DEPARTMENT OF GEOGRAPHY
MAHARSHI DAYANAND UNIVERSITY, ROHTAK

EXECUTIVE SUMMARY OF FINAL REPORT

F.No. 39-1/2010 (SR)

FOR
MAJOR RESEARCH PROJECT
IN
GEOGRAPHY

Entitled

Planning for Conservation and Management of Natural Resources at Village Level using Remote Sensing and GIS Techniques in Mahendragarh District, Haryana.

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Executive Summary of Final Report

Project: "Planning for Conservation and Management of Natural Resources at Village Level using Remote Sensing and GIS Techniques in Mahendragarh District, Haryana."
F.No. 39-1/2010 (SR)

Objectives of the project:

(i) Objectives- 1: Land use/ Land cover changes were studied using the remote sensing satellite imagery and GIS for 2002 and 2012. During this period, the Mahendragarh district experienced many changes in Land use / Land cover pattern. Area under built-up, transport network, canal network, open scrub and forest land had increased 0.25%, 0.19%, 0.02%, 0.02%, 1.91%, 2.85% respectively. The area under hills, water bodies and agricultural land decreased 0.36%, 0.18% and 6.09%, respectively.

(ii) Objectives- 2: Various central and state government-sponsored natural resource development programmes were studied in detail. There were programmes related to micro-irrigation to incentivize farmers to adopt irrigation techniques that help conserve and manage water. Integrated watershed development programme also implemented in a phased manner in the district at village level. The agriculture department also sponsors many schemes related to awareness and new techniques. Farmers were slowly adopting new technologies and paid little attention to water conservation and soil health status.

(iii) Objective- 3: In the Mahendragarh district, water, soil and vegetation were in distress. Multi-criteria overlay analysis was applied to find zones where a natural resource management plan could be applied. Soil quality is not good in most parts of the district, and the ground water table is decreasing faster. Farmers were over-dependent on chemical fertilizers and water-guzzling crops for their livelihood, which was an unsustainable crop cycle in the long run. Therefore, the natural resource conservation zone had to find out using geospatial technology, and maps were prepared from the same.

(iv) Objectives- 4: A threefold strategy for sustainable utilization of resources and development planning of area has been proposed. Using geospatial technology and a district database, suitable sites for rainwater harvesting and groundwater recharge are identified. Secondly, to reduce the burden on groundwater, sites for water storage tank has been identified, and these tanks will be connected to the canal and its distributaries. Water from these tanks will be distributed need and rent basis. Thirdly, to reduce dependence on monoculture, organic farming with the help of biofertilizers and crop diversification is proposed, which will be supported by Bio and Land rehabilitation centres (BLRC). Suitable sites for BLRC are proposed having 5 to 20 nearby villages put stray animals and provide solid waste for generation of organic manure. Through proper implementation of these strategies, pressure on natural resources will reduce and help the local community and administration better manage and conserve resources for sustainable development of the area.

Achievements of the Project:

Various detailed administrative and thematic maps such as block-level and tehsil level distribution of villages, topography, geology geomorphology, soil types, drainage system, artificial drainage network, vegetation and other maps are prepared using GIS technology, which helps the administration to understand better the physical setup of the district and problems which the need to be focused by them. These base maps will also help the local community better prepare for natural resource management and implement plans for society's wellbeing at meso and micro levels by the administration.

LU/LC change and NDVI maps at the block level helps to identify problematic agricultural regions where the agricultural growth is stagnant or ineffective. The present study observed LU/LC change for 2002 to 2012, and maps were prepared. Administration and local people can compare the maps at CD blocks and better understand the changes. NDVI maps helped to identify vegetation and greenery deficient regions in the district. It was observed in the present study that the overall vegetation cover is increased from 2002 to 2012, but some patches are deficient in green cover. Using these maps, the administration can prepare localized plans to improve the vegetation cover in problematic areas.

Identification of sites for three structures viz. rainwater harvesting, groundwater recharge, and check dam help to stabilize groundwater table and the water shortage problem in the region may be solved. Construction and working of these provide the strength to the local community to cope with the issue of water scarcity in the summer season. It also helps the farmers better adapt to the water demand and water supply equation.

The water storage tanks are also proposed in the district, which will connect with canals and distributaries for recharge. These tanks will be equally distributing the water at the farm level. Using alternative sources for irrigation purposes will help to stabilize the groundwater table. This type of investment in the district will benefit farmers and local people in water supply for irrigation and drinking purposes.

