	Trumpet flower	**Patala***, **patalai**, **pader**, **padri**, **padal**	Root	Tribes (not recorded in recent past)	Near Threatened	Absence of regeneration, reduced rains
Terminalia arjuna (Roxb. ex DC.) Wight & Arn. (Combretaceae)	Arjun tree, white murdah	**Arjun***, **kahu**, **kahua**, **koha**, **anjani**, **arjan**	Bark (stem), fruit (seed)	Baiga, bhil, gond, kol, korku, sahariya	Near Threatened	Uprooting due to soil erosion, destructive harvesting

*Popular names of MTRs, **Sourced from Patil *et al.* 2021

Indigenous communities' dependence on MTR

Almost all the indigenous communities interacted (Adivani, baiga, bhil, bhilala, bhumia, gond, korku, panika, rajgond and saharia) agreed that they used various forest products and depended partially on the MTR for their livelihood, albeit supplemented their income with agriculture. Mostly the elders were involved in MTR-based NTFP collection for livelihood and younger generation was taking very little interest in it. Both koli and sahariya communities in exclusive case studies agreed that their lifestyle changed on account of main streaming of societies due to the access to rural development programmes of the government. However, our house-hold surveys [n = 100 (Dewas), 80 (Sheopur), 80 (Damoh), 60 (Panna), 70 (Balaghat) and 50 (Umaria)] indicated that they had different sources of income (wages from forestry works, direct forest income, wild fish and aquaculture, income from non-forest wages, income from own business, income from agriculture, income from livestock, and other sources). Within the direct forest income, they secured earnings from fire wood, **mahua** (*Madhuca longifolia*), **achar** (*Buchnania lanzen*), **tendu patta** (*Diospyros melanoxylon*), poles, **salai** (*Boswellia serrata*), **kullu** (*Sterculia urens*), **harra** (*Terminalia chebula*), **shatawar** (*Asparagus racemosus*), **aonla** (*Phyllanthus emblica*), soil, thorny bushes, leaves for shed, fodder and grass, and others. Thus, a few MTR (**Achar**, **salai**, **kullu**, **harra** and **aonla**) were the source of livelihood but in selected ecozones/FD. **Salai** contributed the most in Sheopur FD of Chambal ecozone followed by the contribution of **achar** and **aonla** both in Damoh FD of Central ecozone. **Aonla** and **achar** contributed in all the six ecozones followed by **salai** in four ecozones. Rest of the MTR were collected for ceremonial use and as health supplement by the villagers and traditional healers.

General uses of MTR

House-hold survey further revealed that the communities studied depended on the MTR for sociocultural as well as medicinal uses. The traditional healers stated that they could treat many diseases with the help of *Jarhi-booti* (herbal preparations) but the attendance of patients was on decrease as compared to earlier days. Our survey also revealed that even in the small villages situated on the fringe of forests, people were mostly dependent on allopathy or modern medicine (91% - 100%) for treatment of various ailments like, headache, body ache, fever, cough and cold, vomiting, constipation, diarrhea, skin infection etc. while use of herbal medicine (0% - 9%) appeared like an exception. It was revealed during the interviews that dependence on herbal treatment, contrasting to this revelation, was very high among the previous generations. Current status of ailment and ecozone/FD wise use details are given in Supplementary Table 1. It was also observed during the surveys that qualified MBBS doctors were rarely available in the interiors of rural areas, hence, the villagers had to approach quacks (commonly known as *Jhola Chhap* doctors) for their treatment. However, the traditional healers interviewed responded that they used **salai** for sciatica (pain, back pain) and wound (bleeding); **maida** (*Litsea glutinosa*) for dysentery and sexual weakness; **shyonak** (*Oroxylum indicum*) for post-delivery protection to women from cold; **aonla** for stomach disorders, cough and amoebiosis; **harra** for stomach disorders and cough; **patala** (*Stereospermum chelonoides*) for treatment of migrain; and **arjun** (*Terminalia arjuna*) for concoction prescribed in treatment of blood pressure, diabetes and heart diseases. They did not report medicinal use of **achar**, **pilu** (*Salvadora oleoides*), **bija** (*Pterocarpus marsupium*), **varuna** (*Crataeva magna*) and **katira** (*Choclospermum religiosum*). In general, these healers did not reveal much about the details of doses, combination of ingredients etc., rather they appeared secretive. In particular, a sahariya *Bhagat* (traditional healer) during a Focus Group Discussion refused to reveal his ethnobotanical skills, though he boasted that he had a very good clientele for human and animal cure.

During the household survey the respondents stated use of the MTR in socio-cultural activities like family events (birth, marriage, death etc.) and traditional festivals (Diwali, Holi, Navratra etc.). **Salai** trees wielded a substantial demand for marriage ceremony. *Kham* (pole) of **salai** tree was decorated and erected at the centre of the marriage *Mandapam* (auspicious tent). Use of **salai** *Kham* in marriage ceremony ranged between 32% to 88% in different ecozones/FD. In Balaghat district, **achar** poles (8%) were also used in similar manner. **Aonla** fruits were used in rituals of festivals like Diwali, Navratra and Dev-uthani-gyaras. Use range of **aonla** was not detected in Sheopur and Umaria FD but varied between 15% to 35% in remaining four ecozones/FD. Barring these family function and festival uses, there was little dependence of the forest fringe communities on the MTR for socio-cultural purposes. However, one of the sahariya respondents revealed that there was a tradition to donate **salai** trees to the son in law as dowry. Indigenous community also preferred gifting furniture of **bija** to their daughter as dowry.

Status of MTR

Analysis of tree occurrence data across the ecozones indicated that except **pilu** and **shyonak**, other eleven MTRs were present in minimum two or more compartments out of total 44 compartments surveyed. **Aonla**, **salai**, **achar**, **arjun**, **kullu**, **bija**, **harra**, **patala**, **katira**, **varuna** and **maida** were present in decreasing order: 91%, 82%, 75%, 70%, 66%, 48%, 41%, 14%, 11%, 7%, and 5%, respectively showing vulnerability of latter. Spread evenness across the ecozones also suggested that

eleven species out of 13 MTR were present in the forests of all the six divisions. Of total trees (71037) enumerated, **achar** (36.7%) trees were present in maximum numbers followed by **salai** (26.7%), **aonla** (17.7%), **harra** (7.6%), and **arjun** (4.7%). **Patala** (0.7%) and **kullu** (0.5%) trees were present in small numbers followed by further small numbers of **varuna**, **katira** and **maida** (all <0.01). Absence of "proportionate" number of trees of all the 11 species in the lower girth classes recorded during regeneration survey clearly indicated bleak future for these species. So far as the type of damages to the trees of MTR species were concerned, field observation suggested that hollowness of stem was the most prominent type of damage impacting survival of **salai**, **aonla**, **achar** and **harra** followed by destructive harvesting in **salai**, **aonla**, **achar** and **arjun**. Trees of **salai**, **aonla**, **arjun** and **achar** were also suffering from wind damage.

