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# GIS FOR DECENTRALIZED GOVERNANCE- ALMORA DISTRICT, UTTARAKHAND

## GIS for Natural Resource Inventory and Development Planning

Geospatial Technology is recognized widely as a scientific tool that enables acquisition, integration and analysis of geographically - referenced spatial information that can be utilized for effective planning, management and decision making locally and globally. This multi faceted technology can effectively support governance, enable sustainable development, support business processes as well as bring location based information closer to people.

Developments in GIS in India however, both in policy and law, have thus far empowered to a greater extent government and business at national and regional level. The real challenge in this sector is to extend this technology to local communities for self governance and to enable them to participate on equal footing in regional and national development.

DCAP has made an attempt to fill this gap by taking up a challenging project to bring GIS to local communities as a tool for developmental planning on a block-level pilot scale in Almora district, Uttarakhand.

A program was implemented with the objective of empowering local communities and Panchayat Raj Institutions in Takula Block, Almora District, to prepare local development plans [Annual and Five Year Plans] with the help of latest GIS tools, aimed at integrated Natural Resource Management, with a focus on the conservation, development and management of Water Resources. The planning was based on Participatory Inventory of Natural Resources, Demography and Infrastructure. The larger goal of the program was to support the recharge of the endangered Kosi River, the lifeline of the district.

**Genesis**

Through an earlier program of DCAP, an impact study of the Uttarakhand Water Act of 1975 [then known as Kumaon and Garhwal Water Act of 1975] was conducted, for which water resources data was sourced from Government agencies at various levels. An analysis of this data revealed that the real condition of water resources at village level, as well as land and forest resources which are determinant factors, could not be assessed by the kind of official data available. The latter focused only on the water systems [irrigation or drinking water] constructed by Government agencies, their physical characteristics, and intended coverage. Time series data showed little else than 'increase' in coverage, with no information on water sources per se. The Minor Irrigation Census which commenced in 1986/87 also provided very limited understanding of water resources and systems. The health of water resources systems are intrinsically linked to land and vegetative resources, besides anthropogenic activities. Official data on water, however, have always been and continue to be isolated from these integral factors. For the purpose of the legal impact study, DCAP therefore undertook a comprehensive primary survey on water resources covering 60 villages in four districts in Uttarakhand to assess the ground level situation. This experience led to the conviction that participatory natural resources inventory on a larger scale was required for not only understanding the real status of water resources, but also to enable decentralized location-specific planning.

In 2011-14, DCAP implemented a program "STRENGTHENING THE ROLE OF PRIs IN NATURAL RESOURCES INVENTORY AND WATER RESOURCES DEVELOPMENT PLANNING IN ALMORA DISTRICT, UTTARAKHAND" with the support of the NRDMS [Natural Resources Data Management System], a Division of the Department of Science and Technology, Govt of India.

The objectives of the program were to inventorize natural resources and other related data through participatory methods using latest scientific tools on a block level, convert data to digital GIS format, facilitate local village level planning on the basis of such data, and lay the basis for developing block level perspective plans for water resources conservation and management, in tandem with land and forest resources. The larger goal of the program was to revive the Kosi River through protection and development of its tributary watersheds.

A sequence of laboratory based scientific work in computer cartography/GIS application, orientation and dialogue with Panchayat and community representatives, and community based participatory survey and planning was adopted for the program. The institutions involved were Gram Sabha members of 175 villages, representatives of 89 Village Panchayats, Takula Block Kshettra Panchayat and Almora Zilla Panchayat, as well as the District Administration, and Departmental Officials at District level.

Activities included orientation and consultation meetings with Gram Sabha and Panchayat representatives from all 175 villages in a series of workshops; digitization of village cadastral maps; conversion of image files into vector files in GIS Software, participatory survey and collection of

