Application of Google Maps for Guiding Medicinal Plants Conservation Action Program
A case study of Sikkim State

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Abstract:

Anthropological pressures are threatening more and more species of plants to go extinct, and there is a need to conserve them. For conservation of plants, it is very important to know their geographical ranges and critical areas that need protection of wild genepool to conserve them in wild. Foundation for Revitalization of Local Health Traditions has been working on Medicinal Plants knowledge documentation and conservation efforts since 1993 (FRLHT, 2006). A comprehensive database has been curated by FRLHT providing data on geographical distribution of Wild Indian Medicinal Plants using GIS (Ved and Sathya Sangeetha, 2013) for this purpose. To provide easy access to this distribution data to researchers, a software module was developed. Here we present the process and operation details for the module developed for Sikkim state.

The distribution data module's main focus is to give a quick preview of the natural distribution of important medicinal plants. This helps in focusing the conservation efforts to protect these plants. The distribution is recorded on four levels. First being global level, where each country in which the plant present is highlighted. This helps in understanding the distribution throughout the world. Second is national level map, where states with presence are highlighted. Third, is district level presence maps. The last level is point distribution maps, where each occurrence is plotted using the latitude and longitude value of the presence. These maps are useful to understand the distribution of narrow endemic plants.

This information primarily feeds in the Conservation Assessment and Management Planning (CAMP) workshop, where medicinal plants species are prioritized for a particular state for conservation action with the application of International Union for Conservation of Nature and Natural Resources (IUCN) guidelines (http://envis.frlht.org/conservation-concern-species-india.php). The analysis of presence of a species by botanists and floras will help in guiding resource managers and policy makers for establishing or proposing Medicinal Plants Conservation Areas (MPCAs) at state level through State Forest Departments (FRLHT, 2006 and Ved and Sathya Sangeetha, 2013). These MPCAs are *in-situ* conservation sites for preserving prioritized wild medicinal plants resources in its natural habitat (http://envis.frlht.org/mpca.php). The following paper will discuss how distribution data can be curated from flora, field observations, specialized databases and online data and use of Google Plotting approach for guiding conservation action programs.

Key words: *in-situ* conservation, MPCAs, Google Maps, medicinal plants

Introduction:

It is estimated in India that between 40-70% of the local flora is used human and veterinary health care. (Shankar, 1996). This puts lot of pressure on the resources, since they are extracted for use in food, fuel as well as medicine. In order to conserve medicinal plants genepool in wild, in-situ conservation sites are established. Over two decades and more, FRLHT, MOEF&CC, DANIDA, UNDP, NMPB, State Forest Department and State Medicinal Plants Board have established 108 MPCA (Srinivasamurthy et al. 2003) across India in states such as Uttarakhand, Rajasthan, Arunachal Pradesh, Madhya Pradesh, Chhattisgarh, West Bengal, Maharashtra, Orissa, Karnataka, Andhra Pradesh, Kerala, Tamil Nadu.

Presently, FRLHT is working with Sikkim State Medicinal Plants Board (SSMPB) for prioritization of medicinal plants of conservation concern and guide them for conservation action for resource management and augmentation. During September to November 2014, CAMP workshop was organized at Gangtok, India which lead to prioritization of 48 species in a august gathering of expert field botanists, IUCN specialist, healers, foresters, traders, Indian System of Medicine specialist. During this process, actual field data from the botanists were curated along with latitude and longitude information for most of the locations. This data was further analyzed and Google maps were used to plot the information and design maps related to location and species wise using Herbarium and Raw Drug Module which has a section on Distribution Data Module (Deepali A. Nawale, 2014-15).

Location wise Google maps, will list all the prioritized species recorded in that particular place. Based on ascending order of number of species found in that location, resource managers can decided whether to establish an MPCA in that location or not.

In species wise Google maps, a detail regarding various locations where a particular species is found growing naturally is marked. This will enable planners and field botanist to cite the species in wild, conduct population studies and support in species conservation, recovery or augmentation programs.