The qualitative assessment revealed that the villagers were also aware of the most responsible reasons of decline of different MTR. They identified lack of regeneration and wind damage of **salai** tree, lack of regeneration of **katira** tree, destructive harvesting of **maida** gum, destructive and unripe harvesting of **aonla** fruits, uncontrolled grazing and illicit felling for **bija** tree, lack of regeneration and destructive harvesting of **kullu** gum, destructive harvesting for **harra** fruits, destructive and unripe harvesting of **achar** fruits, uprooting due to soil erosion of **arjun** tree, uncontrolled grazing of **varuna** and lack of regeneration of **patala** trees. On protection issue of these useful tree for them, it was perceived that the responsibility lied with the forest department as custodian of forest resources.

Discussion

Socio-demography of informants

Focus group discussion generally comprised of both male and female participants. Middle aged participants were always more than older people. An average composition of sahariya (n = 45) and koli (n = 52) participants varied between 60% to 66% (male) and 34% to 40% (female). Among the men, older (>45 years) and middle-aged (25-45 years) participants were in a ratio of 45:55. In most of the cases males were the active participants, mostly a few, but females did not object the responses of their counterparts. During the structured FGD (questionnaire based) male to female respondents' participation varied between 70% - 65% (male) and 30% - 35% (female). In Indian context, male dominant societies of indigenous people, such situation is very common (Jha et al. 2023). However, lesser involvement of younger generation in NTFP (Non-timber forest product) collection activities indicated their migration towards developing sector of the society. Contrary to this, elder generation sticking to forest-based livelihood is reported earlier in different regions also (Shackleton *et al.* 2001; Sunderland et al. 2014).

Folk medicinal use of MTR

Very low use of herbal medicine among the forest and fringe dwelling tribespeople in the study area indicated their access to and knowledge of alternate system. This was evident from the responses of house hold survey about very high preference for allopathy treatment for common ailments. Other reasons could be disappearing traditional knowledge as well as low availability of raw resources. Erosion of traditional ecological knowledge in indigenous communities around the world is reported earlier also (Rayes-Garcia *et al.* 2013, Turvey *et al.* 2018) and parallel decline of the world's biological diversity is also recorded in the works of Sutherland (2003) and Thomas *et al.* (2004).

However, traditional healers reported limited use of seven MTRs in the studied area without mentioning it community wise. It can be speculated that tribal and other communities like, adivani, baiga, bhil, bhilala, bhumia, gond, korku, panika, rajgond, sahariya and yadav (Patil *et al.* 2021) would be using these MTR. Though this appeared to be deficient extraction of information especially due to secretive nature of traditional healers. Such cultural practice of the traditional knowledge holders is reported from other regions also (Bandyopadhyay & Mukherjee 2005, Birhan *et al.* 2018, Dinbiso *et al.* 2021). However, available literature could be useful in overcoming this deficiency as proxy since the same tribal communities outside FDs in study area also used such MTRs for different ailments. Moreover, earlier studies confirmed the present reporting also. For example, Dwivedi *et al.* (2008) reported that tribes of Madhya Pradesh used **aonla** for stomach disorder. Kol and gond from Rewa and Sidhi (Vindhyan ecozone) used **aonla** for cough, **arjun** for heatstroke, and **bija** for acidity (Bharati *et al.* 2016). Baiga tribe of Sidhi used **shyonak** for jaundice (Ranjan & Mishra 2020). Some other tribes like, saket and bhil in addition to gond, baiga and kol of Sidhi district used **maida** for diarrhea, dysentery and scabes, **shyonak** for stomach problem, boils, and wounds, **bija** for skin diseases, sores, and boil, **harra** for anorexia, cough, hiccough, jaundice, renal epilepsy, fever, and leprosy, **achar** for urinary disorder, and **salai** on small and chicken pox scares (Saket 2018). In another district of Vindhyan ecozone (Anuppur), Rao *et al.* (2022) reported herbal use by baiga and gond tribes for diabetes (**arjun**), headache (**bija**), cough (**harra**), and menstrual problem (**salai**). Nath & Khatri (2017) reported that herbal healers used **arjun** for heart ailments, **maida** for dysentery and **harra** for cough in tribal pockets of Chhindwara and Betul districts (Satpura ecozone). Rai

et al. (2000) reported use of plants by gond in Chhindwara district for cure of dandruff (**aonla**), diabetes (**bija**), heart troubles (**arjun**) and indigestion (**harra**). In the district of Satpura ecozone (Hoshangabad), Quamar & Bera (2014) reported use of **harra** as purgative for bowel problem, **arjun** for headache and spermatorrhea, and **shyonak** for diarrhea and rheumatism. Upadhyay (2013) also reported use of bark of **salai**, **arjun**, **shyonak**, and **bija** for treatment of backache, stomach ache; diarrhea; vomiting, diarrhea; and toothache and mouth ulcer, respectively, by gond and kokru tribes in Hoshangabad. Traditional healers (ojha, vaidya of baiga, gond and sahariya tribes) from Dindori, the easternmost district of Satpuda ecozone, were engaged in using **aonla** for bronchial disorder, **arjun** for weakness and mouth blister, and **harra** for digestion, ulcer, cough, hiccups, leprosy, cardiac disorder, and wounds (Singh *et al.* 2022). Samar *et al.* (2020) reported traditional knowledge use by bhil, gond and sahariya tribes in Guna district (Chambal ecozone) about **aonla** used in fevers, vomiting, indigestion, habitual constipation and efficacious eye wash in ophthalmia, **arjun** on pimples and other minor skin eruptions, symptomatic hypertension, cirrhosis of liver, as anthelmintic for ascaris, in diarrhea and fever, and for rickets in children, and **harra** in ulcers, wounds, helminthiasis, jaundice, cough, epilepsy, ophthalmopathy, skin diseases, leprosy, cardiac disorders and neuropathy. In another district (Shivpuri) of Chambal ecozone, Yadav and Khare (2014) reported herbal treatment by sahariya tribe. They used **aonla** for constipation, **arjun** for earache, and **harra** for bronchitis.