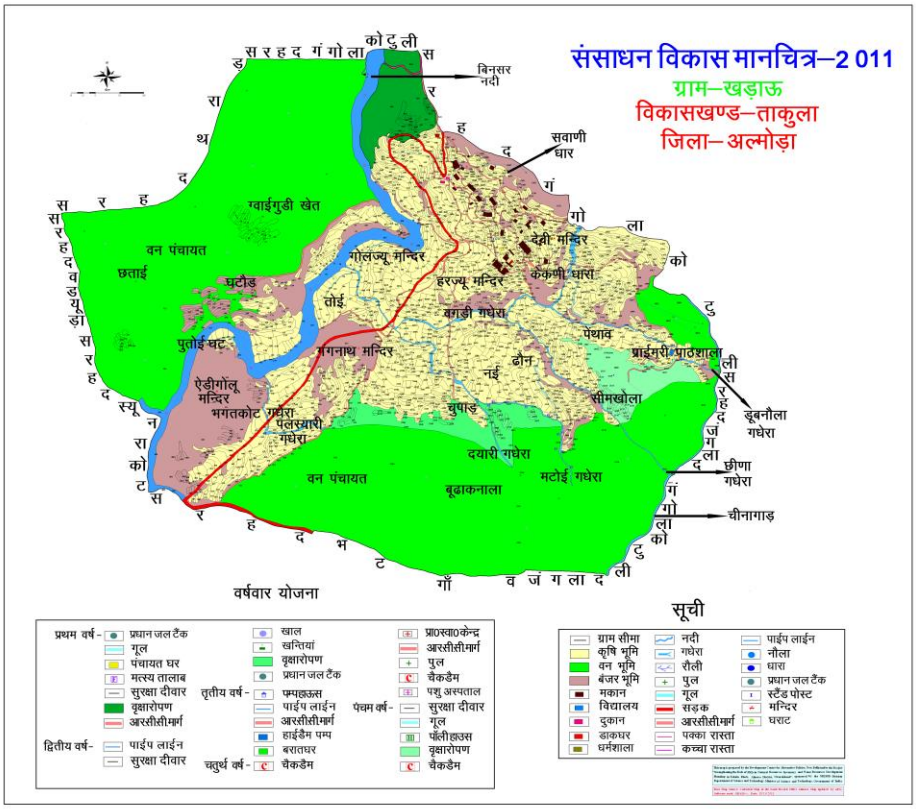
demographic, natural resources and infrastructure data from all villages of block; survey of felt needs and problems in each village; preparation of database on GIS platform; preparation of Village Resources Map on GIS platform; distribution of printed maps to each village, and consultative meetings with Gram Sabha members to finalize map and prepare Annual/Five Year Plans; incorporation of updated data and Plans on VRMs; preparation of Planning Map; distribution of printed Village Resources and Planning Map to all Village Panchayats; presentation of data to District Administration and orientation to Departmental Officers, besides uploading data on office computers; presentation of report to NRDMS, DST, GoI, and data for uploading of all village maps on NSDI website.

The project outputs include digitized Cadastral Maps at 1:1000 scale for 175 villages and following Maps on GIS Platform:-

- 175 Village Maps [ Resource and Planning Maps]
- 89 Gram Panchayat Maps
- 7 Nyaya Panchayat Maps
- 1 Block Map
- Database on Demography, Infrastructure and Natural Resources integrated with all Village / GP / NP / Block Maps
- Inventory of problems and needs [in terms of development schemes and programs] of everY revenue village
- Thematic Maps at Block level on various Natural Resources issues, with link to individual Village Maps and Database

