# Rapid Mapping Exercise (RME) of Medicinal and Aromatic Plants (MAPs): The Uttarakhand Experience

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## Genesis

The Uttarakhand Forest Department is vested with the larger responsibility of managing forests (71%) under various categories viz., Protected Areas (PAs), Reserved Forests (RFs), Protected Forests (PFs) and un-classified forests for biodiversity conservation and ecosystem services (both tangible and intangible), meeting the biomass demands of the local communities and a variety of other functions. The department has been proactive in the conservation and development of Medicinal and aromatic plants (MAPs) in the state. Major activities pertaining to this sector include control of illegal harvest of MAPs from the Reserved Forests, protection of natural habitats, development of MAP nurseries, inventory and monitoring of MAPs, promoting MAP plantation under afforestation and reforestation drives. The department has also taken steps to control illegal harvest of MAPs from wild. To implement this, the MAP species have been grouped into three categories viz., (i) species banned for collection (ii) species open for collection, and (iii) species which can be sustainably harvested. In recent years the department has given special emphasis on incorporating Non Timber Forest Produce (NTFP)/MAPs in forestry Working Plans, especially for those forest divisions, which fall under non-forested areas such as alpine grasslands, rocky and drier tracts which otherwise do not support forest vegetation and are congenial for the growth of a variety of MAPs.

The state of Uttarakhand has been projected as 'Herbal State' of India. To make this a reality, the Government of Uttarakhand has formulated several conservation and development plans for this sector. The production and development of MAPs in the state are closely linked to rural livelihood, traditional health care system, growth of pharmaceutical industries and conservation on a sustainable basis, it would be essential to assess the resource availability, regeneration potential and harvestable

limits without depleting the natural populations of high value MAPs.. It has been realized that *in-situ* conservation of MAPs has to be backed by effective *ex-situ* conservation measures, such as development of herbal gardens and training of farmers in propagation of high value MAPs.

Therefore, need for preparing comprehensive Conservation, Development and Harvest (CDH) plans for various Forest Divisions has been felt. A collaborative project between the Wildlife Institute of India and Uttarakhand Forest Department was initiated during 2008-2012 on the **Rapid Survey and Mapping of** C**ommercially Important Medicinal and Aromatic Plants** in various Forest Divisions of Garhwal region with following objectives: i) To quantify the availability of commercially important medicinal plants in various forest ranges of Garhwal region, ii) To generate a spatial database on the distribution and abundance of medicinal plants for the future monitoring and conservation planning, and iii) To evolve strategies for sustainable harvest of medicinal and aromatic plants along with recommendations for conservation and development.

**Approach**

A manual on Rapid Mapping Exercise (RME) for Medicinal and Aromatic Plants developed by Rawat et al. (2004, Fig. 1) was used. The following are the basic steps for the preparation of inventory of Medicinal and Aromatic Plants (MAPs):

**A)** **Reconnaissance:** During reconnaissance the administrative and ecological zones of the survey area are delineated and a preliminary checklist of locally and commercially used plants available in the area, forest types, existing trails, and size of the area are recorded with the help of local communities/forest staff.

**B)** **Stratification:** Based on the initial reconnaissance and knowledge of the area each survey locality, block/compartment is divided into smaller natural units or strata, which are mainly based on landform, terrain, disturbance regime, altitude and vegetation types.

**C)** **Trail/ Transect selection and marking:** Sampling within each stratum is done on either side of the trails/transects, which are laid randomly. However, in a rugged and hilly terrain it is not feasible to lay a straight line or random transect. Therefore, for the practical reasons transects are laid along least beaten trails wherever feasible.

**D)** **Laying out sample plots:** The length of transects/trails depend on the size of the forest. Usually within a forest patch (*ca.* 5 $km^2$), 1 km long transect is laid with 20 circular plots (10m radius each) at a distance of 50m either side and avoided 10-15 m area considering the disturbance to the area (Fig. 1).

**E)** **Data collection:** The individual MAPs (all the medicinal trees, shrubs, climbers and herbs) are counted within the sample plots. In addition to MAPs environmental data such as altitude, aspect, closest associates of the survey species, topography, perennial water and human pressures such as grazing, uprooting, and fire incidences are recorded.