Our finding on above MTRs regarding threatened status is confirmed in a recent study Khanna *et al.* (2021) except *Phyllanthus emblica*. However, another dimension of cultural relationship reflected in use of such MTRs by the indigenous people in health care of their livestock. Products like bark, leaves, and seeds from *Terminalia arjuna* (Garnayak *et al.* 2023, Gogoi & Bohra 2021, Patil & Deshmukh 2015), *Boswellia serrata* (Gavale & Patil 2020), *Emblica officinales* (Gawali & Patil 2020, Gwalwanshi & Bishwas 2017), *Litsea glutinosa* (Guruprasad & Devi Prasad 2019), *Terminalia chebula* (Gwalwanshi & Bishwas 2017), *Oroxylon indicum* (Kamatchi & Parvati 2020) and *Buchnanaia lanzen* (Kushwaha 2020, Patil & Deshmukh 2015) are used to cure various livestock ailments.

In view of the availability of abundant traditional knowledge, it is noteworthy that modern medical care, occupation shift and improved education appear to have little effect on knowledge of ethno-medicine. However, these factors combining with a general inclination to western culture seem to divert people's interests and pushing traditional medicine and cultural practices in the background (Kiringe 2005). Nevertheless, government support can reinvigorate the faith in herbal medicine for the financially weaker indigenous people.

Cross cultural linkages of MTR

Though this is a small study on herbal use by people involving 13 MTR and 12 indigenous communities, above deliberation on our survey revealed that there is cross cultural relationship as regards the use of plants for treatment of various ailments by different tribes of MP. From this, two models were created showing their linkages: 1. Plant-ailment-tribes and 2. Ailment-plants-tribes (Figs 2 and 3). Such models have been recently proposed by Jha and Smith-Hall (2023) also. Cross cultural linkages are also reflected in use of **salai** poles and **aonla** in different festivals by various tribes. This helped learn cross-cultural variability of plant use (MTR) knowledge and understand the human-nature interface among indigenous (baiga, bhil, gond, kol, korku, sahariya, saket) communities (Siram *et al.* 2023). This also helped determine the similarities and differences of medicinal ethnobotany among people living in distant places (Kazanci *et al.* 2020). Nevertheless, it is more urgent now than ever to record the researched knowledge of medicinal use of MTRs by indigenous communities of the study area not only for the purpose of biocultural conservation, but also to provide insights to scientists engaged in the search for new herbal veterinary therapies and especially to local stakeholders as also suggested by Abbasi *et al.* (2013).

MTR and livelihood prospect

As per the community members' involvement in NTFP collection from the local forests and traders' assessment, the MTR under study (Table 1) could be grouped into commercial category (**salai**, **aonla**, **achar**, **kullu**, and **harra**) providing a small part of livelihood endowment for management purpose. Across the ecozones, it is 9.5% of direct forest income which itself is 48.5% of total household income (INR 110778 in the assessment year 2015). Such a small amount could only be treated as safety-net income for the household. Ironically, this meagre buffer income for such highly underprivileged community is bound to go down since the future of such income providing MTR is very grim on account of resource loss due to physical damage to the old crop and bleak regeneration of the species. Peoples' perception indicated that extreme events like frequent droughts and heavy rains affect crops like **arjun** and **salai** adversely. Chaturvedi et al. (2011) have also reviewed that impacts of climate change on forests have severe implications for the people who depend on forest resources for their livelihoods. Adding fuel to the fire is noninvolvement of younger generation in the time-taking labour-intensive operation of NTFP collection. Nevertheless, protection of biodiversity and conservation of medicinal plants is essential for the livelihood security and ensuring the availability of medicinal plant in future (Sen & Chakraborty 2017).