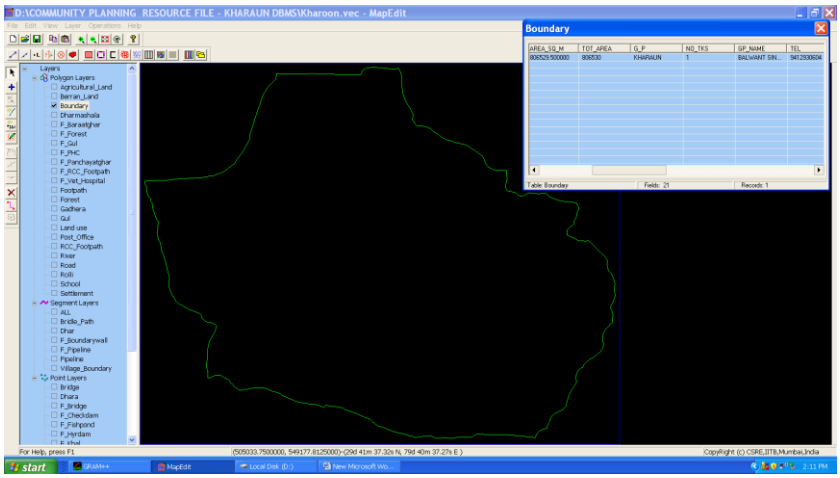
**Samples of Village Maps**

Community Resource and Planning Map Kharaun Village

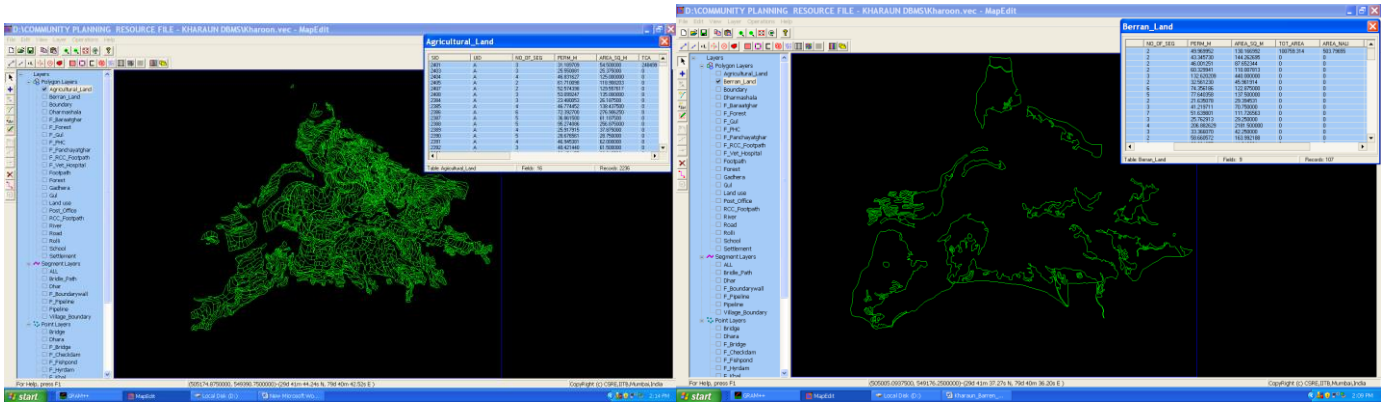



The cadastral based Resource and Planning map of Kharaun Village provides geospatial information on all resources, as well as indicates the geographic location of each of the developmental projects selected by the villagers to be implemented on an annual basis. On the GIS software, spatial data on resources are available in layers. Each resource or a combination of resources can be selected and viewed along with the database pertinent to that resource.

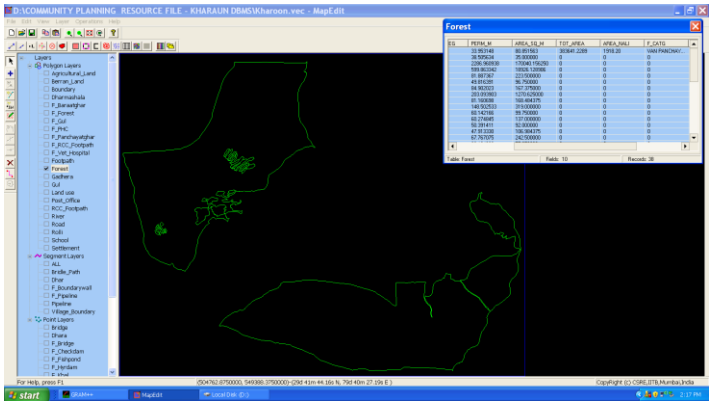
Village data Base in Gram + - Karaun Village Boundary with data



Karaun Village Agricultural Land with database and Village Barren Land with database




Karaun Village Forest with database




**Review of Project Results**

For the first time in the history of the state land administration, village cadastral maps were utilized for preparing NR maps and for developmental planning, whereas hitherto they have only been used for revenue purposes. The maps provide a platform for combining information about land, water and forest resources, that too in an updated form.

The participatory comprehensive survey conducted at each revenue village provided a wide range of information on Demography [2 Main Parameters and 15 Sub Parameters]; Natural Resources [14 Main Parameters and 46 Sub Parameters]; Constructed Water Systems [11 Main Parametres and 51 Sub parameters]; Other Infrastructure [18 Main Parameters and 21 Sub Parameters] – in total, 45 Main Parameters and 133 Sub Parameters. The GIS software used was Gram ++, developed by IIT Mumbai, and available at 2.5% of the cost of similar software of international brand in the market. The data can be viewed as ‘layers’ on the base map, along with related database, with all features geo-tagged.

***Water Resources of Takula Block, an Overview.***

The inventory of water sources in 175 villages presents the following comparative picture of status of water resources tributary-wise and Nyaya Panchayat wise