The construction of bio and land rehabilitation centres may be a revolutionary step towards the wellbeing of farmers. These provide the protection and nurturing for stray animals, thereby helping farmers and using their wastage in fertilizer and vermicompost. Excess/more than required fertilizer and dairy products will be sold in the market as a source of income for BLRC. These centres will also help produce organic manure and incentivize farmers for

organic farming. Organic farming with the help of bio-fertilizers improves farm production quality and will help farmers earn a good income compared to current agricultural production. Soil quality and level of nutrition will also improve in these practices. It also reduces the dependency of farmers on chemical fertilizers. Solid management will be improved because the excess biodegradable waste will be supplied to BLRC sites for manure production.

Summary of findings:

In present study, the condition of natural resources of the Mahendragarh district had been studied using geospatial technology for period 2002-2012. The study area has experienced significant variation in land use / land cover changes at the block level during the previous decade (2002-2012). For this time period, Satnali (34.47 sq. km area) has seen the highest rate of agricultural land loss, followed by Mahendragarh (27.94 sq. km area), Nizampur (27.14 sq. km area), and Nangal Chaudhary (27.14 sq. km area) (21.55 sq. km. area). The majority of forest cover area has expanded under the category of protected forest cover (along the road & canal network). Certain patches of land inside the reserve forest category have turned into herbal gardens/parks. Around 85 kilometres of new link roads and a 20-kilometer-long network of miner canals were created during this time period. The water body has diminished in size. The built-up area has expanded by a factor of two, most notably in the urban sector.

In soil of the Mahendergarh district has very low nitrogen concentration in around 90% of the overall area. Due of low soil nitrogen levels, nitrogen-based fertilisers are widely used. Soil phosphorus concentration is poor or non-existent in around 80% of the land area. In Mahendragarh, the long-term prospects of irrigation and the ramifications of continuing current water management methods are more worrying. Time series analysis of water-table fluctuations elucidates the temporal variation in aquifer recharge and ground-water availability. Water table fluctuation is regulated by recharge and discharge. Streams and channels are mainly dry in the district, and seasonal rainfall is the only source of groundwater replenishment, while discharge occurs by evaporation and withdrawal. The consistent downward trend observed there, regardless of rainfall amount, implies poor recharging as a result of low rainfall and overexploitation of groundwater resources. The groundwater table in majority of the study area has rapidly decreased. NDVI Value less than 0.05 was found in 0.58% of area in 2002 which decreased to 0.3% area in 2012. In 2002, NDVI value between 0.05 to 0.2 was found in 29.14% area of the district which decreased to 22.10% area in 2012. NDVI value of 0.2 to 0.3 was observed in 40.86% area of the district in 2002 which decreased to 29.69% area of the district in 2012. In 2002, 29.42% area of the district was found in NDVI value more than 0.3 which increased to 47.92% of area in 2012.

Problems Related to Natural Resource Management and Planning:

During the field visit, 10% of the area of the district Mahendragarh was covered. The main problems observed by the researchers were as follows:

- Problems related to agriculture in general and specific to cropping pattern
- Solid Waste Management
- Water availability for drinking and irrigation
- Problems related to the physical environment

➢ Problems related to agriculture in general and specific to cropping pattern

The existing cropping pattern in Mahendragarh does not support the regional ecosystem. There is an ardent need to take some important and immediate steps to address the problem. The agricultural system in Mahendragarh is affected by mainly four problems which include excessive use of chemical fertilisers, the problem of canal water supply, market access for agricultural products and crop security. These challenges are also negatively influencing the farmers and the entire physical environment of the area.

- Chemical fertilisers:

There is abundant and uncalculated use of insecticides, pesticides and weedicides in order to maximise crop productivity and hence income of the farmer. However, this continuous usage leads to the percolation of chemicals inside the soil and degradation of its healthy parameters such as pH, organic content, moisture, nutrients etc. Ultimately, there is a decline in soil quality, and its fertility is destroyed.

- The problem of canal water supply:

Water supplied through the canal is not sufficient in quantity. However, water-guzzling crops such as wheat, cotton are grown, which require abundant water for their complete life cycle. Due to this, farmers have resorted to using groundwater in excess. Further, groundwater is used for drinking and other daily uses. This has led to a decline in groundwater level gradually over the long term.

