

Micro-level planning using spatial database

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Any development programme to be implemented over a State or region needs micro-level information and levels of planning such as identifying the right areas, allocation of funds, monitoring the activity, assessing the results, etc. Socio-economic development of any place thus, is directly proportional to effective micro-level planning. Even after more than 50 years of independence, Assam, the land of the Red River and Blue Hills, still is in need of a suitable sustainable developmental plan. This article tries to justify the idea of incorporating Geographic Information System into micro-level planning and usage of spatial database, which will enhance the effectiveness and efficiency of such plans. The article also attempts at encompassing and addressing all the factors necessary to develop Assam socially and economically.

Keywords: Central Compiling System, Geographic Information System, micro-level planning, spatial data.

LEVELS of information and planning go into the formulation of any development before such programmes get implemented. In India, this started in 1951 in the form of centralized and macro-level economic planning; a multi-level decentralized planning developed later. Planners recognized that location of services and infrastructure facilities play an important role in promoting development in rural areas of the country. In the eighth Five-year Plan (1990–95), emphasis was given to decentralization and micro-level planning (MLP) with people's initiative and participation in the process of development up to the level of Gram panchayat.

MLP is a dynamic process and involves planning at the grass root level taking each individual, family and category of the community of a hamlet, as the basic unit of planning and forum to analyse their situation critically and understand the power relations existing in every sphere: political, socio-economic and cultural.

Another principal component, which has slowly made its presence felt in all levels is the Spatial Database (SD), which is a collection of spatially referenced data that act as a model of reality or to put it in other words, spatial data include the type of geographical entities of interest and their location and geometry or topographical relationships with each other.

The creation of databases was first initiated in 1989 on the recommendation of the committee on Study Group on Information Gap, constituted by the Planning Commission, Government of India based on (i) plan information, (ii) plan monitoring and (iii) plan evaluation in districts. This committee also recommended the development of

databases with respect to (i) socio-economic, (ii) agro-economic, (iii) infrastructure, (iv) demographic and (v) natural resources.

This article discusses the amalgamation of these two tools, viz. MLP and SD. As MLP involves levels of micro-database generation at a macro scale (multi-levels), incorporation of the spatially referenced database will prove to have an edge over any run-of-the-mill planning. The concept behind such database is to provide an analytical objective base for decision at plan formulation, monitoring and evaluation levels, which will help increase the effectiveness of grass root-unit-level planning.

Such development of a MLP with SD should be mainly focused on areas where development is yet to reach or where the rate of development is not at par with other areas. Assam is one such area. Battered by insurgents and natural calamities, Assam is one of the poorest among all the northeastern (NE) states, its per capita income being Rs 6221, which is the lowest. Most of the States in the NE region have a per capita income of over Rs 9000. Assam has the highest incidence of poverty, i.e. 36% as compared to the national average of 26%. However, as far as variety of natural richness is concerned, Assam is second to none. Thus, Assam can be an perfect example as to the success of a MLP when incorporated with the Geographic Information System (GIS). The economic backwardness, in spite of the resource richness of the State shows the lack of proper coordination between planning and implementation of the socio-economic upliftment schemes or the lack of an effective plan. This is reason enough to consider Assam as the pilot study area.

There is a strong need to establish a sound multi-sectoral SD in the State, with suitably designed data structure under the GIS environment that it could achieve, which would be the focal point of this article. The article also elucidates upon the analysis of application of GIS at the MLP stage,

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its use as a monitoring tool and the use of spatial information technology for participatory planning to speed up the planning, implementation and evaluation.

A short insight into Assam

Before going into the details of how to help the State, a short insight into its essence, existence and physiography is required to gauge the 'what', 'why' and 'how' of the situation/predicament in which it is now.

In the Epics, Assam was known as 'Kamrupa' or 'Pragjyotish'. Human inhabitation of this area dates back to about 2000 BC. Historically Assam had been under many sieges, invasions and reigns, which attribute to its present fusion of many cultures and races of people, that is continuing till date. Assam presents a fusion of Mongol-Aryan culture. The Ahoms ventured into Assam in about AD 1228. After independence, Assam witnessed several separation of territories.