Nyay Panchayat –wise distribution of Streams, Rivulets and Naulas [springs used as drinking water sources], Dharas[natural springs] and their status. [P=Perennial; S=Seasonal; D=dry]

| S.No | Nyay Panchayat | Total GPs | Total Villages | Total Streams | | | Total Rollis | | | Total Naulas | | | Total Dharas | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P | S | D | P | S | D | P | S | D | P | S | D |
| | **Main Kosi River** | | | | | | | | | | | | | | |
| 1 | **Chanauda** | 14 | 28 | 41 | 42 | 1 | 18 | 105 | 7 | 42 | 3 | 1 | 26 | 3 | 0 |
| | **Binsar River [tributary to Kosi]** | | | | | | | | | | | | | | |
| 2 | **Takula** | 9 | 14 | 42 | 8 | 0 | 10 | 42 | 4 | 66 | 1 | 0 | 13 | 0 | 0 |
| 3 | **Basoli** | 17 | 30 | 51 | 24 | 1 | 116 | 64 | 0 | 60 | 2 | 0 | 18 | 0 | 0 |
| | **Mansa River [tributary to Kosi]** | | | | | | | | | | | | | | |
| 4 | **Bhainsad Gaon** | 9 | 13 | 20 | 15 | 0 | 16 | 3 | 2 | 26 | 1 | 1 | 15 | 0 | 0 |
| 5 | **Baiganiya** | 10 | 28 | 39 | 18 | 0 | 62 | 4 | 2 | 40 | 0 | 1 | 10 | 2 | 0 |
| | **Sai River [tributary to Kosi]** | | | | | | | | | | | | | | |
| 6 | **Donigaad** | 11 | 22 | 45 | 18 | 0 | 44 | 3 | 0 | 0 | 37 | 1 | 13 | 0 | 0 |
| 7 | **Someshwer** | 19 | 40 | 72 | 16 | 2 | 71 | 20 | 0 | 41 | 13 | 3 | 16 | 0 | 0 |
| | **Total** | **89** | **175** | **310** | **141** | **4** | **337** | **241** | **15** | **275** | **57** | **7** | **111** | **5** | **0** |

| Total Perennial Sources | Total Seasonal Sources | Total Dry Sources | Total Sources |
|---|---|---|---|
| 1033 | 444[30%] | 26 | 1503 |

The data shows that while perennial water sources are the highest in number, a considerable extent of water sources [30%] are seasonal and some are dry. This must be viewed in the backdrop of the trend

in the Kosi Watershed in Almora District over the last several decades in which there has been an increasing conversion of perennial sources into seasonal and then dry.

P: Perennial; S: Seasonal; D: Dry

| S.No | Nyay Panchayat Nyaya | Total GPs | Total Villages | Total Water Sources | | | Total | Village average | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P | S | D | | P | S | D | T |
| | **Main Kosi River** | | | | | | | | | | |
| **1** | **Chanauda** | 14 | 28 | 127 | 153 | 9 | 289 | 4.53 | 5.46 | 0.321 | 10.321 |
| | **Binsar River [tributary to Kosi]** | | | | | | | | | | |
| **2** | **Takula** | 9 | 14 | 131 | 51 | 4 | 186 | 9.35 | 3.64 | 0.28 | 13.28 |
| **3** | **Basoli** | 17 | 30 | 245 | 90 | 1 | 336 | 8.167 | 3.0 | 0.03 | 11.2 |
| | **Mansa River [tributary to Kosi]** | | | | | | | | | | |
| **4** | **Bhainsad Gaon** | 9 | 13 | 77 | 19 | 3 | 99 | 5.92 | 1.46 | 0.23 | 11 |
| **5** | **Baiganiya** | 10 | 28 | 151 | 24 | 3 | 178 | 5.39 | 0.857 | 0.107 | 6.36 |
| | **Sai River [tributary to Kosi]** | | | | | | | | | | |
| **6** | **Donigaad** | 11 | 22 | 102 | 58 | 1 | 161 | 4.63 | 2.64 | 0.045 | 7.32 |
| **7** | **Someshwer** | 19 | 40 | 200 | 49 | 5 | 254 | 5.0 | 1.225 | 0.125 | 6.35 |
| | **Total** | **89** | **175** | **1033** | **444** | **26** | | | | | |

The inferences that can be drawn from the above table is:

- Chanauda Nyaya Panchayat is drained by main Kosi River
- Takula and Basoli NPs are drained by Binsar River [tributary to Kosi]
- Bhaisad Gaon and Baiganiya NPs are drained by Mansa River [tributary to Kosi]
- Donigaad and Someshwar NPs are drained by Sai River [tributary to Kosi] and also Kosi River

The values in red colour indicate the village wise average number of perennial sources, seasonal sources, dry sources and total available sources. Nyaya Panchayats with villages having least perennial-source average, highest seasonal and dry sources, and least total sources are marked in red.

1. Chanauda NP has the most red-values. It indicates the status of the main Kosi River.
2. Among the tributaries, Binsar and Sai have equal number of red values [3]

3. Sai River has less perennial sources than Binsar and less village wise total average of sources, and is therefore at less advantage than Binsar.