- Crop security:

Crops are often destroyed by stray animals wandering into the field. Abundant stray animals in the area and lack of appropriate fencing of agricultural fields are two primary reasons for crop destruction. Farmers don’t have adequate income levels to afford sufficiently protective fencing. Management of stray animals is required in a manner that facilitates farmers work while protecting animal rights.

- Market-driven cropping pattern:

Farmers have adopted cropping patterns based on demand, market availability and income generation. There is no incentive for them to grow environment-friendly diverse crops. Diverse crops and environmentally synced crop systems not only optimise resource use of area but are also more economical in the long term. Farmer awareness on benefits of diverse crops, along with forwarding linkages in the form of market access, warehouses, e-NAM facilities etc., need to be built. For example, How wheat and cotton crop is not suitable for environment here.

- Solid Waste Management

- The arrangement for Solid waste management doesn't exist in the majority of the rural and urban areas. Of the limited facilities that exist, they are improper and inadequate.
- Poor management of the collection and disposal of solid waste may lead to water Pollution (pollution of surface water/groundwater).
- This may also result in the deterioration of Soil (Soil Pollution).
- Where large quantities of Solid dry waste are stored in hot climates, this may create a fire hazard. Related hazards include Air pollution and fire threat to surrounding buildings and people.

- Water availability for drinking and irrigation

- Water is neither available in adequate quantity nor of appropriate quality to fulfil the needs of all people in the region. The problem exists due to the lack of water itself and appropriate water supply infrastructural network.
- This has led to a drastic increase in the usage of groundwater for all activities, from drinking to farming. Hence, there is a declining quality and quantity of groundwater level over time.

- Problems related to the physical environment:

- Vegetation and tree cover are minimally present. It was observed during the field visit that vegetation cover is being adversely affected because of heavy mining activities. The area already affected by mining, i.e. where mining activities have already been undertaken, has no arrangements for restoration and conservation of vegetation. There is no policy for the reconstruction of these sites.

- The natural rainwater recharging system has been destroyed because of unmanaged mining activities. Serious, prolonged, and sustainable efforts are required for the restoration of vegetation and water systems in these regions.

Recommendations:

- Problems related to agriculture in general and specific to cropping pattern

There is a need to adopt integrated and holistic planning in the Mahendargarh region. The approach needs to balance the economy and ecology to create sustainable communities. There are 372 villages. A cluster approach with each cluster covering approximately 10 Km area is recommended

- Introducing the concept of Bio and Land Rehabilitation Centres (**जैव ज़मीन पुनर्वास केंद्र**):

- The Bio and Land Rehabilitation Centres (BLRC) are being proposed to be set up in every cluster on the open public village lands. They will be based on a community-centric, eco-centric model and will become the focal point in the integrated development of that cluster.
- Selection of these by a method of buffering in GIS as per the following weightage:
    - 40% land availability
    - 20% distance from village/ settlement
    - 20% availability of water
    - 20% road connectivity
- These selected centres should contain
    - Covered with a boundary and shall inhabit all stray animals of the nearby area.
    - It should be developed in the form of a natural habitat keeping in view the requirement of community and animals.
    - There will be a provision of adequate water supply for use in centre.
    - Provision of shades should be present for animal.
    - A unit of vermicompost production should be developed in each centre.
    - Provision of setting up biogas plants that can be used for filling up cylinders by families in the cluster.
    - Solar panels for the capture and storage of energy will be supplied to the cluster. Excessive energy can be sold to the state grid.
- Role of farmers of connected villages-
    - Farmers will supply the fodder from their field to these centres

    - Biodegradable/ organic waste will also be collected from the village and will be used to generate organic fertiliser
    - Crop residual will also be supplied to these centres for use in the production of fertiliser.
- Role of these centres
    - Protection and nurturing of stray animals, thereby helping farmers and using their wastage in fertiliser and vermicompost
    - Production of organic/ vermicompost fertiliser will be given back to the farmers against the quota of fodder and biodegradable waste that they provide.
    - Excess/more than required fertiliser will be sold in the market as a source of income
    - Production of milk and dairy products and selling them to generate revenue
    - Supplying organic fertiliser, dairy products, green energy
- Sukhet Model: An idea similar to the above proposed have been successfully piloted by Dr Rajendra Prasad Central Agricultural University in Samastipur and the Krishi Vigyan Kendra in Madhubani, whereby people can get gas cylinders refuelled in exchange for waste and cow dung they sell.
- Potential Impact of BLRCs:
    - Stray animals will stay in a protected area, and crops will be secure.
    - It will reduce the farmer expenditure for constructing the boundaries or fencing of the agricultural field, thereby providing more expendable income.
    - The village will be connected to these centres, and these centres will generate employment for people of the nearby area.
    - Improve awareness and knowledge among farmers and village population on sustainable living.
- Impacts of the use of organic fertilisers from these centres
    - There will be a reduction in the use of chemical fertilisers. It will be replaced by organic fertilisers.
    - Less water will be required in the field for applying organic fertilisers compared to chemical fertilisers. Hence, saving of water and helping in recharge of groundwater table and its quality.
    - Reduction in the use of chemical fertilisers will also lead to less expenditure and the more expendable income available to farmers