Nature has also acted as an active agent of change in the physiography of the State, at times creating havoc and at times as a boon. It has been accorded the 'Zone V' status for being seismically very active. Also due to heavy rainfall in the Himalayan and other watersheds of the eastern India region, it is endowed with an extensive river system consisting of the Brahmaputra and the Barak, and their 125 tributaries. These rivers are active agents of erosion, which has given Brahmaputra the status of being the largest sediment-carrying river in the world, amounting to considerable rise in the river bed through the years. Assam is characterized by extreme humidity. Its most distinguishing feature is the copious rainfall between March and May, at a time when precipitation in upper India is at its minimum. The year may be divided into the winter and the rainy season. Cold weather lasts from October to February and the rest of the year witnesses rainfall.

Economic scenario of Assam

With primarily an agrarian economy, agriculture is the main occupation of the people of Assam and along with the allied occupation it accounts for about 60% of the State's work force. Assam produces a significant part of the total tea production of the world. It also contributes to the production of more than half of India's petroleum.

Assam's potential can be gauged by the fact that its economy is primarily agrarian, as mentioned above, and forest-based. Rich mineral deposits of limestone, clay, copper, coal, oil and natural gas, etc. can be found in Assam. It is also rich in terms of biodiversity, many species being endemic to the region. Forest resources form an important economic base as the forests abound with bamboo, cane and orchids. It is also a gene pool of many unique and rare medicinal plants and herbs. Apart from these, Assam has immense potential for generation of micro hydel power and scope for alternative energy sources.

Challenges

In spite of being resource-rich, the State's fragility is due to economic, social, ecological and geological bottlenecks; the problems being incessant in nature. Some of the main problems are: continuous environmental degradation, riverbank erosion, landslides, recurring floods endemic to the State and the omni-present geological instability leading to huge loss of life and population displacement, which takes a toll on the economy, infrastructural inequity, haphazard and unplanned expansion of towns and cities, insurgency problem, and ethnic clashes, which when put together have acted as a catalyst in bringing about all-round decrease in the development rate. This has resulted in hampering the overall development of the State, which is lagging far behind than the rest of the country.

The following broad points can be noted which are probably affecting the growth of the State:

- (i) Lack of proper communication in terms of poor networking.
- (ii) Lack of proper resource utilization, management and development.
- (iii) Lack of proper management in terms of information technology.
- (iv) Lack of industrial activity and commercialization in terms of horticultural products, handicrafts, cottage industry, etc.
- (v) Lack of infrastructural facilities for mega economic projects like tapping hydroelectric power potential in the form of micro-hydel projects because mega hydel structures may end up as geological disasters; mineral-based projects are also not economically viable.

Though posed with all these challenges, Assam can raise its standards with proper utilization of technology. MLP with SD integration will help track the problems and suggest steps to convert these weaknesses into strengths.

GIS-enabled MLP

Role of spatial database and GIS

A proper and effective methodology, which would tackle the problems of planning and implementation at the micro-level, has long been desired. Successful planning of developmental activities at the grass root level depends on the quality and quantity of data emerging for both natural and socio-economic resources. As a result, it is essential to develop and utilize the spatial information technology together with conventional techniques, which would help in the planning as well as storing of a large amount of data. Without a Central Compiling System (CCS), data remain scattered across many sectoral organizations and departments, which is a major hindrance in planning. The principal problem here is of data-sharing. Various departments of the Government generate different sets of data, which may be repetitive in nature. A CCS built with

the help of the GIS will help overcome this problem and also cut-off considerable economic pressures generated during data compilation and re-compilation. Compiling is suggested so that repetition of the work does not happen and CCS can be used as a library of spatial information.

Lacunae in the development process can also be attributed to the fact that proper facts and figures do not reach the drawing board on time to chalk out an effective plan for growth by the planners and managers. The reason for this can be the huge amount of data generated and handled at various sources, which makes way for several anthropogenic as well as system errors – temporal, spatial and anthropogenic to creep into the process, magnifying in magnitude as the process lengthens. This is where GIS-enabled CCS can help. The CCS would be like a repository of all data generated alongwith all ancillary data to get a complete and unbiased picture of the problem.

The role and potential of CCS would be immense in nature. It would be instrumental in the handling, storage and retrieval of data and in turn help analyse different types of scenario with multitude of information generated from the CCS data. SD generation would be the primary step in developing a fully functional CCS and as such SD intermixed with conventional techniques like surveys and Participatory/Rapid Rural Appraisal (P/RRA) with help generate immense data. GIS would help in the integration of the spatial data with other ancillary non-spatial data picked up from the CCS and generate useful information system, which can then be utilized for any planning and management activity.