The above data can help in targeting investment for water resources conservation and development in the Block.

The table below shows the order of streams in 3 Nyay Panchayats. This is representative of the whole block as well.

| Nyaya Panchayat | No of Villages | Total Streams | Order of Streams | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1st | 2nd | 3rd | 4th | 5th |
| Takula | 14 | 55 | 49 | 2 | 3 | 1 | |
| Basoli | 21 | 64 | 50 | 9 | 2 | 2 | 1 |
| Chanauda | 28 | 85 | 81 | 4 | - | - | - |
| | 63 | 204 | **180** | 15 | 5 | 3 | 1 |

It can be seen that 88% of streams are first order streams. This data is significant as it helps in assessing the kind of interventions required.

| .No | Size of Stream | Mode of Treatment |
|---|---|---|
| 1 | 1st and 2nd | Biological Treatment – kaccha band - inexpensive |
| 2 | 3rd and 4th | Kaccha band with wire mesh |
| 3 | 5th and 6th Order | Check dam -2.5 metre height |

***Planning Process - Results***

The planning process undertaken in this project has yielded several significant results.





Firstly, it revealed the actual problems and needs of the local communities.

It also enabled their own choice of developmental schemes which are in tandem with the status or availability of natural and infrastructural resources, and demographic needs, which have been surveyed with the involvement of the local people.

This is in contrast to data that is generated by district or state agencies according to their own priorities and needs and as per the requirement of the various schemes and programs that are decided at the top, without any consultation with local people either in surveys or decision making on schemes.

The data generated from below shows a variation in the number and nature of problems and needs village wise, and Nyay Panchayat wise. Some problems and needs are village specific, and some are area specific.

The Survey showed that by and large, natural resources related [particularly water resources] problems and needs predominate over other categories of needs

The Water resources was the priority followed by forest, infrastructure and land issues. Natural Resources as a whole constitute the single most important category as well.

**Problem Categories Distribution**

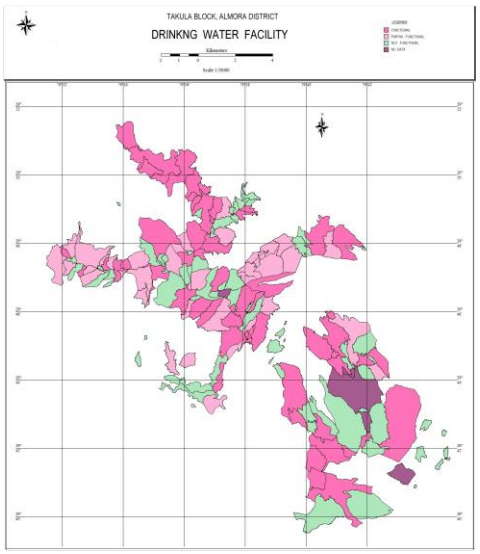
| | |
|---|---|
| Water Resources – Sources and Systems- availability, repair and maintenance, water quality | 32% |
| Land related problems – agricultural land, barren land | 7% |
| Forest related problems | 20% |
| **All Natural resources** | 59% |
| Sanitation | 5% |
| Infrastructure | 17% |
| Social Welfare Rights | 3.5% |
| Local Institutions | 5% |
| Government Institutions/functioning/officials | 5% |
| Right to information; to be consulted | 2.5% |

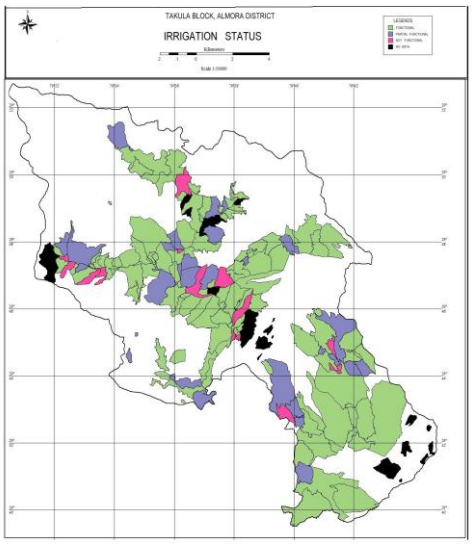
Distribution Pattern of Schemes Identified by Local Communities.