**F)** **Data analysis and Interpretation:** Data on the presence/absence and availability of MAPs in an area are quantified in terms of frequency, density and cover for the each transect.

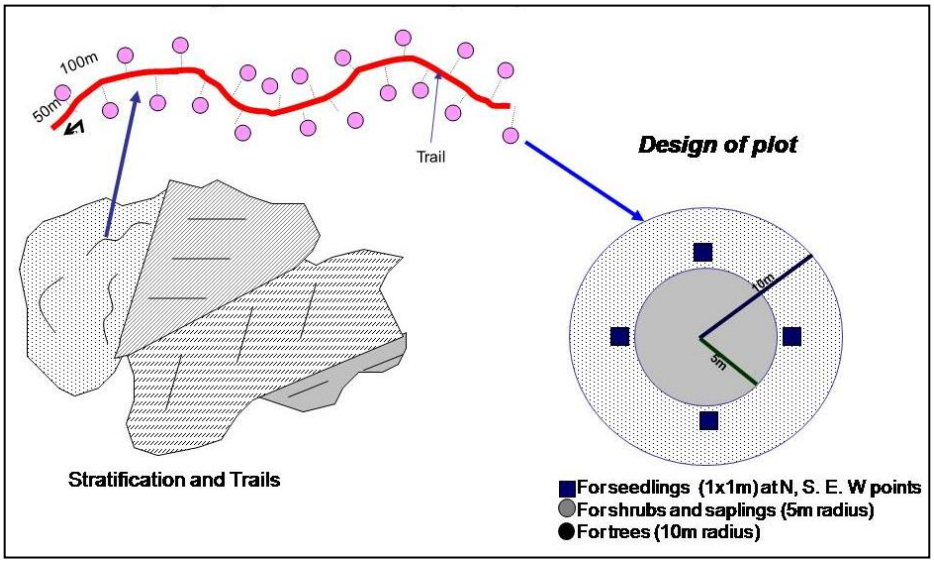



Fig. 1. Schematic representation of transect layout and sample plots.

The frequency and density of each species is calculated, while for spreading and mat forming medicinal plants cover (in terms of % area coverage on the ground) is a better measure of estimating availability. It is also useful for mapping and monitoring if the measurements are taken within the fixed plots. Mean cover of individual species were estimated for the each transect for the mapping purpose.

**Need for monitoring**

Biological monitoring, the activity of recording specific information about a species in a consistent manner over time (number of individuals, various phenophases,

habitat preference, rate of spread and impact on other species), provides data that lead to a better understanding on its distribution and abundance, which contribute towards its effective management at various climatic zones. In recent years several biotic mainly anthropogenic and abiotic factors pose various kinds of challenges for the medicinal and aromatic plants in various climatic zones and the monitoring has been very difficult due to establishment and proliferation of exotics.

The permanently marked sample areas are essential to monitor long-term changes in plant biodiversity in different ecosystems. The ecosystems may be very different at different stages depending on the requirements of their constituent species, mainly due to abundance, richness, and community structure. Changes over the long-term and the influences of climate, biotic cycles and anthropogenic impacts can only be determined by long-term monitoring. Monitoring at regular intervals for a minimum of five years, allows significant fluctuations in observed values to be recognized as unusual events rather than as normal responses. Such data lead to much more informed conclusions about the biology of an organism or the interactions within an ecosystem in response to abiotic and biotic variables and may further be used to envisage the future scenarios due to climate variability.

**Major habitats in Garhwal region**

The state of Uttarakhand has enormous wealth of Medicinal and Aromatic Plants (MAPs), known as minor forest products or non-timber forest products (NTFPs), form an important raw material and economic resource base in the state. Historically, Uttarakhand has been the abode of a large number of saints and sages for centuries, which during the course of their meditations developed the science of Ayurveda. In fact, one of the greatest Ayurvedic texts, Charaka Samhita holds this region in high esteem and describes it as the best habitat of herbal wealth. The medicinal plant diversity in the state is severely threatened by natural as well as anthropogenic disturbances, such as tree cutting, grazing, lopping, fuel wood, fodder and litter removal apart from elevation and habitat. The state is divisible into four distinct ecological zones *viz*., Sub-tropical, Temperate, Sub-alpine and Alpine. The sub-tropical region is dominated by *Acacia catechu, Dalbergia sissoo, Shorea robusta*, Mixed broadleaved-conifer (*Pinus roxburghii*) and Chir pine (*P. roxburghii*) forests; temperate region by chir pine-banj oak (*Quercus leucotrichophora*), banj oak, Alder (*Alnus nepalensis*), Alder mixed, Harinj (*Q. glauca*) and mixed broadleaved forests,

