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MANAGEMENT OF RARE AND ENDANGERED MEDICINAL PLANT USING GEOINFORMATICS APPLICATION IN LOWER SUBANSIRI DISTRICT OF ARUNACHAL PRADESH, INDIA

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Abstract

The indigenous knowledge regarding medicinal plants and their utilization is being increasingly realized and put to use by the modern medicine system. For pharmaceutical industries, these plants form a major source of raw materials, which has elevated the demands of medicinal plants, as resulted into unregulated exploitation of plant resources and fragmentation of natural habitats causing population deletion. As a part of contribution towards conservation of medicinal plant resources, inventory of existing resources and spatial patterns of the resources are essential for short term as well as long term management strategies. The use of GIS and Remote Sensed data for mapping of medicinal plants are under taken for conservation as an evolving strategy. Using tools like Arc-GIS 10.1 and Erdas 13 on Resourcesat II/LISS III data, a total of 13 medicinal plants were mapped through GPS points of each medicinal plant and distribution maps of wasteland/fallow lands in various altitudes 1500-2500masl in the study area was generated. And finally a GIS database on species distribution, population and habitat were generated. In every area of occurrence of medicinal plant, primary data like number of individuals, types of vegetation, soil type, pH and soil moisture were collected. The study provides baseline information for formulating conservation strategies and plans for sustainable management of medicinal plant resources in the region. It also suggests for reintroduction of these medicinal plants on priority basis in the wastelands areas as well as in the community plantation areas.

Key words: Medicinal Plants, GIS, Lower Subansiri, Wasteland, Management, Conservation.

Introduction:

The Indian subcontinent is one of the most distinct bio-geographic regions of the world, with a rich repository of medicinal plants contributing about 7000 species (Ved *et al*., 2015). It has also been approved as the world's second largest exporter of medicinal plants after China (UNDP, 2015). It is estimated that almost 65% of India's population depends upon traditional medicines for sustenance and healthcare needs (WHO, 2002).The medicinal plants play a vital role in the development of new drugs (Alves and Rosa, 2007), collection of which cause tremendous pressure on the wild populations. Arunachal Pradesh contributes about 500 medicinal plants of which 44 species are under threatened category of IUCN (Ved *et al*., 2003). Biodiversity assessment and the needs of