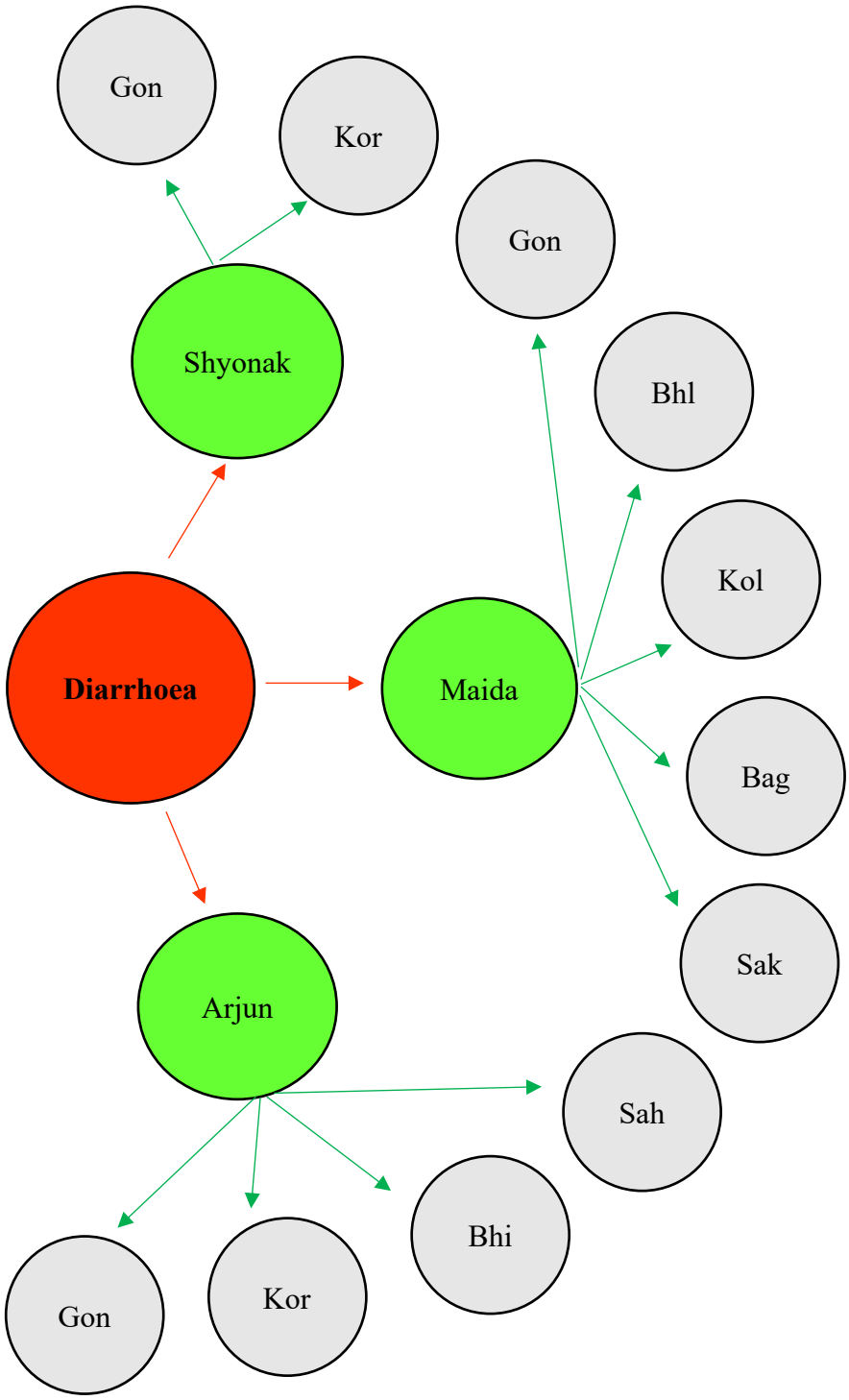

Figure 2. Diagram representing Ailment-plant-tribes model. Single ailment being treated by different communities using multiple MTR. Tribes involved are Sah=Sahariya, Gon=Gond, Bhi=Bhil, Kor=Korku, and Bag=Baiga, Kol=Kol, and Sak=Saket. **Arjun** = *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn., **maida** = *Litsea glutinosa* (Lour.) Robinson, **shyonak** - *Oroxylum indicum* (L.) Vent.

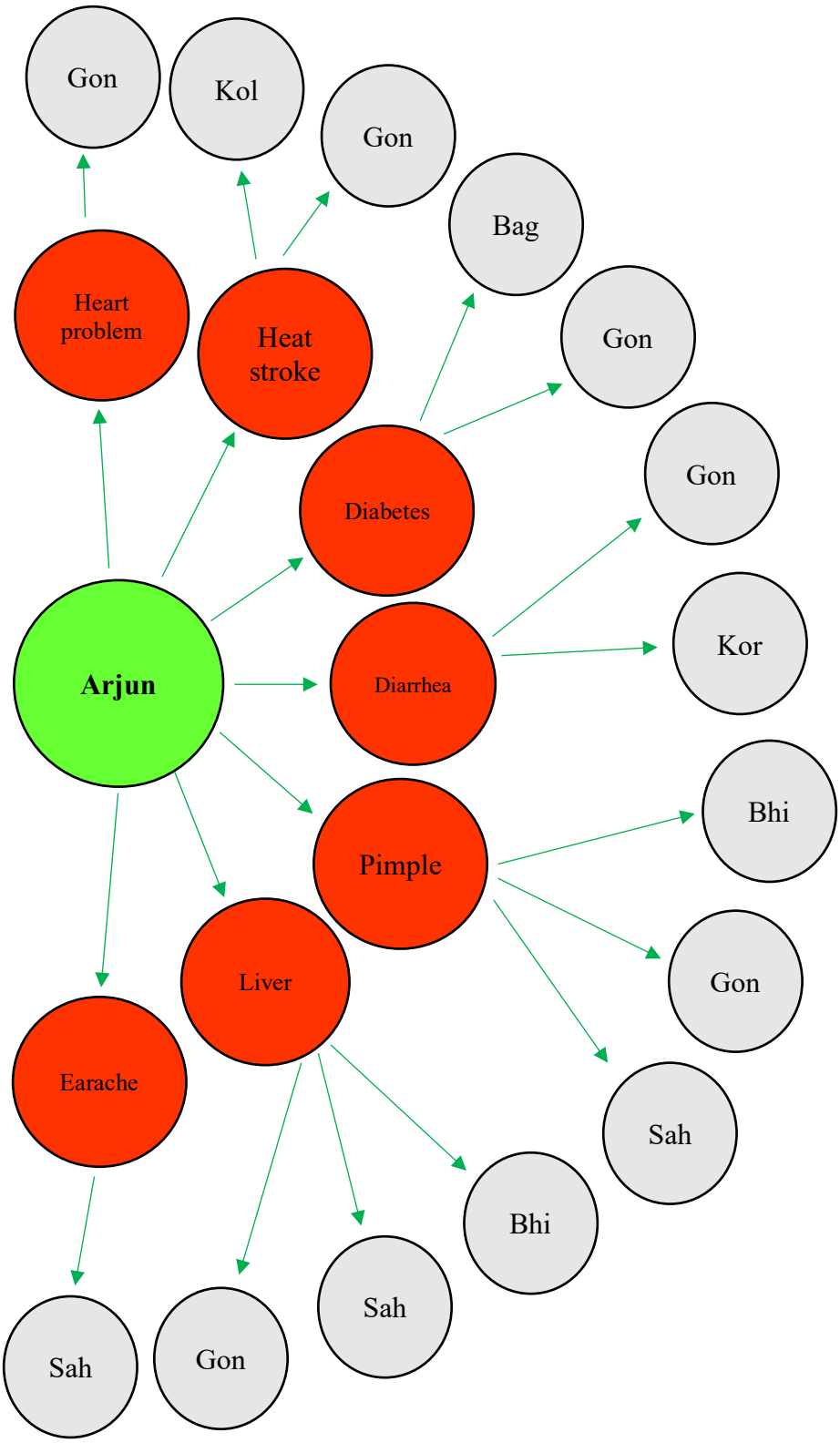

Figure 3. Diagram representing Plant-ailment-tribe model. One MTR could be used for treating various ailments by several tribes. Tribes involved are Sah=Sahariya, Gon=Gond, Bhi=Bhil, Kor=Korku, and Bag=Baiga. **Arjun** = *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn.

Conservation perspective of MTR

Herbal use of some MTRs (**katira**, **kullu**, **patala**, **pilu** and **varuna**) recorded in literature (Alam *et al.* 2021, Dhiman *et al.* 2019, Kotresha & Harihar 2011, Khanam *et al.* 2022, Meera & Chidambaranathan 2017, Sumanth *et al.* 2013) could be treated as proxy of concurrent use by the local tribes. Absence of such reporting during the survey in the study area indicated loss of

traditional knowledge and non-availability or absence of resources in the ecozones. Aswani *et al.* (2018) and Fernández-Llamazares *et al.* (2021) in Rayes-Garcia (2023) also affirmed that indigenous local knowledge systems are globally eroding due to the negative impact of globalization, colonialism, and environmental change. Moreover, Patil and Kumar (2015) have reported that the commercial demand for botanical raw drugs has put the medicinal plant resources under great stress. Patil *et al.* (2021) have further recorded that MP is no exception for this stress and medicinal trees of threatened category growing naturally in the state forests are facing various problems like dwindling natural regeneration, forest department's lack of concern as medicinal trees are given lesser priority compared to timber, long term gestation period of medicinal trees making them unprofitable proposition for planting by private entrepreneurs, overexploitation of such trees due to lack of awareness or greed and poverty of dependent people etc. Prasad *et al.* (2019) observed that the gums and resins trade in India faces declining trend in the production base of such produce due to ruthless tapping and unorganized harvesting approaches. In particular, Alam *et al.* (2021) have reported overexploitation of **katira** for gum and medicinal uses and Kalaskar *et al.* (2015) have recorded **patala** facing threat of extinction due to habitat destruction, illegal trade and over exploitation. In the case of **pilu**, Arora e*t al.* (2014) and Verma (2016) have stated that this plant is decreasing at very fast rate due to overexploitation, its low seed germination power, low seed viability and inefficiency of propagation through vegetative method.