Also when one mentions location-specific planning at the grass root level, there is no multi-sectoral database at one point to be synthesized and compound data suitable for developmental planning. Whatever meagre database is available, it is neither consolidated nor marginally used in planning. CCS would help in bridging this gap. Data available in the CCS would also help in developing predictive models.

Due to its protean nature, GIS can be used in almost every theme involved in development, planning and management. The following are some of the areas where GIS can be implemented and CCS data used:

- (i) Documentation, appraisal and analysis of natural resources and their current status of utilization, identification of constraints, and exploitation of untapped resources.
- (ii) Documentation of natural hazards and suggestions for mitigation measures.
- (iii) Documentation and analysis of demographic and socio-economic scenario, human–environment equation, indigenous knowledge system, etc.
- (iv) Documentation of various anthropogenic activities, such as agricultural, agro-based small- and medium-scale industries, trade and commerce, transport, settlements, etc.
- (v) Assessment of environmental status with reference to forest and its dispersal pattern, distribution pattern of the endangered species of flora and fauna, spatial index of hot spots, etc.
- (vi) Preparing local and/or problem-specific action plans for sustainable development towards social upliftment.
- (vii) Providing an information base at the district, block and village levels at one point for decision-making.

Areas to be addressed

Although themes and their parameters related to natural resources and socio-economic data are well known for such a database, emphasis should be given for designing suitable data structure to accommodate customized data structure also for respective areas like, indigenous knowledge system, cultural heritage and natural resources management, that are endemic to Assam.

SDs of various themes can help in environmental audit and impact assessments, which are now mandatory for every developmental activity. The process of environmental impact assessment (EIA) involves identification, measurement, interpretation and communication of methods. There are a number of techniques like overlays, ad-hoc methods, impact checklists, impact matrices and cause–condition–effect networks been developed for EIA. GIS helps in speeding up these processes and is also cost-effective.

This tool is especially helpful in gauging environmental parameters. As in the case of fluoride contamination of groundwater in Assam, SDs would prove to have an edge when used with the conventional surveying techniques carried out by the State Health Department. Together with the fluoride data collected by the Health Department, other data related to population, geology, occurrence of water table, number of deep tube wells, meteorological data, land-use data and other related data can be overlaid and interlinked to get a virtual picture of the real scenario. These types of databases and thematic maps can help in generating prediction maps, which can steer future actions. Such information can help the concerned departments in zoning the affected and likely to be affected areas and taking action with better response time. The same can be adopted for epidemic control, e.g. malaria. Integration of GIS with real-time information system can be used for depicting potential surges in disease transmission for implementation of rapid response strategies. Its buffer zone-creation capabilities help in studying the impact of a specific vector-breeding site on the community within its impact zone. Further, network capabilities can be applied to a variety of planning, administrative and operational activities.

Meteorological databases are cumbersome, do not have the spatial component and association with other factors is not taken into account. When amalgamated with GIS, these databases provide proper information which can be