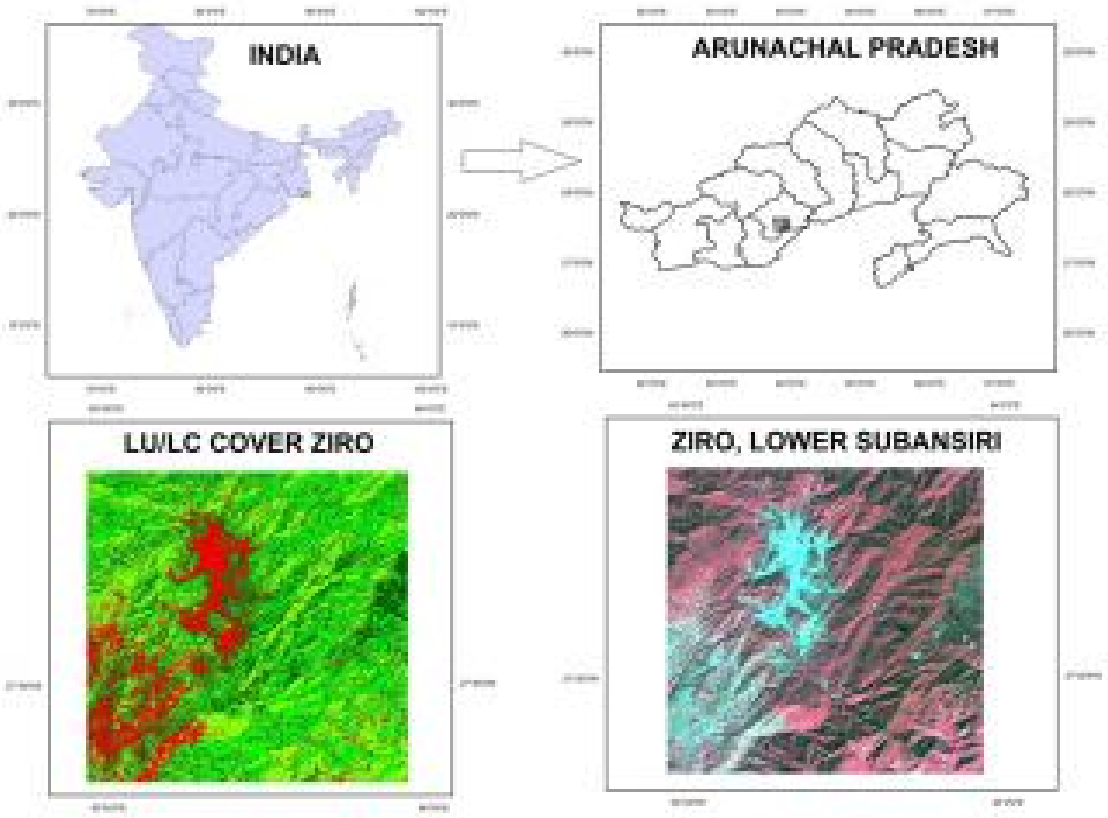
information have been addressed by scientists, decision makers, researchers and many others. In the meeting of Fourth World Parks Congress recognized that individuals and organizations involved in protected areas' work need better information for making decisions regarding conservation issues (IUCN, 1993). They made a range of recommendations concerning the need for better information and information management practice. Similar problems were also discussed in the meeting held at the National Commission for Wildlife Conservation and Development (NCWCD) in Riyadh, 9-10 June 1996, the Arabian Plant Specialist Group (APSG), identified many problems. Availability of information among them on the distribution and occurrence of plant species across the region was inadequate, that there was no networking between botanists in the region, and that there was a lack of a centralized organization. The used of GIS (geographical information system) and remote sensed data are becoming one of the modern technologies which provides large amount of information integrated together in an ease representation. The role of GIS is to integrate and analyse all these forms of data for assessment and monitoring purposes. Salem, (2003) suggested that the best conservation strategy should integrate the available methods and the better use of existing information in a complementary manner. So an attempt has been made to integrate ground zero information and spatial data, to represent the in depth information of medicinal plants population, distribution and habitat using GIS and remote sensed data. The used of GIS in plant conservation has been reported by many workers in and around the world (Sperduto and Congalton, 1996; Natarajan and Srinivasan, 2013; Ved et al., 1998). However, there is a gap in the eastern Himalayan region of India using modern technology for information analysis and management.

Materials and Methods:

Study area:

The study has been conducted in lower Subansiri district of Arunachal Pradesh in the eastern Himalayan region of India. The District lies between 92º40' and 94°21' East Longitude and 26°55" and 28°21' North Latitudes, covers an area of 3,460 (approx) sq.km., is bounded on the North by Kurung-Kumey and Upper Subansiri; on the South by Papum Pare and Assam; on the East by West Siang and some part of Upper Subansiri; and on the West by Kurung-Kumey and Papumpare Districts of Arunachal Pradesh (Fig 1). The altitude of Lower Subansiri district headquarters varies from 1500-3000 meters above sea level. The climatic condition of the district varies from place to place as well as season to season. The climate is largely influenced by the nature of terrain depending upon altitude and location of place. In the foot hills or low high belt area of the district, the climatic condition is moderate in comparison to high belt areas, where during winter is very cold and chill, and in summer it is pleasant. December and January are generally the coldest months, and July and August are the warmest months. There are three major tribes in the district namely Apatanis, Nishis and Hill Miri with the population of 55,726 comprising 28,425 males and 27,301 females as per 2001 census.

Fig 1: Map of Study site.