Above narratives provided baseline information on medicinal trees as critical genetic resources in central India. It is suggested that local people and the local government unit (FD) should actively participate in shared management responsibilities for viable conservation and sustainable use of the resources as also suggested by Dapar *et al.* (2020). This may have two distinct benefits: protection of cultural identity as well as restoration of livelihood options of indigenous people. Additionally, *nistar* (collection of *paidawar* or minor forest produce including the herbal raw material from the MTR by the villagers absolutely free of cost) policy of the state needs a revisit. Though, it will be a strong policy decision, *nistar* may be suspended temporarily, should there be no positive result in restoration of lost resources.

Conclusion

This study, for the first time, recorded the relationship between MTR and indigenous people through sociocultural and livelihood use and assessed the status of MTR resources in MP, a central Indian state. Medicinal trees at-risk contributed in the livelihood of the indigenous people but the contribution varied greatly from ecozone to ecozone. These trees also played their role in sociocultural activities like marriage ceremony and different festivals and health care but found waning use. In cultural function tree species was being replaced due to scarcity of original species. Even herbal use for health care showing cross cultural relationship and good prospect of cheaper treatment was being taken over by the modern system of medicine but at the elementary stage. Indigenous Traditional Knowledge was found on the disappearing path as the younger generation was not taking interest in forest-based activities. Both livelihood activities and cultural involvement saw some constraints due to low availability with reducing trend in quantum of MTR due to poor regeneration, and natural damages due to extreme climatic events.

The data collected in this study could facilitate improvement of resource management and add to upliftment of underprivileged status, to some extent, of the indigenous community dependent on them. A mechanism of shared management responsibility and revisit of *nistar* policy may be useful in restoration of link between resource utilization and culture of the community. Keeping in view, the advantages of herbal health care system like easy access, cost effectiveness, no side effects vis a vis disadvantages of allopathy system like, non-availability of modern medication, environmental impact etc. the former should be revived and promoted.

Declarations

List of abbreviations: CAMP = Conservation and Management Prioritization; FD = Forest Division; FGD = Focus Group Discussion; ITK = Indigenous Traditional Knowledge; MP = Madhya Pradesh; MTR = Medicinal tree at-Risk; NTFP = Non-Timber Forest Product; *Nistar* = It's a vernacular word implied here for collection of *paidawar* or minor forest produce including the herbal raw material from the MTR by the villagers absolutely free of cost

Ethics approval: All participants provided oral prior informed consent

Data availability: The authors confirm that the data supporting the findings of this study are available within the article.

Competing interests: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author contributions: Both the authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by AKP. Some more analysis and first draft of the manuscript was written by KKJ. AKP commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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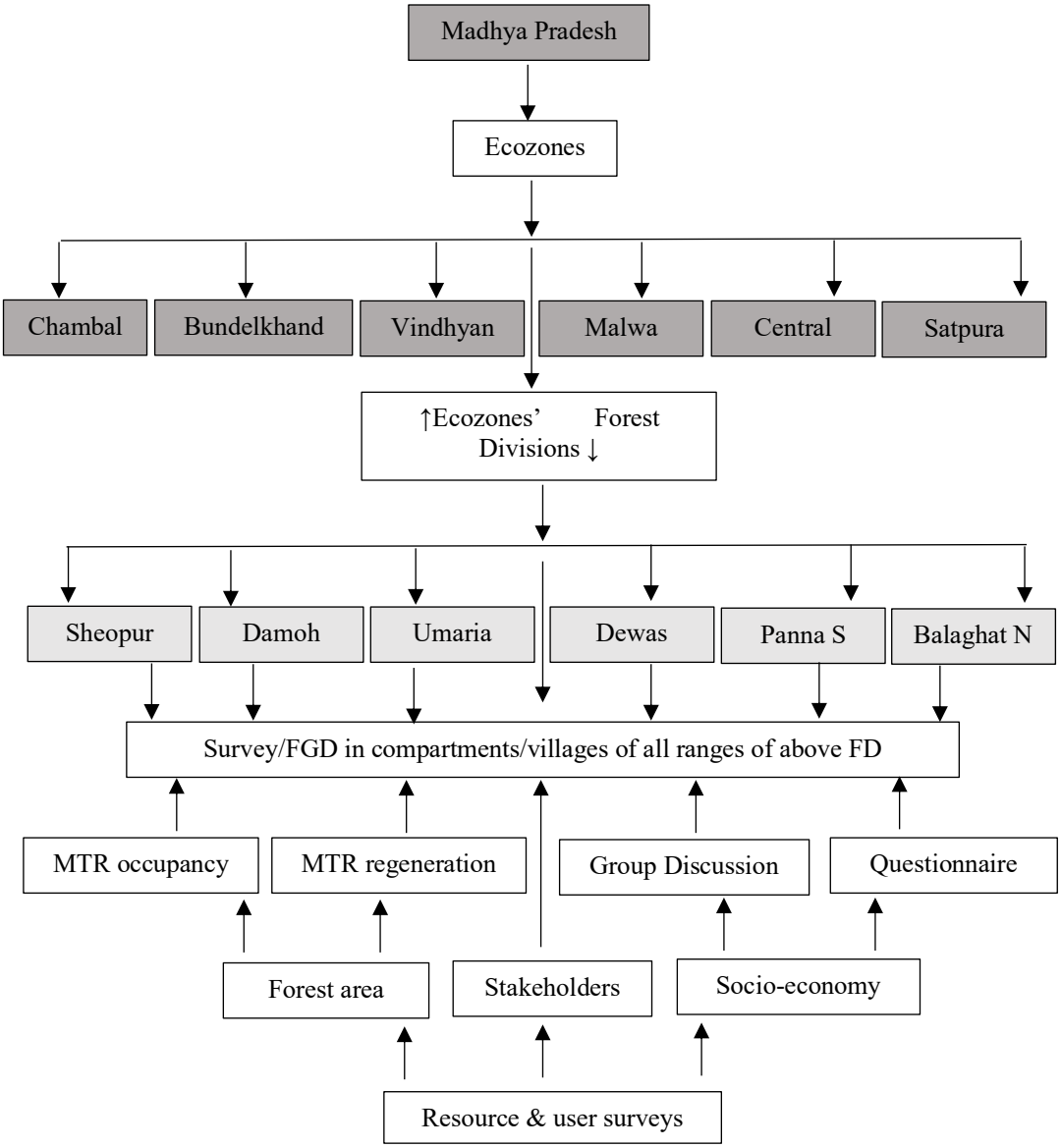
Supplementary Materials