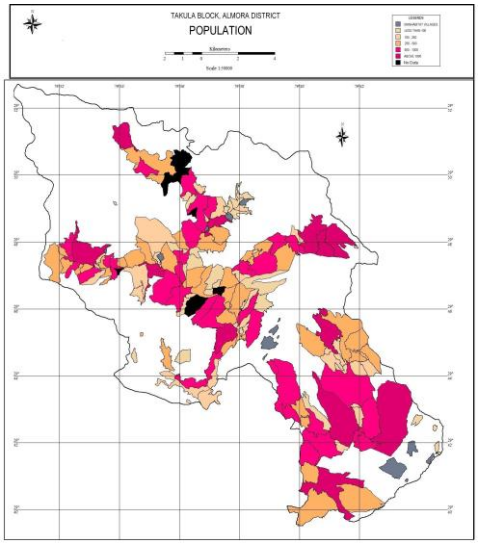
| **Scheme Category** | % |
|---|---|
| **Water Related Schemes** | 29 |
| **Forest and Land Related Schemes** | 14.5 |
| All Natural Resources | 43.54 |
| Sanitation | 3 |
| Infrastructure | 16.12 |
| Health | 3 |
| Housing | 4.83 |
| Education | 3 |
| Economic Programs | 24.19 |
| Social Welfare | 1.61 |

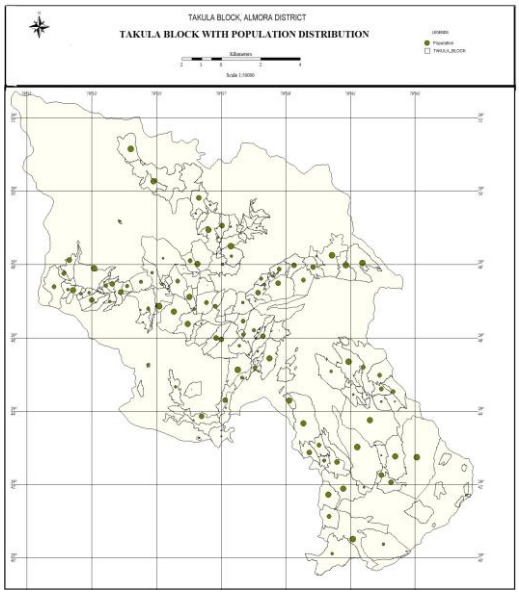
Thematic maps on Village, Gram Panchayat, Nyay Panchayat or Block level may be developed as per need of analysis and targeting of resources and schemes. Screen shots of a few of these maps are presented below.

The following block level thematic map on the left below shows the distribution of drinking water systems according to functionality- functional [dark pink], partially functional [light pink], non functional [green]and villages with no systems[purple]. The map on the right shows the status of irrigation systems – functional, partially functional or non-functional.