Survey and data collection:

Extensive field survey was conducted by selecting two type of forest i.e. Protected forest and community lands in Ziro, the headquarter of Lower Subansiri district of Arunachal Pradesh. The selected sites for the study are largely dominated by the Apatani tribe, which are famous for wet rice cultivation, home garden, bamboo and pine plantation (Rai, 2005; Tangjang & Arunachalam 2009). So the field survey was done only in the community owned less disturbed forest and protected forest (Table 1). The survey was done during the month of March-May 2014. GPS points of every occurrence of medicinal plants were collected along with their habitat, soil pH/ moisture% and forest types were also recorded. The populations of medicinal plants were counted manually during the field survey at the selected study sites. For the conservation purpose GPS points of some wasteland/ fallow lands were selected on the basis of soil suitability. The soil samples were collected in 2 different depths (0-15 & 15-30 cm). Soil pH was measured using digital pH meter (M.K VI) and the soil moisture was determined by:

$$\text{Moisture content (\%)} = \frac{\text{Loss in weight on drying}}{\text{Initial sample weight (g)}} \text{ X } 100$$

Table 1.Selected survey sites.

Sl. No.	Name of the site	Forest status
1.	Talley valley	Wildlife Sanctuary
2.	Hija	Community forest
3.	Bulla	Community forest

Methods for preparation of distribution map through GIS:

To prepare the distribution and site suitability map of the medicinal plants a satellite imagery of resources at II/LISS III data of March, 2011 was downloaded from Bhuvan website. The image is then geo-reference into UTM/WGS 84 projection followed by subsetting the image in Erdas Imagine 9.2. After that the AOI (area of interest) imagery are subset with SOI (survey of India) topo-sheet and geocoding it according to image projection. And then digitization of the toposheet followed by generation of LU/LC (land use/land cover) through unsupervised classification using Erdas imagines 9.2 (Fig 2).

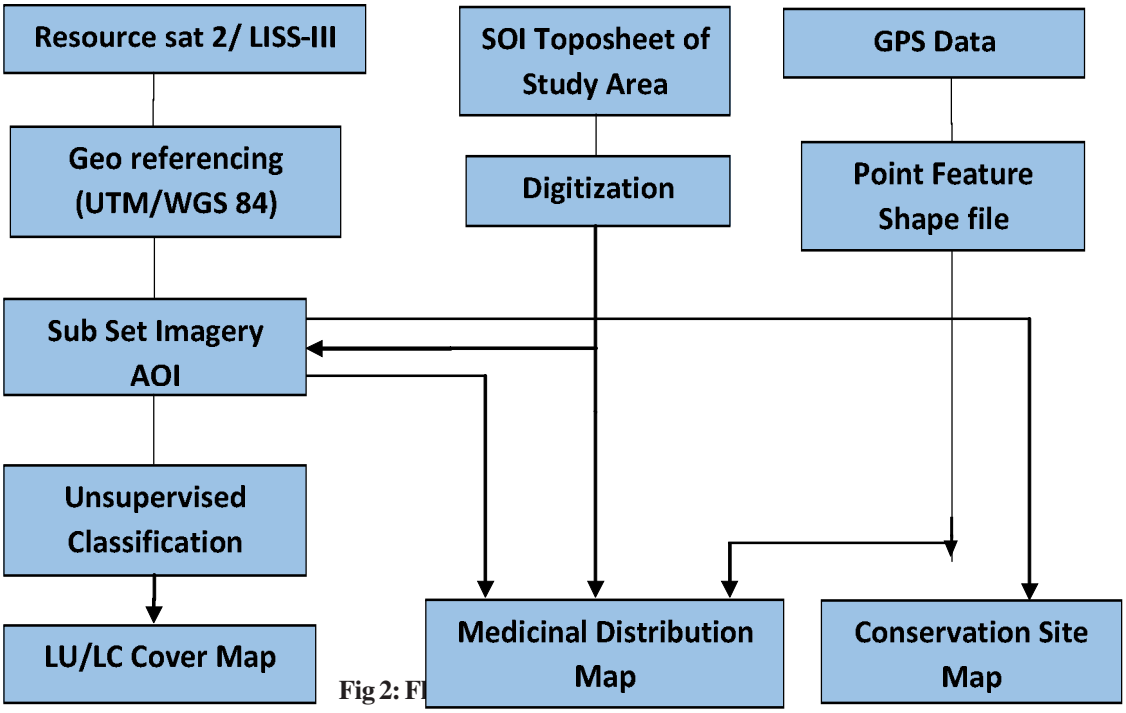


Fig 2: Fl

Result and Discussion:

A total of 13 medicinal plants were documented from the protected and community forest areas of Ziro, Lower Subansiri district. The mapping of the medicinal plants shows that the species are distributed along the altitudinal gradient from community forest to protected forest (Fig 3). Forming a long connected line/chain which happens to proved that these species has been distributed in a close range with favorable topography and climatic condition. However, among them 5 species were observed having site specific nature with low population size of below 500 individuals i.e.*Taxus wallichiana, Paris polyphylla, Panax sikkimensis, Sinopodophyllum hexandrum* within the elevation of 1900-2250masl occurring only in the protected area (Talle Wildlife Sanctuary).These species are also under the threatened category of IUCN as per Ved *et al*., (2003).The study shows that Talle Wildlife Sanctuary was having more species (10 nos.) compare to Bulla (6 nos.) and Hija (5 nos.) shown in table (2). This has proven that the species are affected by various anthropogenic activities. The presence of Anti-HIV-1 activity on *Rhus chinensis* Wang *et. al*., (2008) as well as the anti-tumor activity of *Sinopodophyllum hexandrum* (Qazi *et al*., 2011) and *Paris polyphylla* (Man *et al*., 2009) are invaluable findings which made the plants promising, and the occurrence of other endangered medicinal plants like *Taxus wallichiana, Panax sikkimensis, Piper pedicellatum* has strongly made a point that the study area has good diversity of important medicinal plants which needs further conservation and management (table 2). The soil physical characters were almost similar as of soil type from sandy loamy to fine loamy and covered with thick layer of decomposed dark humus. The rocks observed in the hills are Schist and Dolomites. Soil pH of the study site and the wasteland were found comparatively same (table 3) i.e extreme to moderate acidic in nature. Moreover, the soil moisture percent was found slightly different with more moisture content in forest areas then wastelands. Considering the environmental factors (temperature, humidity, rainfall and soil pH/ moisture) the medicinal plants with economic importance, rare and threatened can be introduced in the wasteland areas presented in the figure (4). The cultivation of medicinal plants has also been taken up by few locals but were unsatisfactory, as medicinal plant cultivation needs better understanding of phenology, germination process and habitat requirement for fruitful propagation. The various kinds of plantation done among the Apatani tribes were documented and found to be very convincing in the field of conservation and sustainable management of medicinal plants. They are almost similar with the modern days forestry, the concept of farm forestry and plantation forestry were practices from several years. The Apatani categorized the artificial forest into 3 types i.e. Bije, Sansung, and Morey. Bije are normally the individual bamboo plantation forest whereas the Sansung are mostly individual forests mostly dominated by pine trees and Morey are the mixed forest which includes bamboo, pine, *Castanopsis*, *Magnolia, Mahonia* etc. Morey's are usually classified as Uru Morey (Sub-clan forest), Hallu Morey (Clan forest), Lemba Morey (Village forest), Booth Morey (Community forest) etc. Ranthii are the sacred grove which are located in every Apatani villages. The Hake-Tari medicinal plant conservation area (MPCA) located in the Ziro plateau is one of the novel initiatives taken up by the government of Arunachal Pradesh with the help of local community under UNDP project. So the findings of the paper will serve as another key factors for proposing more conservation area as highlighted in the figure (4), keeping the objective of CBD i.e. equitable sharing of the benefits with local community.

Table (2): List of plants observed in the study sites.