Data Collection:

For collection of the data methodology being followed is outlined in (Ved D. K. et al. 1998). Data was collected using various source during Conservation Assessment and Management Prioritization (CAMP) of Medicinal Plants of Sikkim, jointly organized by Foundation for Revitalization of Local Health Traditions (FRLHT) and State Medicinal Plants Board (SMPB) of Sikkim and State Forest Department (SFD) supported by National Medicinal Plant Board (NMPB) (Ved and Suma, 2015).

1. **Literature survey:**

This includes referring to different international, national and regional floras (including e-floras), multidimensional databases (FRLHT's database, 2015), well known websites, which gives us the range of locations (including precise latitude and longitude where ever available) for a particular species in the form of digital maps (http://envis.frlht.org/digital-atlas-main.php) and herbarium images (http://envis.frlht.org/digital-herbarium-main.php).

2. **Application of Digital Accessible Knowledge (DAK):**

In addition to these sources, data was also accessed for various internet sources specially the Global Biodiversity Information Facility (GBIF, 2015). This data was downloaded using R language (R Development Core Team 2014) and the package rgbif (Chamberlain et al. 2014). This data was then augmented with more records form social networking sites like Flickr using the techniques described in (Barve, 2014).

3. Field observations from CAMP workshop and botanical surveys:

Field survey is important factor from which we can get location name, latitude and longitude. In Sikkim CAMP workshop, presence of a particular species with respect to its location names and number of locations, population status was documented systematically from botanical field experts, local forest department staffs, healers, researcher, and State Medicinal Plants Board (SMPB) officers. Specialist on one family (Example: Orchidaceae) or taxa (Example: *Panax* sp.) were involved to get precise locations of a species which have narrow distribution or endemics. Botanical surveys conducted in various regions of Sikkim were also documented and the reports were shared for preparation of maps.

4. Application of herbarium collections:

Herbarium is a repository of processed and dried plant specimen with correct botanical identity and an unique accession number. These specimens carry basic information related to a plant species collected from a region. Viz-scientific name, local name, field characters, locations of collection, latitude longitude information, date of collection. This information is used for mapping purpose.

5. Data Organization and curation:

After collecting raw data from different source as discussed above, this information was organized in table format using Microsoft Excel 2010 i.e. data tabulation was created having fields like species name, location name, latitude, Longitude and source reference. If latitude and longitude are already located, then it is entered as it is and rechecked using map application. For those locations which lacked latitude longitude information, data was obtained through various websites like GBIF, Google Earth and personal communication with researchers who have conducted studies in those regions. This Excel sheet was converted to MS Access for exporting it to Distribution Data Module.

6. Distribution data module preparation:

This is a module which helps in plotting locations of plant species on Google Map. For preparing this module following steps were taken:

a. Designed a UI (User Interface) using GMap control in Visual Studio 2010, for uploading and retrieval of latitude and longitude of a location where a species was cited/ recorded.

b. Exported data from Excel to Microsoft Access 2010, so that it is easy to link data to the module as backend and generated map as per location and species wise (Table 2).

Result and Discussion:

Through the Google plotting exercise, more than 100 locations were marked on the GMap. On these maps plant details with respect to presence details were laid. This resulted in two type of maps viz.

1. Species wise maps:

Figures (1) and (2), represents species wise mapping for '*Thalictrum foliolosum* DC.' and '*Rhododendron anthopogon* D. Don' accordingly. The tabulation on left hand side of both the images shows list of locations where a species occurs naturally and in which altitude. This information can be used to understand the range of distribution of a species and take up further population studies and resource management and augmentation measures.

In another instance (Figure 3), plotting exercise can help in locating narrow endemics. This will also show region sensitivity. Example: *Panax sokpaiyensis*, is a narrow endemic (Shiva Kumar Sharma and Maharaj Krishan Pandit. 2009), to Sikkim is assessed as Endangered (globally) because of limited number of locations and population size plus suspected harvest in wild as gingseng. When locations were plotted on the map, we could infer that the

documented locations in CAMP workshop are in close proximity. This inference also supports the threat assessment process. Further it gives focus to resource managers to design specific conservation action programs like establishing MPCA exclusively for this species.