    - It will also aid in increasing the soil fertility
    - As the input cost of farming is reduced, the average income of farmers will increase. This will help in the overall well being of families and the growth of the regional economy.
    - The use of organic fertilisers will generate organic food for consumption. This will lead to less accumulation of chemicals inside the human body, and hence health indicators will improve.
    - Ultimately, quality of life will certainly improve.
- Parallel to this, farmers should be educated about the best horticulture practices. This helps to diversify crops, increase revenue and provide insurance for crop loss.

➢ Solid Waste Management

- Spreading awareness about proper waste segregation as well as reducing the usage of plastic in daily life activities such as carrying cloth bags for market shopping.
- Promote the use of compost, conversion of waste into energy through these centres for all households, especially in rural areas.
- A separate evaluation must be carried out if all the rules mentioned under Solid Waste Management Rules 2016 are being followed by municipal authorities.
- Biomining and Bioremediation techniques should be explored, which are not only cost-effective but also environment-friendly.
    - Bioremediation: Bioremediation uses natural microorganisms to break down toxic and hazardous substances in solid waste by aerobic and anaerobic means.
    - Biomining: Biomining is the process of using microorganisms (microbes) to extract metals of economic interest from rock ores or mine waste. Biomining techniques may also be used to clean up sites that have been polluted with metals.

➢ Water availability for drinking and irrigation

- In order to ensure the supply of water to every farmer, two thing needs to be done
    - Improving canal water supply network in the area
    - Flood irrigation practice should be replaced by drip and sprinkler irrigation methods.
- This can potentially ensure that water used through flood irrigation in one acre of land will be sufficient to irrigate 10 to 20 acres of agricultural land through drip and sprinkler irrigation.

- Since the density of the number of wells is very high in the study area, this practice of use of drip and sprinkler irrigation will certainly improve the quality and volume of groundwater in the area.
- For this purpose, financial assistance may be provided to develop a community-based water supply system. Community-based water storage tanks should be constructed, which will be connected through a canal water supply. This storage of water will then be connected to the sprinkler irrigation system of the farmers.
- It is also observed that the plantations done by government agencies at mining sites are being dried out (and hence destroyed) due to a lack of water. These sites of plantation can also be revived and benefitted by these community-based water supply systems.
- In this way, the physical environment of the area can also be improved.

➢ Problems related to the physical environment

- Forest areas in the district shall also be developed as natural habitats in the interest of the conservation of biodiversity of the area.

➢ Potential sites for Bio and Land Rehabilitation Center:

To find the suitable site for Bio and Land Rehabilitation center multi criteria analysis has been used. Accessibility of roads and water and availability of open land is considered to find suitable sites. A village which have a setup of BLRC for surrounding villages, the average distance should not be more than 10 km. Using the weighted overlay analysis we find the 26 clustur sites which have potential to develop BLRC in the Mahendragarh district. Some sites have 5 to 8 village and some sites have 15- 25 villages in its cluster. Number of villages in each cluster is vary from 5 to 27. Farmer's biggest challenge is to travel to reach the BLRC for availing their services, for this purpose minimum travel distance is encouraging (Map: 6.10). The distance for villeges to reach BLRC is ranges from 1 km to 8 km. These 26 center is near the water and road and situated on open lands.

➢ Potential site for construction of water storage tank:

To find the suitable sites for construction of water storage tank multi criteria analysis has been used. A water storage tank will serve approximately four square kilometer of area and it will be connected with a water supply for its recharge. Most of tank is connected to canals, minors and sub-minors. Number of tank in Mahendragarh suitable for irrigation purpose has

407 which will connected to canals and minors with approximately 489 km long water supply system.