Supplementary Figure 1. Flow chart depicting survey and sampling methodology adopted for studying cultural and livelihood linkages between medicinal trees at risk and indigenous communities (adivani, baiga, bhil, bhilala, bhumia, gond, korku, panika, rajgond and saharia) in central Indian province, Madhya Pradesh. Survey/FGD in compartments/villages of all ranges of above FD forms the centerstage of the methodology. Down arrows, linking the boxes, showing stratification of sampling while up arrows indicate survey efforts made. Upper (five rows) and lower (four rows) boxes are territorial and procedural units, respectively. FD = Forest division, FGD = Focus group discussion, MTR = Medicinal trees at risk

Annexure 1

Photographic guide for the medicinal trees at risk (Photo sources: FRLHT Bangalore, MFPPARC, Bhopal and internet images)

1. **Salai** (*Boswellia serrata*) : Bark

2. **Varuna** (*Crataeva magna*): Flowers, fruit, bark

3. **Katira** (*Cochlospermum religiosum*) : Fruits and flowers

4. **Maida** (*Litsea glutinosa*) : Habit, leaves and inflorescence

5. **Shyonak** (*Oroxylum indicum*): Inflorescence and pods

6. **Harra** (*Terminalia chebula*) : Tree habit, leaves, inflorescence and fruits

7. **Achar** (*Buchanania lanzan*) : Bark and fruits

8. **Bija** (*Pterocarpus marsupium*) : Tree habit, bark and sawn wood

9. **Pilu** (*Salvadora oleoides*) : Tree habit, and leaves

10. **Kullu** (*Sterculia urens*) : Bark colour and texture, inflorescence and gum exudate

11. **Patala** (*Stereospermum chelonoides*) : Leaves and flowers

12. **Aonla** (*Phyllanthus emblica*) : Fruits

13. **Arjun** (*Terminalia arjuna*) : Bark and fruits

Annexure 2

Structured questionnaire for Focus Group Discussion with villagers
{Abridged from original: texts in italics (with deleted tables) are not used in present study}

Village Survey 1 (V1)

A. Geographic and climate variables
B. Demographics
C. Infrastructure
D. Forest and land cover/use
E. Forest resource base
F. Forest Institutions
G. Forest User Groups (FUG)

Village Survey 2 (V2)

A. Risk
B. Wages and prices
C. Forest services

Part A: About the selected Medicinal Trees at Risk (MTR) from the adjoining forests.
A-1. Availability in the nearby forests, part/parts of MTR used and changes in the availability.

S No.	Scientific Name/ Common Name/ Local Name	Availability	Changes in availability of these MTR[1]	Reasons behind change in availability[2] (Top 3)
1	**Salai** (*Boswellia serrata*)			
2	**Katira** (*Cochlospermum religiosum*)			
3	**Varuna** (*Crataeva magna*)			
4	**Meda Lakdi** (*Litsea glutinosa*)			
5	**Shyonak** (*Oroxylum indicum*)			
6	**Aonla (***Phyllanthus emblica*)			
7	**Bija** (*Pterocarpus marsupium*)			
8	**Pilu** (*Salvadora oleoides*)			
9	**Kullu** (*Sterculia urens*)			
10	**Harra** (*Terminalia chebula*)			
11	**Achar** (*Buchanania lanzan*)			
12	**Patala** (*Stereospermum chelonoides*)			
13	**Arjun** (*Terminalia Arjuna*)			

[1] 1=Declined substantially, 2=Moderately Declined, 3=No Change, 4=Moderately Increased, 5=Increased substantially [2]1= Over exploitation for the medicinal raw material, 2= Illicit felling for timber, 3= Forest fires, 4= Encroachments, 5= Illicit felling for fuel wood, 6= Climate change, 7= Change in the surrounding habitat, 8= Pest or Diseases, 9=Better forest protection, 10= Plantation of the Species, 11= Better JFM by Forest Department, 12= Others (Specify)…….

A-2. Uses (Rituals) of these MTR in socio-cultural activities.

S No.	MTR	Uses in Family Events				Uses in Festivals			
		Birth	Marriage	Death	Others	Diwali	Holi	Navratra	Others
1	**Salai**								
2	**Katira**								
3	**Varuna**								
4	**Maida Lakdi**								
5	**Shyonak**								
6	**Aonla**								
7	**Bija**								
8	**Pilu**								
9	**Kullu**								
10	**Harra, Harad**								
11	**Achar**								
12	**Patala, Patalai**								
13	**Arjun**								

#Medicinal/ Non-medicinal

A-3. Change in awareness across age groups.

A-4. What if the MTR vanish from the forests?

Part B - About other Medicinal Plants from the adjoining forests

General Information

Annexure 3

Structured questionnaire for House Hold (HH) Survey
(Abridged from original: text in red with deleted tables are not used in present study)

Annual household survey 1 (A1)

Control information
A. Identification
B. Household composition
C. Land
D. Assets and savings
E. Forest resource base
F. Forest User Groups (FUG)- JFMC

Annual House Hold Survey 2 (A2)

A. Crisis and unexpected expenditures
B. Forest services
C. Welfare perceptions and social capital

Annual House Hold Survey 3 (A3)

A. Direct forest income (income from Processed and unprocessed forest products)
B. Fishing and aquaculture
C. Non-forest environmental income
D. Wage income
E. Income from own business (not forest or agriculture)
F. Income from agriculture - (Rabbi and Kharif crops)
G. Income from livestock
H. Other income sources

Questionnaire regarding MTR for HH level survey

Part A: About the selected Medicinal Trees at Risk (MTR) from the adjoining forests.

A-1. Whether any member of the HH collects the herbs from MTR? For which purpose?