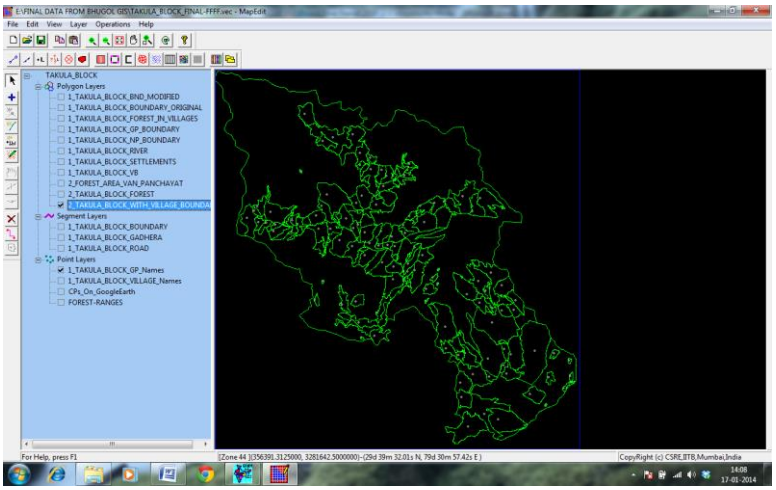



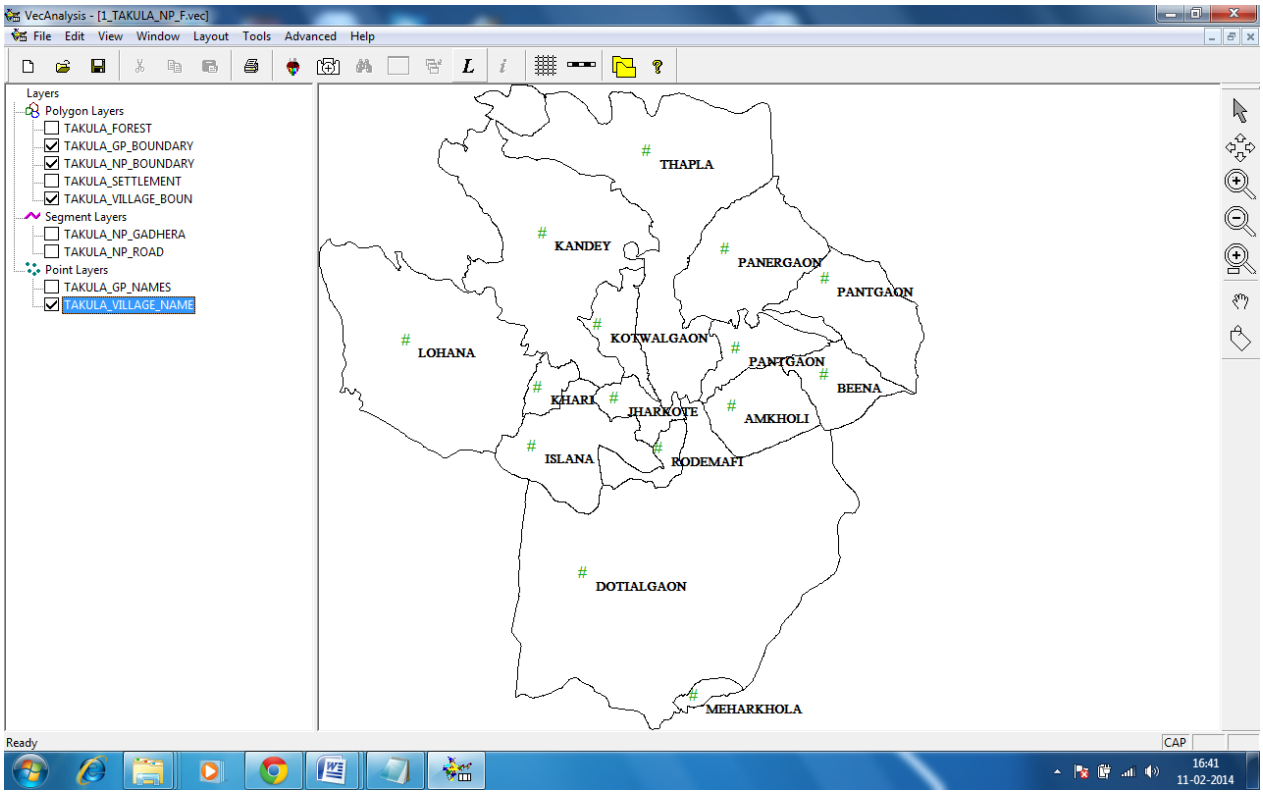

The above maps show the distribution of population in terms of number of households – the left in colour and the right in graduated circles.

On the software, Block level data may be viewed in layers as per requirement of analysis.

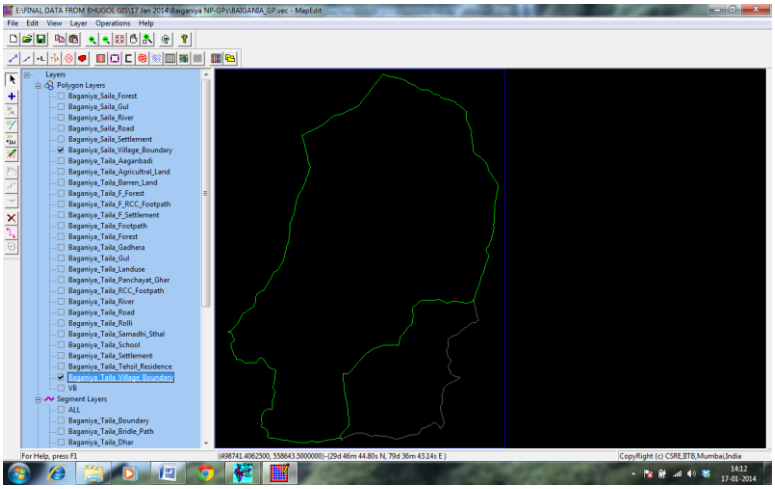
Takula Block Boundary showing Gram Panchayat Boundaries