tilonj oak (*Q. floribunda*), silver fir (*Abies pindrow*), horse chestnut (*Aesculus indica*), maple (*Acer spp*.), kail (*Pinus wallichiana*) and deodar (*Cedrus deodara*) forests, sub-alpine region by kharsu oak (*Q. semecarpifolia*), conifer (*Abies pindrow-A. Spetabilis-Picea smithiana*), Conifer-broadleaved, silver fir (*A. Spectabilis*), birch (*Betula utilis*) forests with krummholtz (*Rhododendron campanulatum*) and alpine region by various kind of herbaceous plant communities (Adhikari & Rawat ).

**Rapid Mapping Exercise (RME) in Garhwal region: A case study**

RME for Medicinal and Aromatic Plants in Garhwal region (7 districts; Fig. 2), Uttarakhand was conducted during 2008-2012. Garhwal region with 15 reserve forest divisions with 80 ranges covering an area of 11528.26 km$^2$ (UKFD Statistics, 2009-2010), of which Uttarkashi, Tehri and Badrinath divisions are the largest divisions with an area 2243.7, 1432.7 and 1346.5 km$^2$ and Haridwar, Chakrata and Soil Conservation Kalsi divisions are the smallest divisions with an area 33039.0, 36168.4 and 23318.5, respectively.


Fig. 2. Map of Uttarakhand showing Garhwal Division.

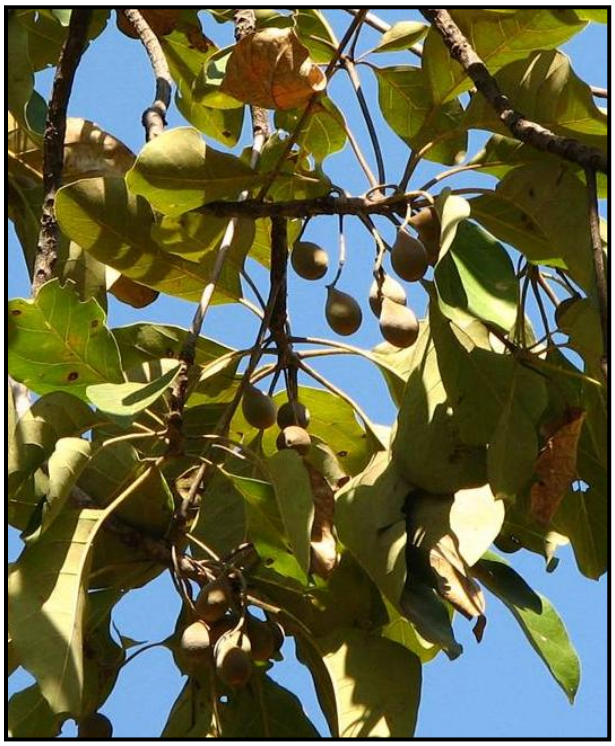

Fig. 3. Map of Garhwal region showing surveyed areas (light grey coloured) along with protected areas.

In all, 582 transects were laid in various Forest Divisions (FDs). The number of transects laid in each reserve forest divisions of Garhwal region varied as per the area available and different habitat types for each ranges in FDs (Badrinath FD - 49, Chakrata FD - 33, Dehradun FD - 81, Garhwal FD - 36, Haridwar FD - 13, Kalsi SCD - 3, Kedarnath WD - 34, Lansdowne FD - 28, Mussoorie FD - 27, Narendranagar FD - 35, Rudraprayag FD - 23, Tehri FD - 79, Tons FD - 34, Upper Yamuna FD - 43 and Uttarkashi FD - 64).