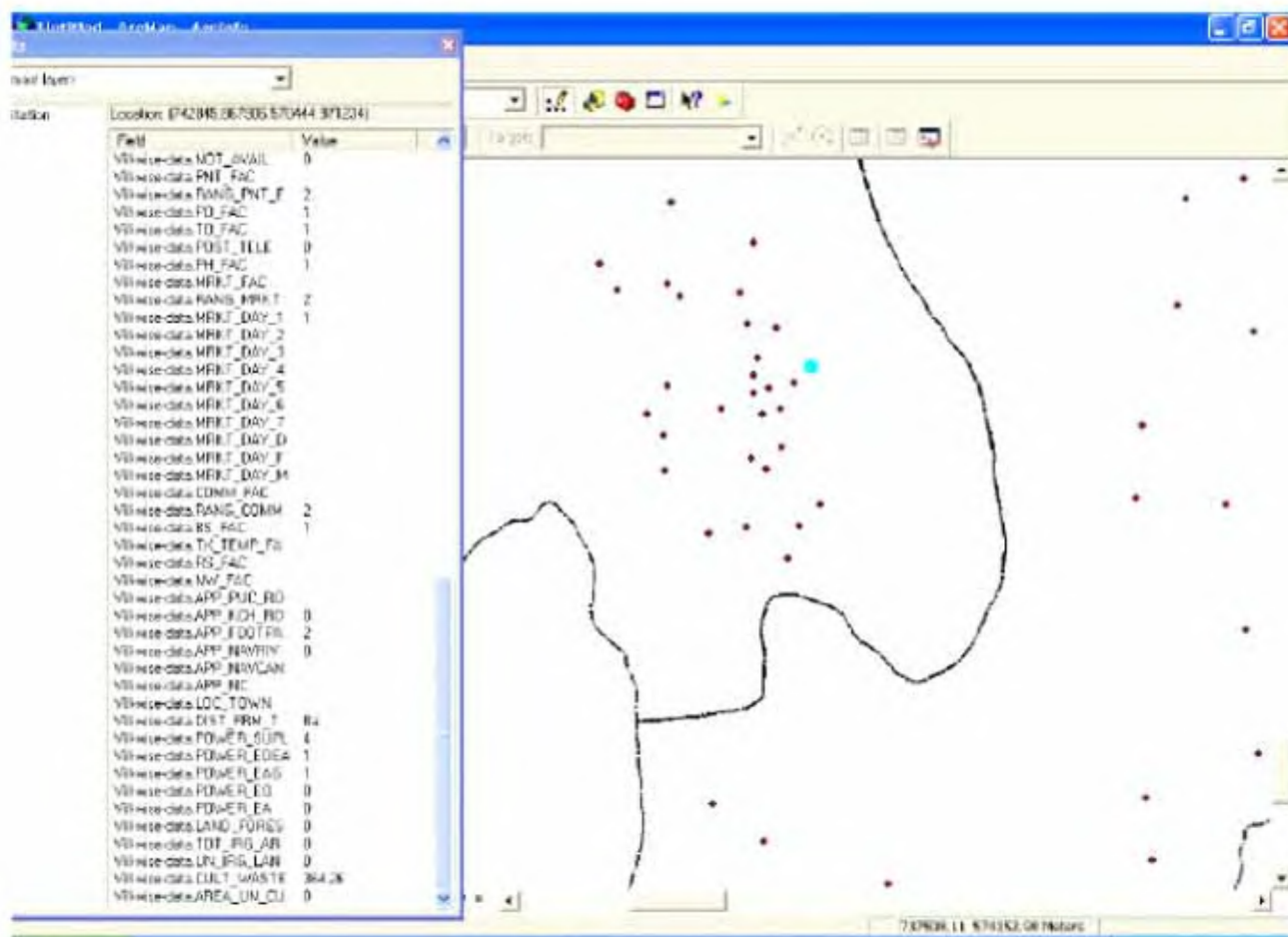


Figure 1. Example of a village-level database.

directly accessed and proper case-specific analysis done for use by other departments affected by these data, like the Health Department for controlling any epidemic. Figure 1 exemplifies the spatial representation of village-level census data for Assam (census data published in the year 2003), which can be used for checking the connectivity of different roads to their nearest village, Gram panchayats, administrative headquarters, etc. for village-level planning. Once prepared, the database can always be updated at a central location as and when new features and information are added.

All the rivers in Assam are prone to floods, the prime natural hazard of the state mainly because half of them are glacier-fed and also receive heavy rainfall within a short period. During floods, such databases would prove to be of immense help for carrying out relief operation in less amount of time. Alongwith the floodplain information, parameters like population affected, relative time for flood water to inundate a place, resources present, response team location, and nearest area for population to be relocated can be merged as layers and proper response time calculated for maximizing relief operations. GIS can also help in synthesizing the natural linkage scenario in pre-

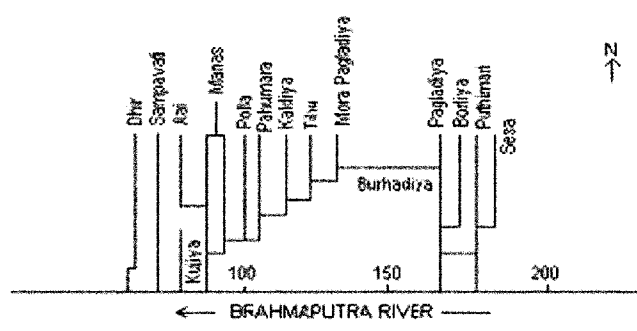


Figure 2. Natural linkage in the Brahmaputra.

dicting the direction of flood-water flow and with the meteorological database and CWC data regarding water level, flood prediction would cease to be a dream. Figure 2 illustrates the natural linkage pattern of rivulets present in the Brahmaputra River. The data present with CWC for such linkages can be further hyperlinked with additional data from the CCS and a proper study carried out on the flood pattern or how natural linkages help regulate flood flow.