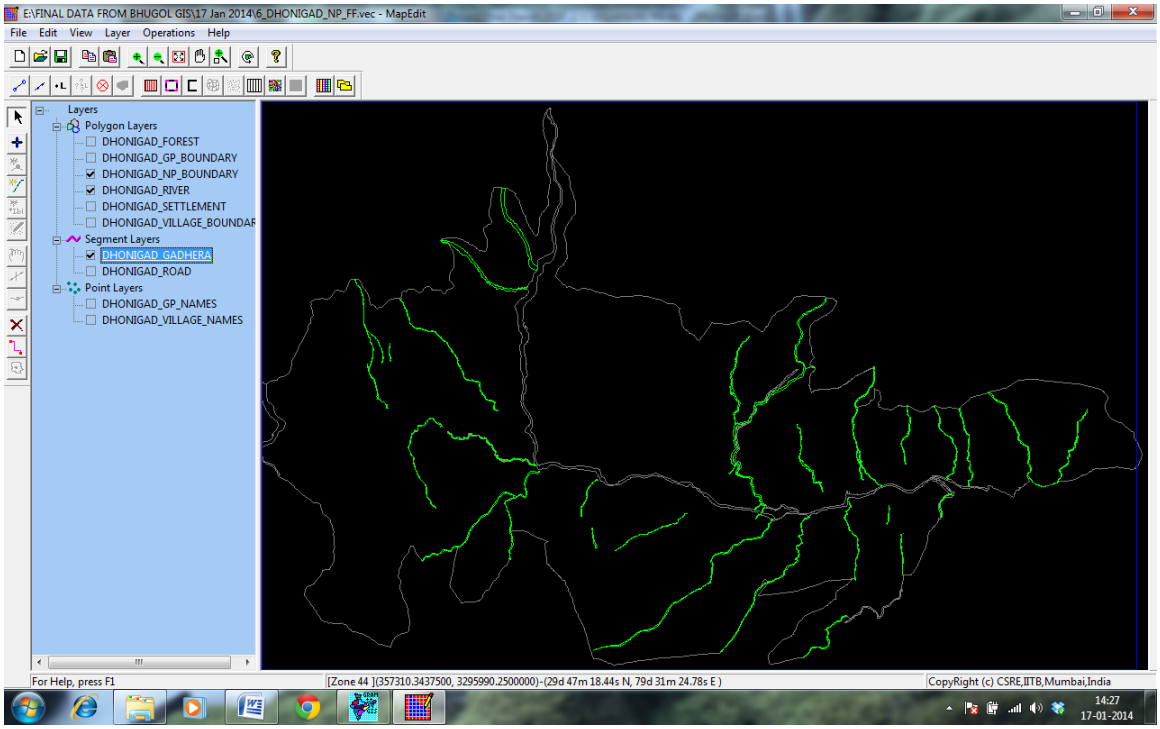
A Nyay Panchayat Map with Gram Panchayat Boundaries



Baiganiya Gram Pranchayat [with Baiganiya Saila and Baiganiya Taila villages]



Donigaad Nyaya Panchayat with Rivers and Gadheras



## Relevance of Project Concept for Hill Areas

In the hill regions of Uttarakhand, the actual boundaries of villages have never been delineated in cadastral maps since the initial land revenue settlements two centuries ago. Boundary points have only been described in revenue settlement processes as the distances are very large and terrain very difficult. Only the agricultural plots and settlement areas have been delineated in village cadastral maps. Forest Areas are not included, as they are provided for separately in forest maps. For the first time, through GIS mapping, village boundaries have been delineated, including forest, barren, agricultural and settlement areas, and all other infrastructural resources have been included. By this method, an integrated natural resources-based development planning at micro-level is made possible. Village maps may be integrated with watershed maps for watershed planning and development.

Since hill villages are scattered and far flung, accessibility is a critical issue in achieving development support. Once a database for a village is created and uploaded on a server at block, district, or state level, the issue of accessibility is overcome, besides opening up possibilities of data exchange and participatory data management on all developmental issues with local communities, using emerging communication technologies.

The technology enables monitoring and evaluation, or comparative analysis of developmental data from village to state level to improve targeting of developmental assistance.

The technology can enable participatory multi-village planning, implementation and dispute resolution purposes in contiguous villages. In the hilly areas, upstream and downstream villages are intimately connected in resource availability and use. Streams and rivulets cross village boundaries, and forests are used by more than one village in tandem. Many Van Panchayat areas are managed /accessed by more than one village. Water sources are located in one village and the water supplied by pipeline to another village. About 45% of total piped water supply systems in Almora District are multi-village systems. Conflicts in resource use abound. Natural resources boundaries rarely correspond with administrative boundaries, and maps based on contiguity and watershed basis would be very useful to understand problems and needs and find solutions for the same.

## Larger Relevance

The project concept may be replicated to good effect throughout the country, in any geographical terrain. GIS technology can enable the democratization of data, which is critical for real participation of citizens in their own development, in a continuing process, thereby strengthening local self governance as prescribed in the Constitution. When developed in future, it will strengthen the scope of decentralized governance based on actual conditions and needs as experienced by people, and help to reduce the present disjoint that prevails between the current developmental paradigm and society's needs and real conditions.