Sl. No.	Name of species	Family	Occurrence/ Population Size	Habitat	Pharmacological compounds reported
1.	*Berberis aristata* Sims.	Berberidaceae	S1, Low	Temperate Mixed Forest	Antihyperglycemic, antioxidant and anti-neurodegenerative and neuropsychi-atric potential. Singh &Kakkar (2009); Kulkarni & Dhir (2010).
2.	*Clerodendrum serratum* (L.) Moon.	Lamiaceae	S2, S3, Low	Sub-tropical broadleaf Forest	Antioxidant, anticancer, antibacterial, anti-inflammatory and wound healing activity. Singh *et. al*., (2012)
3.	*Embelia ribes* Burm.f.	Primulaceae	S1, S2, S3, Moderate	Sub-tropical broadleaf Forest	Wound healing and antimicrobial activity. Rani &Khullar (2004); Swamy *et. al*., (2007)
4.	*Gaultheria fragrantissima* Wall.	Ericaceae	S1, S2 Abundant	Temperate Mixed Forest	Anti-inflammatory, anti-oxidative. Liu, *et. al*., (2013) ; Karuppusamy *et. al*., (2011)
5.	*Mahonia nepalensis* var. *pycnophylla* Fedde.	Berberidaceae	S1, S2, S3 Moderate	Temperate Mixed Forest	Antineoplastic, anti-inflammatory, antihypertensive agent. Mai *et. al*., (2014)
6.	*Paederia foetida* L.	Rubiaceae	S2, S3, Low	Sub-tropical broadleaf Forest	Antidiarrhoeal activity. Afroz, *et. al*., (2006)
7.	*Panax sikkimensis* R.N.Banerjee.	Araliaceae	S1, Low	Temperate Mixed Forest	Anti-neurotoxins, cytotoxic activity. Kim & Park (2011).
8.	*Paris polyphylla* Sm.	Melanthiaceae	S1, Low	Temperate Mixed Forest	Antitumor and antimetastatic activity. Man *et. al*., (2009)
9	*Piper pedicellatum* C. DC.	Piperaceae	S1, S3, Low	Sub-tropical broadleaf Forest	Reducing, stabilizing and capping agent of Ag-Au nanoparticles. Tamuly *et. al*., (2013)
10.	*Rhus chinensis* Mill.	Anacardiaceae	S1, S3 Low	Sub-tropical broadleaf Forest	Anti-HIV-1 activity. Wang *et. al*., (2008)
11.	*Sinopodophyllum hexandrum* (Royle) T.S.Ying	Berberidaceae	S1, Low	Temperate Mixed Forest	Anti tumor Qazi *et. al*., (2011)
12.	*Smilax zeylanica* L.	Smilacaceae	S1, Low	Sub-tropical	Antidiabetic activity Rajesh *et. al*., (2010) broadleaf Forest
13.	*Taxus wallichiana* Zucc.	Taxaceae	S1, Low	Temperate Mixed Forest	Anticonvulsant, analgesic and antiyretic activity.Nisar *et. al*., (2008)

Note: Abundant= >1500; Moderate= <1000; Low= <500; S1= Talle WLS, S2= Hija, S3= Bulla

Table 3: Moisture content and Soil pH of selected forest and wasteland areas.

Name of the Site	Soil Depth(cm)	Moisture (%)	p^H
Bulla community forest	0-15	40	4.38
	15-30	39.93	4.57
Talle WLS	0-15	33.13	5.38
	15-30	30.46	4.73
Hija community forest	0-15	35.06	5.5
	15-30	31.33	5.3
Manipolyang wasteland areas	0-15	25.46	5.62
	15-30	25.86	5.1
Bulla wasteland areas	0-15	25.26	5.82
	15-30	25.66	5.84
Hija wasteland areas	0-15	25.06	5.5
	15-30	21.33	5.5

Fig 3: Distribution map of medicinal plants in the study site.