A-2. Availability in the nearby forests, part/parts of MTR used and changes in the availability.

S No.	Scientific Name/ Common Name/ Local Name	Availability	Changes in availability of these MTR[1]	Reasons behind change in availability[2] (Top 3)
1	**Salai** (*Boswellia serrata*)			
2	**Katira** (*Cochlospermum religiosum*)			
3	**Varuna** (*Crataeva magna*)			
4	**Meda Lakdi** (*Litsea glutinosa*)			
5	**Shyonak** (*Oroxylum indicum*)			
6	**Aonla (***Phyllanthus emblica*)			
7	**Bija** (*Pterocarpus marsupium*)			
8	**Pilu** (*Salvadora oleoides*)			
9	**Kullu** (*Sterculia urens*)			
10	**Harra** (*Terminalia chebula*)			
11	**Achar** (*Buchanania lanzan*)			
12	**Patala** (*Stereospermum chelonoides*)			
13	**Arjun** (*Terminalia arjuna*)			

[1] 1=Declined substantially, 2=Moderately Declined, 3=No Change, 4=Moderately Increased, 5=Increased substantially

[2]1= Over exploitation for the medicinal raw material, 2= Illicit felling for timber, 3= Forest fires, 4= Encroachments, 5= Illicit felling for fuel wood, 6= Climate change, 7= Change in the surrounding habitat, 8= Pest or Diseases, 9=Better forest protection, 10= Plantation of the Species, 11= Better JFM by Forest Department, 12= Others (Specify)……..

A-3. Herbal productivity of a tree in a season (if the answer of A1 is 'yes')

S No.	**Name of MTR**	**Part of the Tree harvested**	**Quantity harvested per tree in Kgs.**			**Quantity collected in an average day**	**No. of hours of collection in an average day**	**No. of collection days in an average season**	**Season of collection (Give duration in dates)**
			Small	Medium	Large				
1	Salai								
2	Katira								
3	Varuna								
4	Meda Lakdi								
5	Shyonak								
6	Aonla								
7	Bija								
8	Pilu								
9	Kullu								
10	Harra								
11	Achar								
12	Patala								
13	Arjun								

A-4. Uses (Rituals) of these MTR in socio-cultural activities.

S No.	MTR	Uses in Family Events				Uses in Festivals			
		Birth	Marriage	Death	Others	Diwali	Holi	Navratra	Others
1	Salai								
2	Katira								
3	Varuna								
4	Meda Lakdi								
5	Shyonak								
6	Aonla								
7	Bija								
8	Pilu								
9	Kullu								
10	Harra								
11	Achar								
12	Patala								
13	Arjun								

A-5. What if the MTR vanish from the forests?

Part B - About other Medicinal Plants from the adjoining forests

B-1. Availability of the top 5 MPs in the adjoining forests (other than the above 13 MTR), their uses, quantities and prices

B-2. What if the top 5 MPs vanish from the forests?

C. General Information -

Annexure 4

Structured questionnaire for Forest staff regarding MTR
(Abridged from original: text in red with deleted tables are not used in present study)

1. Name of the staff:
2. Information regarding availability of 13 MTR in your jurisdiction:

S No.	Scientific Name/ Common Name/ Local Name	Locations where available (Compartment Nos.)	Changes in availability of these MTR[1]	Reasons behind change in availability[2] (Top 3)
1	**Salai** (*Boswellia serrata*)			
2	**Katira** (*Cochlospermum religiosum*)			
3	**Varuna** (*Crataeva magna*)			
4	**Maida Lakdi** (*Litsea glutinosa*)			
5	**Shyonak** (*Oroxylum indicum*)			
6	**Aonla** (*Phyllanthus emblica*)			
7	**Bija** (*Pterocarpus marsupium*)			
8	**Pilu** (*Salvadora oleoides*)			
9	**Kullu** (*Sterculia urens*)			
10	**Harra, Harad** (*Terminalia chebula*)			
11	**Achar** (*Buchanania lanzan*)			
12	**Patala, Patalai** (*Stereospermum chelonoides*)			
13	**Arjun** (*Terminalia Arjuna*)			

Uses (Rituals) of these MTR in socio-cultural activities.

S No.	TMT	Uses in Family Events				Uses in Festivals			
		Birth	Marriage	Death	Others	Diwali	Holi	Navratra	Others
1	**Salai**								
2	**Katira**								
3	**Varuna**								
4	**Meda Lakdi**								
5	**Shyonak**								
6	**Aonla**								
7	**Bija**								
8	**Pilu**								
9	**Kullu**								
10	**Harra, Harad**								
11	**Achar**								
12	**Patala, Patalai**								
13	**Arjun**								

[#]Medicinal/ Non Medicinal

3. *Availability of the top 5 MPs in the adjoining forests (other than the above 13 MTR), their uses, quantities and prices.*
4. *How to stop the MTR/MPs from becoming extinct?*
5. *Persons who have grown the MTR/MPs artificially in the range.*
6. *Name, address and contact number of the local purchasers of the herbs from MTR and MPs mentioned above?*

Annexure 5

Survey schedule for local healers
(Abridged from original: text in red with deleted tables are not used in present study)

Name of Healer:

Part A: About the selected MTR from the adjoining forests.
A-1. Availability in the nearby forests, part/parts of MTR used and changes in the availability.

S No.	Scientific Name/ Common Name/ Local Name (Tick mark the trees present in nearby forests)	Part Used by the Local Healer. (Max)	Changes in availability of these MTR[1]	Reasons behind change in availability[2] (Top 3)	How do you Procure these MTR[3] (Give rates if not 1)	Major diseases treated (Top 3)		
1	**Salai** (*Boswellia serrata*)							
2	**Katira** (*Cochlospermum religiosum*)							
3	**Varuna** (*Crataeva magna*)							
4	**Meda Lakdi** (*Litsea glutinosa*)							
5	**Shyonak** (*Oroxylum indicum*)							
6	**Aonla (***Phyllanthus emblica*)							
7	**Bija** (*Pterocarpus marsupium*)							
8	**Pilu** (*Salvadora oleoides*)							
9	**Kullu** (*Sterculia urens*)							
10	**Harra, Harad** (*Terminalia chebula*)							
11	**Achar** (*Buchanania lanzan*)							
12	**Patala, Patalai** (*Stereospermum chelonoides*)							
13	**Arjun** (*Terminalia arjuna*)							