2. Location wise maps:

There were more than 100 locations plotted on the GMap. Prioritization of location was carried out using number of species present in a particular latitude longitude from data set. For Example: Tamzey topped in the list harboring more than 18 threatened plant species representing all categories of threat from Endangered to vulnerable (Figure (4) and Table 1) thus showing diversity and species richness. Considering various other threats in this region including over exploitation, developmental activities, this particular location is proposed as a MPCA to conserve wild population of the species.

References:

1. Deepali A. Nawale. 2014-15. Herbarium and Raw Drug Module, FRLHT. Department of Computer Science, K. K. Wagh Arts and Commerce, Science and Computer Science College, Nashik. University of Pune. (Post Graduate Dissertation, unpublished)
2. Barve, V. 2014. Discovering and developing primary biodiversity data from social networking sites: A novel approach. Ecological Informatics 24:194–199.
3. Chamberlain, S., K. Ram, V. Barve, and D. Mcglinn. 2014. rgbif: Interface to the Global Biodiversity Information Facility API. [Online.] Available at http://cran.r-project.org/package=rgbif.
4. FRLHT, 2006, Conservation and Adaptive Management of Medicinal Plants - A Participatory Model: Medicianl Plants Conservation Areas and Medicinal Plants Development Areas. FRLHT, Banglore, India.
5. R Development Core Team. 2014. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. [Online.] Available at http://www.r-project.org/.
6. Shankar, D. 1996. Conserving the Medicinal Plants of India: The Need for a Biocultural Perspective. The Journal of Alternative and Complementary Medicine 2:349–358. Mary Ann Liebert, Inc. 2 Madison Avenue Larchmont, NY 10538 USA.
7. Shiva Kumar Sharma and Maharaj Krishan Pandit. 2009. A New Species of *Panax* L. (Araliaceae) from Sikkim Himalaya, India. Systematic Botany 34(2):434-438. 2009 .
8. Srinivasamurthy, T. S., M. Karnat, V. Prabhakaran, S. N. Jadhav, S. Elkunchwar, K. Ravikumar, and U. Ghate. 2003. Medicinal plants conservation and sustainable use through forest gene banks. Indian forester 129:179–186. Forest Research Institute.
9. Ved D. K., Barve Vijay, Noorunnisa Begum S., and Latha R. 1998. Eco-distribution mapping of the priority medicinal plants of southern India . Current Science 75:205–208.
10. Ved D. K. and Suma T. S. 2015 Prioritization of Wild Medicinal Plant Species of Sikkim for Informed Conservation Action.In: Medplant - ENVIS Newsletter on Medicinal plants; 8(1,2,3&4): 10-11 http://envis.frlht.org/newsletters/Envis_Newsletter_April_2015.pdf
11. Ved D. K. and Sathya Sangeetha, 2013, Mapping Geographical distribution of Wild Indian Medicianl

Plants; 6 (1, 2, 3 & 4): 11-12 http://envis.frlht.org/newsletters/Envis_Newsletter_June_2013.pdf

12. Editors: Suma Tagadur Sureshchandra, D. K.Ved, Thinley Gyatso Bhutia, Vijay Srinivas, Sumanth M.V., Kaliamoorthy Ravikumar, S.N. Venu Gopal, Sathya Sangeetha, Vijay Barve, Tika Prasad Sharma, Sugandhi Rani, Sumy Oomeen, Umesh Kumar Tiwari, N. Balachandran, Haridasan K., Asha Bhosle, Derle Deepak Radhakrishan, Pavitha A., Nandini Mysore, Patchaimal, P., Pempa Tshering Bhutia, Norzang Lachenpa, Ongdup Bhutia, G.S.Goraya, Ganesh Babu, P., Narasimhan D., Sunil Bhursing Deore, Surekha K.V., Tushar Derle, Nikhil Desale, A. Dinesh Kumar, Shilpa Naveen, Tabassum Ishrath Fathima, Sumalatha B.S., Vinay R., Sindhu D., Binny Bhadran, Noorunissa Begum, Sumathi R., Hemanth and Swathi B.H. 04. Inventory of Medicinal and Aromatic Plants of Sikkim: Release Version: .0. FRLHT, Bangalore and SMPB, Government of Sikkim, Gangtok.