Though water may play havoc in Assam, it also makes the State ideally poised to maximize its hold in micro-power

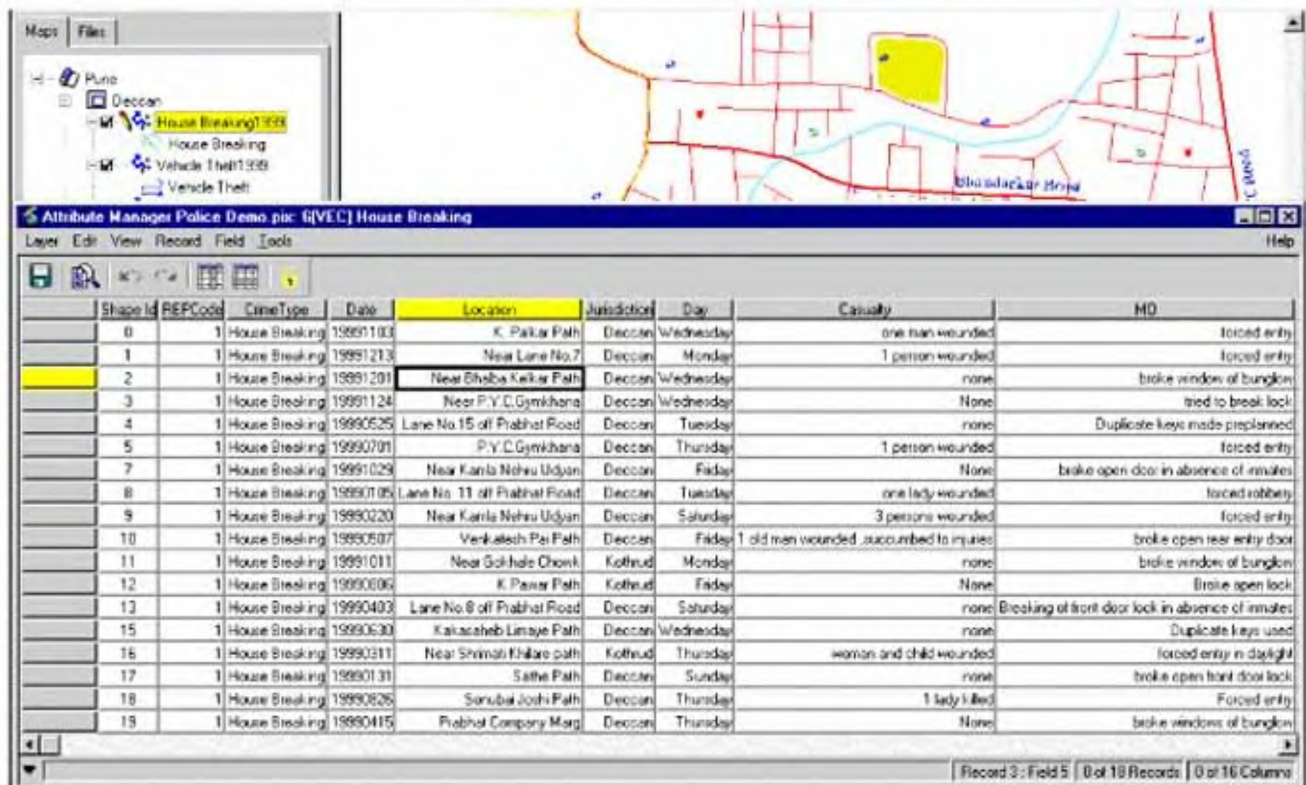


Figure 3. Example of a crime inventory.

generation. First, water resource is available in abundance; secondly, a host of government agencies, educational institutions, voluntary groups, people's science movements, and NGOs are engaged in pioneering technical work; thirdly, a large unemployed, untrained workforce exists seeking opportunities for self-employment. This workforce serves as an asset and can be moulded to hone its entrepreneurial and technical skills, which can be then put to use at a domestic as well as commercial scale. But, several barriers have surfaced dampening these qualities, resulting in slow growth in the renewable energy sector in Assam. CCS-enabled GIS might help the State focus on the growth of the renewable energy sector.