A total of 95 (12 trees, 13 shrubs, 10 climbers and 60 herbaceous species) highly commercially important MAPs were recorded in various transects, of which 54 species have been prioritized for conservation and development for Garhwal region, along with potential blocks and ranges recommended for conservation and development. All the high value medicinal trees recommended for conservation and assisted natural regeneration within respective Forest Blocks/Ranges. Few ranges have been stands out as most ideal range for the conservation, development and harvest of various MAPs for some important MAPs. Rotational harvest (4-5 years) of certain species has been recommended for some blocks.

**Status of Bahera (*Terminalia bellirica*) in Garhwal: An example**

*Terminalia bellirica* locally known as Bahera under family Combretaceae generally found between 400-1300 m altitude is a large deciduous tree and native to India or Malaya. Its fruits and seeds are used for different kinds of ailments, such as asthma, bronchitis, cough, diabetes, dysuria, gastric problems, leprosy, liver problem, muscular pain, piles and stomachache (Singh and Dey 2005, Khare 2007, Adhikari 2003, 2010).



**Distribution in Garhwal**: The maximum population of *Terminalia bellirica* was found in Lansdowne FD (South Kotdi Block in Kotdi

Range) with 165.5 ± 0.7 trees $ha^{-1}$ and Haridwar FD (Shyampur Block in Shyampur Range) with 100.4 ± 7.1 trees $ha^{-1}$, however, moderately in Narendranagar FD (Singtali Block in Shivpuri Range) with 43.0 ± 1.4 trees $ha^{-1}$ and in Haridwar FD (Chandi and Shyampur Blocks in Shyampur Range) with 31.9 ± 1.2 trees $ha^{-1}$. It was also occurred in Mussoorie FD, Lansdowne FD, Narendranagar FD, Dehra Dun FD and Lansdowne FD (Table 1).

Table 1: Status of *Terminalia bellirica* in various Forest Divisions of Garhwal. The class depicted L, M and H for low, medium and high, respectively based on density values.

| **Division** | **Range** | **Beat** | **Block (Compartment)** | **Density (Trees $ha^{-1}$)** | **Class** |
|---|---|---|---|---|---|
| Chakrata | River | Tilwari | Kalsi (9) | 7.96±0.7 | L |
| Dehradun | Asarodi | Karwapani East | Karwapani (7b) | 1.52±0.22 | L |
| | | Karwapani East | Karwapani (7b) | 1.52±0.22 | L |
| | | Karwapani West | Karwapani (2b) | 1.52±0.21 | L |
| | | Chandrabani | Laldhang (5) | 4.55±0.36 | L |
| | Badkot | Ghamandpur-II | Ranipokhri (5a) | 4.78±0.67 | L |
| | | Ghamandpur-II | Ranipokhri (1b) | 1.59±0.22 | L |
| | Jhajra | Pondha | Kondoli (13) | 9.55±0.4 | L |
| | | Majhaon-II | Majhaun (11) | 12.73±1.21 | L |
| | Lachhiwala | Dudhli | Dudhli (10) | 1.59±0.22 | L |
| | | Nawada | Nawada (8) | 1.59±0.22 | L |
| | | Non forest (NF) | NF (NF) | 4.78±0.7 | L |
| | Malhan | Sahansara | Sahansara (1a) | 1.52±0.21 | L |
| | Malsi | Malsi DeerPark | Rajpur (1) | 3.18±0.37 | L |
| | Rishikesh | Gola-East | Golatappar (6a) | 1.59±0.22 | L |
| | | Bibiwala South | Bibiwala (11) | 1.59±0.22 | L |
| | Lachhiwala | Nawada | Nawada (10) | 3.18±0.37 | L |
| | Thano | Kalimati | Paled (5) | 3.18±0.37 | L |
| | | Pled | Malkot (3) | 4.78±0.37 | L |
| | | Danda | Thano (3) | 9.55±0.81 | L |
| | | Nahi | Nahi (2) | 11.15±0.67 | L |
| | | Pled | Paled (2) | 12.74±0.99 | L |
| Haridwar | Khanpur | Khanpur South | Sakrauda (2a(i)) | 6.37±0.00 | L |
| | Chiriyapur | Godikhata-I | Kotawali (5b) | 7.96±0.50 | L |
| | | Amsot | Sabalgarh (2a) | 11.15±0.41 | L |
| | | Katewad West | Kotawali (4) | 25.48±0.95 | L |
| | Shyampur | Kansavali | Shyampur (1) | 11.15±0.41 | L |
| | | Sidh-I | Chandi (6) | 12.74±0.82 | L |
| | | Nastarwali | Chandi (4) | 31.85±1.15 | L |
| | | Shyampur | Shyampur (8) | 100.40±7.07 | M |