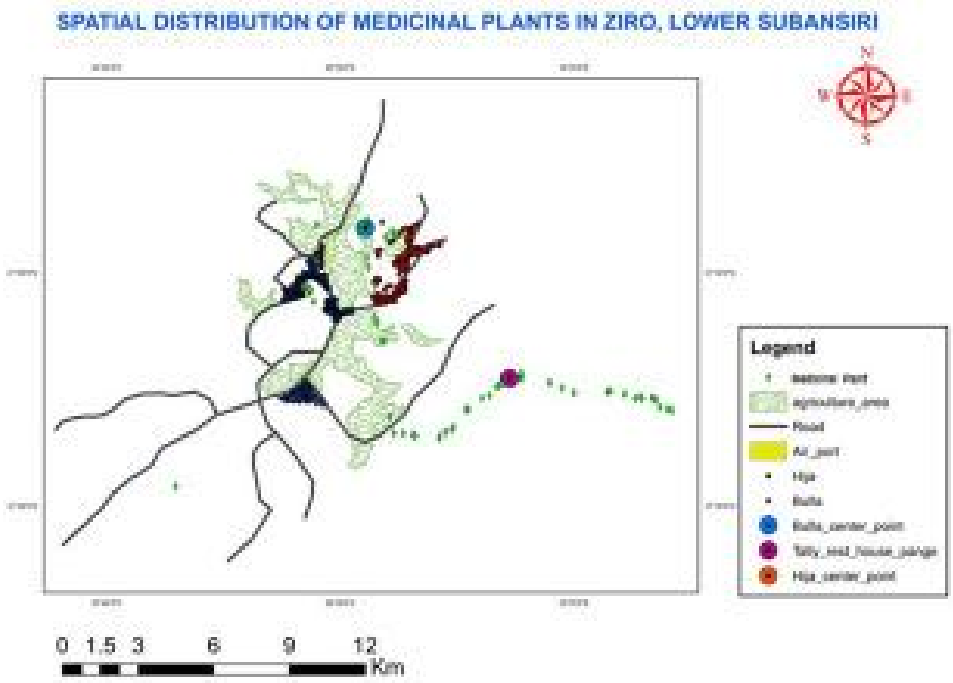
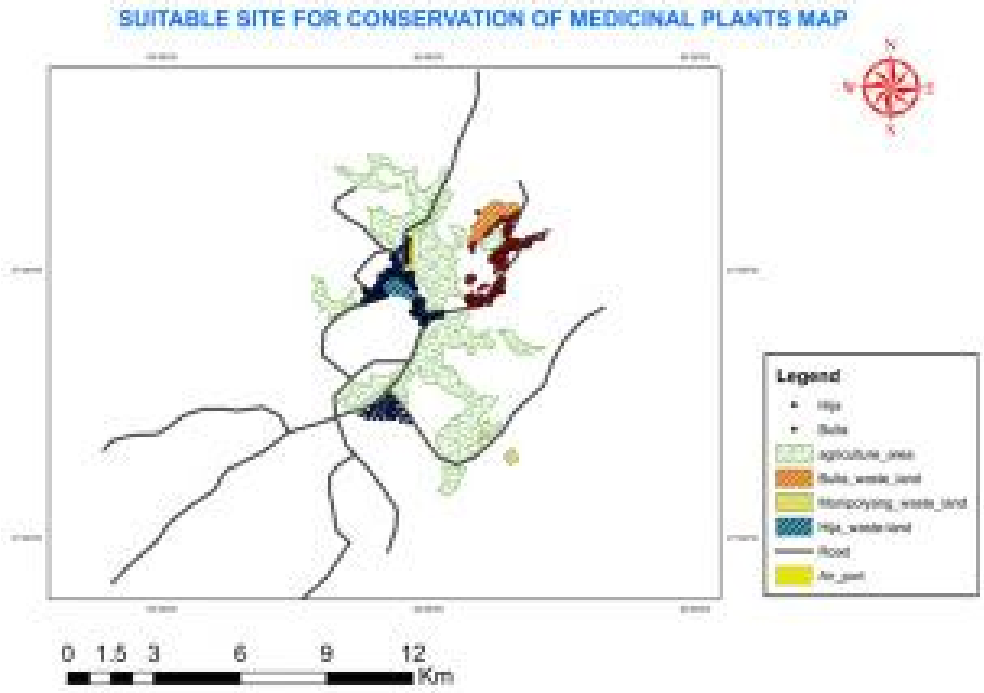


Fig 4 : Suitable sites proposed for medicinal plant



Conclusion:

The study reveals that the selected sites are some of the important areas for conservation of medicinal plants. The comparative study of habitat and soil for the management of medicinal plants could be an important approach for conservation. Similar approach can be made in various parts of the state for assessment of medicinal plant wealth, as most of the medicinal plants are threatened by various anthropogenic activities. The conservation of any flora or fauna can only be fruitful when the local communities are involved in formulating strategies and plan for a particular area. While livelihood support of the community from medicinal plant will only be possible when a transparent marking channel is created were every stakeholder and the local community who work and cultivate these medicinal plants will get equal share of the benefits/profits.

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