CCS data can also be used against insurgency and crime, which can be effectively mapped and monitored using such SD technology. The traditional and age-old system of intelligence and criminal record maintenance has failed to live up to the requirements of the existing crime scenario. Manual processes neither provide accurate, reliable and comprehensive data round the clock, nor do they help in trend prediction and decision support. They also result in lower productivity and ineffectiveness, accessing massive amounts of location-based information. GIS and crime mapping are essential in a State like Assam. Response capabilities often rely on a variety of data from multiple agencies and sources. The ability to access and process information quickly while displaying it in a spatial and visual medium allows agencies to allocate resources quickly and more effectively. Figure 3 depicts how crime

statistics can be inventorized, like details pertaining to location, frequency, nature and loss incurred. It illustrates work done in another city, which can be replicated in the case of Assam and customized accordingly.

The State administration could use such compiled information in the form of SD for urban and rural planning in a more methodical manner like zoning areas landuse-wise, levels of development that have taken place, economic-wise, etc. Utility planning like transport routing, traffic monitoring, and oil and natural gas pipeline routing, which is one of the main sectors in Assam, are other such sectors. The State Education Ministry can use GIS to improve the education scenario. GIS can be thus used to create baseline information to prepare a comprehensive development outline.

These unique tools can also be utilized to develop the tourism potential of the State, which is still unexplored and underdeveloped. Majuli, the biggest river island in the world, is one such case where GIS can prove to be extremely useful. It has got immense potential as it is a seat of vaishnavite culture of the State. It is one of a kind and its hugeness is its uniqueness and so steps for preserving and protecting it and its unique socio-cultural status can be taken up with the help of spatial databases.

Another sector where CCS-enabled GIS can be extensively used is in landslide mapping. Assam, with its many hills, has frequent landslides which take a toll on its economy and life. Landslide inventorization will help in checking the probable landslide hazard zones, so that



Figure 4. Example of a landslide inventory.

adequate steps can be taken to prevent or control it. Figure 4 provides information regarding the effective management of landslides. This is an example of the work carried out for Arunachal Pradesh for making a landslide inventory along the Gahpur–Itanagar Highway. Such inventories would facilitate administrators and planners to properly gauge and formulate mitigation steps.

Biodiversity-wise Assam is one of the major hotspots in the world. It houses 20 wildlife sanctuaries and national parks, including the famous Kaziranga and Manas National Parks and other reserved forest areas. These areas are ecologically sensitive and require careful planning and management. GIS can help the State Forest Department in preserving and monitoring them. CCS-enabled GIS would specially help in monitoring the forest corridors, fringe villages, encroachments, forest depletion, forest fires, distribution of forest guards and animal movement, to name a few.

Conclusion

Sustainable development of any region can only be the result of successful implementation and integration of spatial and non-spatial data into the GIS domain, with proper planning at the micro-level. Planners and managers should be facilitated with maximum data that they can utilize as proper planning tools. Merging of thematic maps would provide a clear picture of any attribute, as it would help the planners associate various parameters together to gauge the effects of any plan and to effectively monitor the utilization of funds. It would be a refreshing approach for individuals and the village community, who till now are totally dependent on government agencies for all kinds of information. This would help in sensitizing the people

and the community about the problems and their solutions. People are handicapped in many ways in exercising their constitutional right of participating in the planning process. They lack experience, expertise and information base to prepare such plans. Furnishing those inputs, basically information to enable them to involve themselves efficiently in the process, would be vital. Another major challenge would be to counter the forces of the vested interest groups, corrupt politicians and bureaucracy, who would lose their power when this MLP gets operationalized. In order to bring a radical change, we have to initiate MLP on a large scale, so as to influence the government. For this, we also need to involve local bodies, NGOs, etc. so that the importance and relevance of the process would be realized and reflected in different sectors. We have to bring an attitudinal change among these key players.

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