| | | | | | |
|---|---|---|---|---|---|
| Kalsi | Timli | Sabhawala | Majari (11b) | 1.52±0.22 | L |
| Lansdowne | Lansdowne | Bhankot | Bhankot (12) | 3.18±0.00 | L |
| | Dugadda | Nauri-I | Nauri (1) | 6.37±0.00 | L |
| | Kotdwar | Gwalgarh | Gwalgad (3b) | 6.37±0.00 | L |
| | | Gularjhala | Sigaddi (18b) | 6.37±0.00 | L |
| | Laldang | Jaspur-II | Sigaddi (7) | 9.55±0.58 | L |
| | Kotdi | North Kotdi-II | North Kotdi (25b) | 11.15±0.96 | L |
| | | Chaukham-I | Dabiana (42) | 15.92±0.82 | L |
| | | South Kotdi- II | South Kotdi (20) | 25.48±0.53 | L |
| | | South Kotdi-I | South Kotdi (19) | 165.46±0.70 | H |
| | Dugadda | Nauri-III | North Kotdi (18) | 19.11±0.42 | L |
| | Dugadda | Dabina-I | Dabiana (3) | 19.11±0.00 | L |
| Mussoorie | Kempti | Melgad | Melgad (2b) | 20.70±0.74 | L |
| Narendranagar | Shivpuri | NF | NF (NF) | 1.59±0.22 | L |
| | Shivpuri | Khainupani | Rishikesh Part (1) | 1.59±0.22 | L |
| | Shivpuri | Khusraila-1 | Khusraila (2) | 14.33±0.47 | L |
| | Shivpuri | Singtali-2 | Singtali (6) | 42.99±1.42 | L |
| Rajaji | Ramgarh | Ramgarh | Asarori (5b) | 1.52±0.75 | L |

**Mapping**

It is visualized that in each range there would be three management units: (i) Conservation area (set aside for the *in-situ* & *ex-situ* conservation of native MAPs where no commercial extraction would be allowed but monitoring and protection would be strengthened), (ii) Development area (where intensive management and propagation of commercially useful MAPs would be undertaken); and (iii) Harvest zone (where local people would be allowed to sustainably harvest the MAPs and would be encouraged to participate in the management of the area).

On the basis of survey conducted in different reserve forest divisions of Garhwal region important block and compartments were identified on the basis of density following a manual on Rapid Mapping Exercise (RME) of medicinal and aromatic plants (Rawat et al. 2004). Individual transect plots' data was used to calculate density a species. To map the species abundance on the map, each transect density was used. Transects with species presence were segregated, of the total transects laid in Garhwal region. Based on density value transects were separated out and divided into three classes (low, medium and high) for plotting on the map. The steps involved are:

Step 1: Highest - Lowest density = A; Step 2: A/3 = B; Step 3: B + Lowest density = C; C = Lowest density range (from lowest density up to C); Step 4: C + B = D (> C up to D is medium density) and Step 5: D + B = E (< C up to E is highest density). For instance, if density of a species ranges between 2 to 10 than A = 10-2 = 8; B = 8/3 = 2.67; C = 2.67 (i.e. B) + 2 (i.e. lowest density) = 4.67 (lowest density range between 2 to 4.67); D = 4.67 (i.e. C) + 2.66 (i.e. B) = 7.33 (medium density range between 4.67 to 7.33); and E = 7.33 (i.e. D) + 2.67 (i.e. B) = 10 (highest density range between 7.34 to 10).