13. **Databases and websites:** FRLHT's database on Indian Medicinal Plants, 2015, FRLHT Banglore. GBIF.org, envis.frlht.org, http://envis.frlht.org/sikkim

Table 1. Conservation Concern Medicinal Plants of Sikkim

Species Name	IUCN Status	Number of Species
Panax sokpaiyensis Shiva K.Sharma & Pandit	EN (G)	1
Allium wallichii Kunth, *Fraxinus floribunda* Wall., *Saussurea obvallata* (DC.) Edgew. and *Swertia chirayita* (Roxb. ex. Flem.) Karst.	EN (R)	4
Aconitum ferox Wall. ex. Seringe, *Bergenia purpurascens* (Hook. f & Thomson) Engl., *Ophiocordyceps sinensis* (Berk.) G. H. Sung, J. M. Sung, Hywel-Jones & Spatafora, *Dioscorea deltoidea* Wall. ex Griseb., *Ephedra gerardiana* Wall. ex Stapf, *Flickingeria fugax* (Rchb. f.) Seidenf., *Fritillaria cirrhosa* D. Don, *Gymnadenia orchidis* Lindl., *Hippophae salicifolia* D. Don, *Hodgsonia heteroclita* (Roxb.) Hook. f. & Thoms., *Jurinea macrocephala* DC., *Litsea citrata* Blume, *Malaxis acuminata* D. Don, *Malaxis muscifera* (Lindl.) Kuntze , *Nardostachys jatamansi* (D. Don) DC., *Neopicrorhiza scrophulariiflora* (Pennell) D.Y.Hong, *Panax bipinnatifidus* Seem., *Paris polyphylla* Sm., *Platanthera edgeworthii* (Hook. f. ex Collett) R.K. Gupta, *Podophyllum hexandrum* Royle, *Polygonatum cirrhifolium* (Wall.) Royle, *Polygonatum verticillatum* (L.) All., *Rhododendron anthopogon* D. Don, *Saussurea gossypiphora* D.Don, *Valeriana jatamansi* Jones and *Zanthoxylum acanthopodium* DC.	VU (R)	26
Betula utilis D. Don, *Juniperus recurva* Buch.-Ham. ex. D. Don, *Mahonia napaulensis* DC., *Meconopsis horridula* Hook. f. & Thomson, *Oroxylum indicum* (L.) Kurz, *Rheum nobile* Hook. f. & Thoms. and *Roscoea purpurea* Sm.	NT (R)	7
Campylandra aurantiaca Baker, *Docynia indica* (Wall.) Decne., *Hedychium spicatum* Sm., *Heracleum wallichii* DC., *Meconopsis paniculata* (D. Don) Prain and *Thalictrum foliolosum* DC.	LC (R)	6
Berberis aristata DC., *Podophyllum sikkimense* R. Chatterjee & Mukerjee, *Trillium govanianum* Wall. ex. D. Don and *Valeriana hardwickii* Wall.	DD	4
Adapted from http://envis.frlht.org/newsletters/Envis_Newsletter_April_2015.pdf		

Table 2: Example of Access table showing latitude longitude details for a particular species (Data obtained from Sikkim CAMP workshop, 2014)

Scientific name of the plant	Habit of Plant species	Altitude (m ASL)	Locations in Sikkim recorded during CAMP workshop, November 2014	Latitude (Decimal)	Longitude (Decimal)	Latitude and longitude source
Panax sokpaiyensis Shiva K.Sharma & Pandit	Herb	1700- 2400	Utteray	27.260591	88.094961	www.latlong.net
Rhododendron anthopogon D. Don	Shrub	3000-4500	Barsey Rhododendron Sanctuary	27.205372	88.107987	Expert
Thalictrum foliolosum DC.	Herb	2500- 3500	Lachen valley	27.72778	88.55278	GBIF
Thalictrum foliolosum DC.	Herb	2500- 3500	Lachung	27.80222	88.70611	GBIF

Figure (1) species wise map for *Thalictrum foliolosum* DC.

Figure (2) species wise map for *Rhododendron anthopogon* D. Don

Figure (3) species wise map for *Panax sokpaiyensis* Shiva K.Sharma & Pandit

Figure (4) location wise map for Tamzey, Sikkim