[1] 1=Declined substantially, 2=Moderately Declined, 3=No Change, 4=Moderately Increased, 5=Increased substantially
[2]1= Over exploitation for the medicinal raw material, 2= Illicit felling for timber, 3= Forest fires, 4= Encroachments, 5= Illicit felling for fuel wood, 6= Climate change, 7= Change in the surrounding habitat, 8= Pest or Diseases, 9=Better forest protection, 10= Plantation of the Species, 11= Better JFM by Forest Department, 12= Others (Specify)…….
[3] 1=Collects Personally, 2=Engage Labour, 3=Purchase from local collectors (Villagers), 4=Purchase from the local market, 5=Purchase from the Whole Sellers, 6=Others

A-2. Efficacy of the treatment with available alternatives -

S No.	Name of MTR	Efficacy of Treatments for the top 3 diseases' treated.			Cost of MTR Herbal Course	Availability of Substitute Medicines	Efficacy of Substitutes [4]	Cost of Substitute Medicinal course
		Use Codes given below[4]	Use Codes given below[4]	Use Codes given below[4]	(RS)	1=No: 2= Yes (Give Names)	Use Codes	(RS)
1	**Salai**							
2	**Katira**							
3	**Varuna**							
4	**Meda Lakdi**							
5	**Shyonak**							
6	**Aonla**							
7	**Bija**							
8	**Pilu**							
9	**Kullu**							
10	**Harra, Harad**							
11	**Achar**							
12	**Patala, Patalai**							
13	**Arjun**							

[4] 1=Ineffective, 2=Effective, 3=Moderately Effective, 4=Highly Effective

A-3. Herbal productivity of a tree in a season

S No.	Name of MTR	Min. Age of the tree for harvesting.	Average Productive life	Part of the Tree to be harvested	Quantity Harvested per tree in Kgs.		
					Small	Medium	Large
1	**Salai**						
2	**Katira**						
3	**Varuna**						
4	**Meda Lakdi**						
5	**Shyonak**						
6	**Aonla**						
7	**Bija**						
8	**Pilu**						
9	**Kullu**						
10	**Harra, Harad**						
11	**Achar**						
12	**Patala, Patalai**						
13	**Arjun**						

A-4. Uses (Rituals) of these MTR in socio-cultural activities.

S No.	MTR	Uses in Family Events				Uses in Festivals			
		Birth	Marriage	Death	Others	Diwali	Holi	Navratra	Others
1	**Salai**								
2	**Katira**								
3	**Varuna**								
4	**Meda Lakdi**								
5	**Shyonak**								
6	**Aonla**								
7	**Bija**								
8	**Pilu**								
9	**Kullu**								
10	**Harra, Harad**								
11	**Achar**								
12	**Patala, Patalai**								
13	**Arjun**								

#Medicinal/ Non Medicinal

A-5. Change in awareness across age groups.

A-6. What if the MTR vanish from the forests?

Part B - About other Medicinal Plants from the adjoining forests

B-1. Availability of the top 10 MPs in the adjoining forests (other than the above 13 TMTs), their uses, quantities and prices

B-2. Change in awareness across age groups.

B-3. What if the top 10 MPs vanish from the forests?

C. General Information -

C-1. How to stop the TMTs/MPs from becoming extinct?

C-2. Persons who have grown the TMTs/MPs artificially in the range.

C-3. Name, address and contact number of the local purchasers of the herbs from TMTs and MPs mentioned above?

Annexure 6

Survey schedule for local trader/whole seller
(Abridged from original: text in red with deleted tables are not used in present study)

1. Name of the Trader/Whole seller:
2. Information regarding availability of 13 TMTs in his catchment area:

S No.	Scientific Name/ Common Name/ Local Name	Villages contributing	Changes in availability of these MTR[1]	Reasons behind change in availability[2] (Top 3)	Purchase price	Sale price	Sale destination
1	**Salai** (*Boswellia serrata*)						
2	**Katira** (*Cochlospermum religiosum*)						
3	**Varuna** (*Crataeva magna*)						
4	**Meda Lakdi** (*Litsea glutinosa*)						
5	**Shyonak** (*Oroxylum indicum*)						
6	**Aonla (***Phyllanthus emblica*)						
7	**Bija** (*Pterocarpus marsupium*)						
8	**Pilu** (*Salvadora oleoides*)						
9	**Kullu** (*Sterculia urens*)						
10	**Harra, Harad** (*Terminalia chebula*)						
11	**Achar** (*Buchanania lanzan*)						
12	**Patala, Patalai** (*Stereospermum chelonoides*)						
13	**Arjun** (*Terminalia Arjuna*)						

[1] 1=Declined substantially, 2=Moderately Declined, 3=No Change, 4=Moderately Increased, 5=Increased substantially

1. *Availability of the top 10 MPs in the adjoining forests (other than the above 13 MTR), their uses, quantities and prices.*
2. *Persons who have grown the MTR/MPs artificially in the range.*
3. *Name, address and contact number of the whole sellers of the herbs from MTR and MPs mentioned above?*

Supplementary Table 1. Division wise preference of households for treatment of common ailments

SN	Common Ailments	Preference of medicine	Dewas %	Sheopur %	Damoh %	South Panna %	North Balaghat %	Umaria %
1	Headache	Allopathy	98.7	97.8	100	91.6	94.2	94
		Herbalism	1.3	2.2	0	8.4	5.8	6
		Mixed	0	0	0	0	0	0
2	Body ache	Allopathy	98.6	97.8	100	91.6	94.6	96
		Herbalism	1.4	2.2	0	8.4	7.4	4
		Mixed	0	0	0	0	0	0
3	Fever	Allopathy	98.6	97.8	100	91.6	75.7	90
		Herbalism	1.4	2.2	0	8.4	24.3	10
		Mixed	0	0	0	0	0	0
4	Cough & cold	Allopathy	98.6	97.8	100	90	91.4	94
		Herbalism	1.4	2.2	0	10	8.6	6
		Mixed	0	0	0	0	0	0
5	Vomiting	Allopathy	98.6	97.8	100	93.3	94.2	96
		Herbalism	1.4	2.2	0	6.7	5.8	4
		Mixed	0	0	0	0	0	0
6	Constipation	Allopathy	98.7	97.9	100	93.3	100	98
		Herbalism	1.3	2.1	0	6.7	0	2
		Mixed	0	0	0	0	0	0
7	Diarrhea	Allopathy	98.6	100	100	93.3	98.5	98
		Herbalism	1.4	0	0	6.7	1.5	2
		Mixed	0	0	0	0	0	0
8	Skin infection	Allopathy	100	100	100	93.3	95.6	98
		Herbalism	0	0	0	6.7	4.4	2
		Mixed	0	0	0	0	0	0