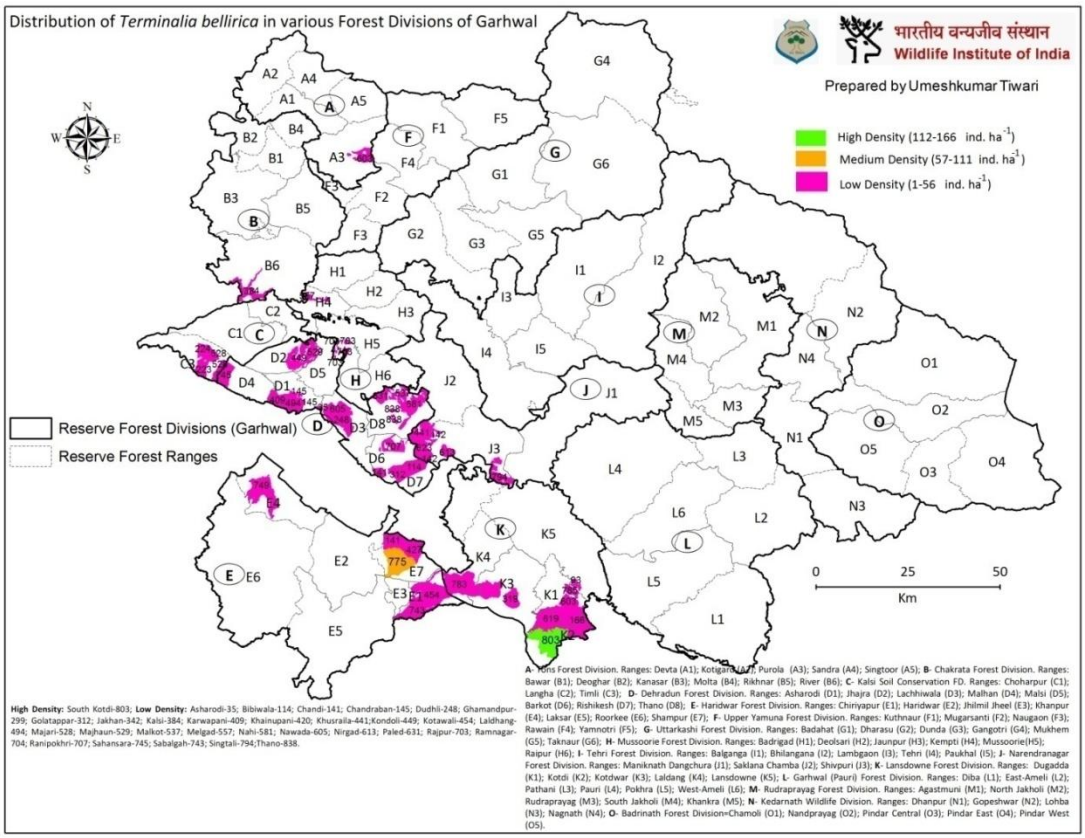



Fig. 4. Map showing the areas with low, medium and high density of *Terminalia bellirica* in Garhwal region.

For the conservation, development and harvest (CDH) plan, forest divisions along with range, beat, block and compartment have been identified and recommended for *Terminalia bellirica* is given in Table 2 and shown in Fig. 4. Rasiyabad (5 and 7) in Jhilmil Jheel Unit and Timali (9 and 10), Majari (1) and Dararith (5a, b and 7a) in Timli range of Kalsi soil Conservation Division are recommended for conservation and development, while Trichot (2 and 3) in Paukhal range of Tehri Forest Division

are recommended for the conservation. It is suggested that every alternate year fruits of *T. Bellirica* can be collected from Haridwar Forest Division.

Table 2: Identified division, range, beat, block and compartment for the conservation, development and harvest plan of *Terminalia bellirica* in Garhwal region.

| **Division** | **Range (Beat)** | **Block (Compartment)** | **Recommendation** |
|---|---|---|---|
| Haridwar | Chiriyapur (Katewad West) | Kotawali (4) | C and D |
| | Shyampur (Nastarwali) | Chandi (4) | C and D |
| | Shyampur (Shyampur) | Shyampur (8) | C and D |
| Lansdowne | Kotdi (North Kotdi-II) | North Kotdi (25b) | D and H |
| | Kotdi (South Kotdi- II) | South Kotdi (20) | D and H |
| | Kotdi (South Kotdi-I) | South Kotdi (19) | D and H |
| Mussoorie | Kempti (Melgad) | Melgad (2b) | C and D |
| Narendranagar | Shivpuri (Singtali-2) | Singtali (6) | C and D |

The above mentioned information generated on the distribution and abundance of MAPs would be ultimately linked for further planning and management of medicinal plants in the state.

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