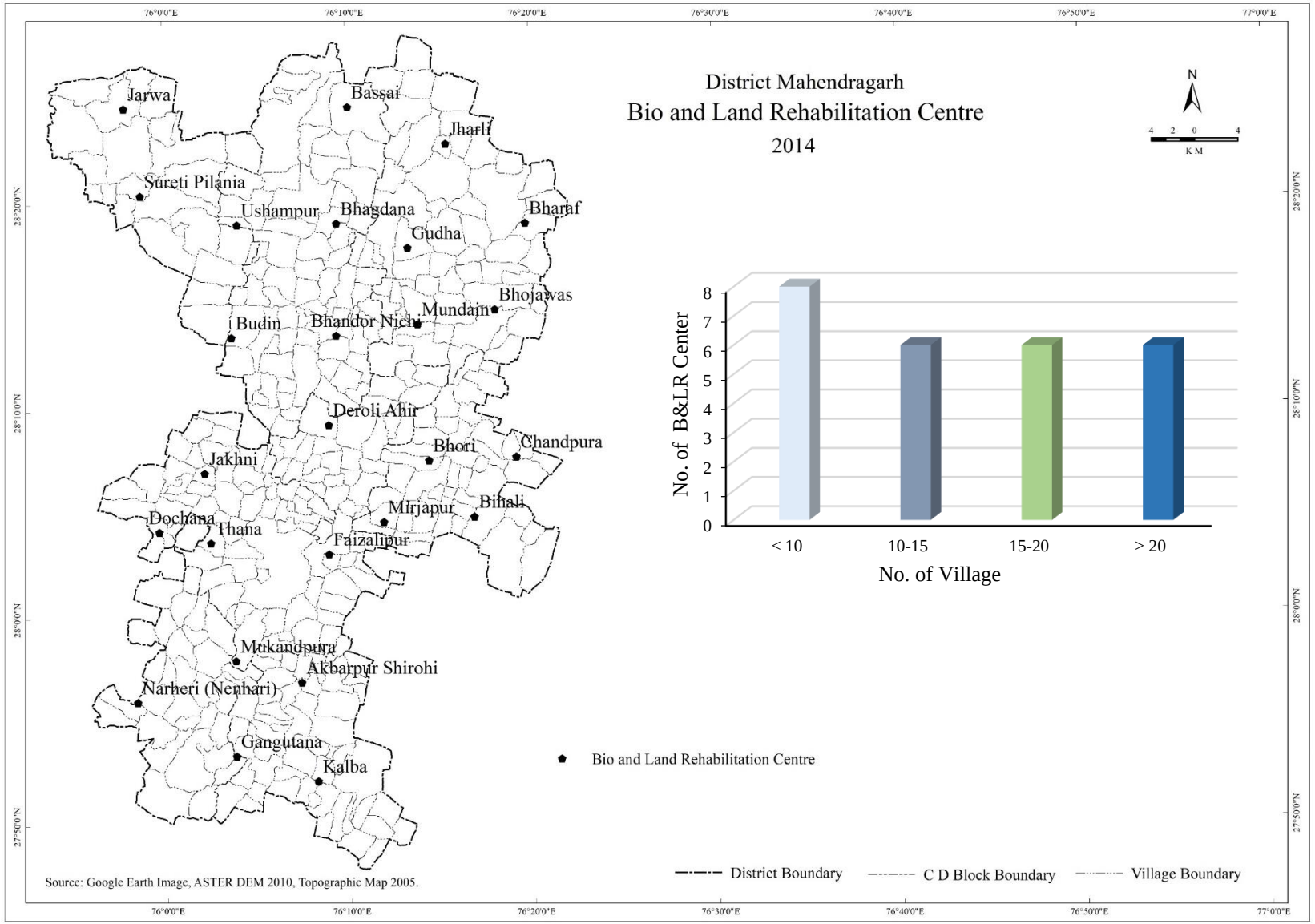
These tanks act as centeral water supply unit for surrounding area and farmers will be able to use water from these tanks for irrigation purpose at rent basis. Govt will ensure the equitable supply to farmer on need basis and crops with maximum water demand should not allowed. This will help govt as well as farmers to efficiently use less water for more irrigation area. These tanks will provide alternate source for irrigation and help to reduce dependency of farmers on groundwater. With the help of government and local community farmers may be able to survive and sustain in agricultural activities.

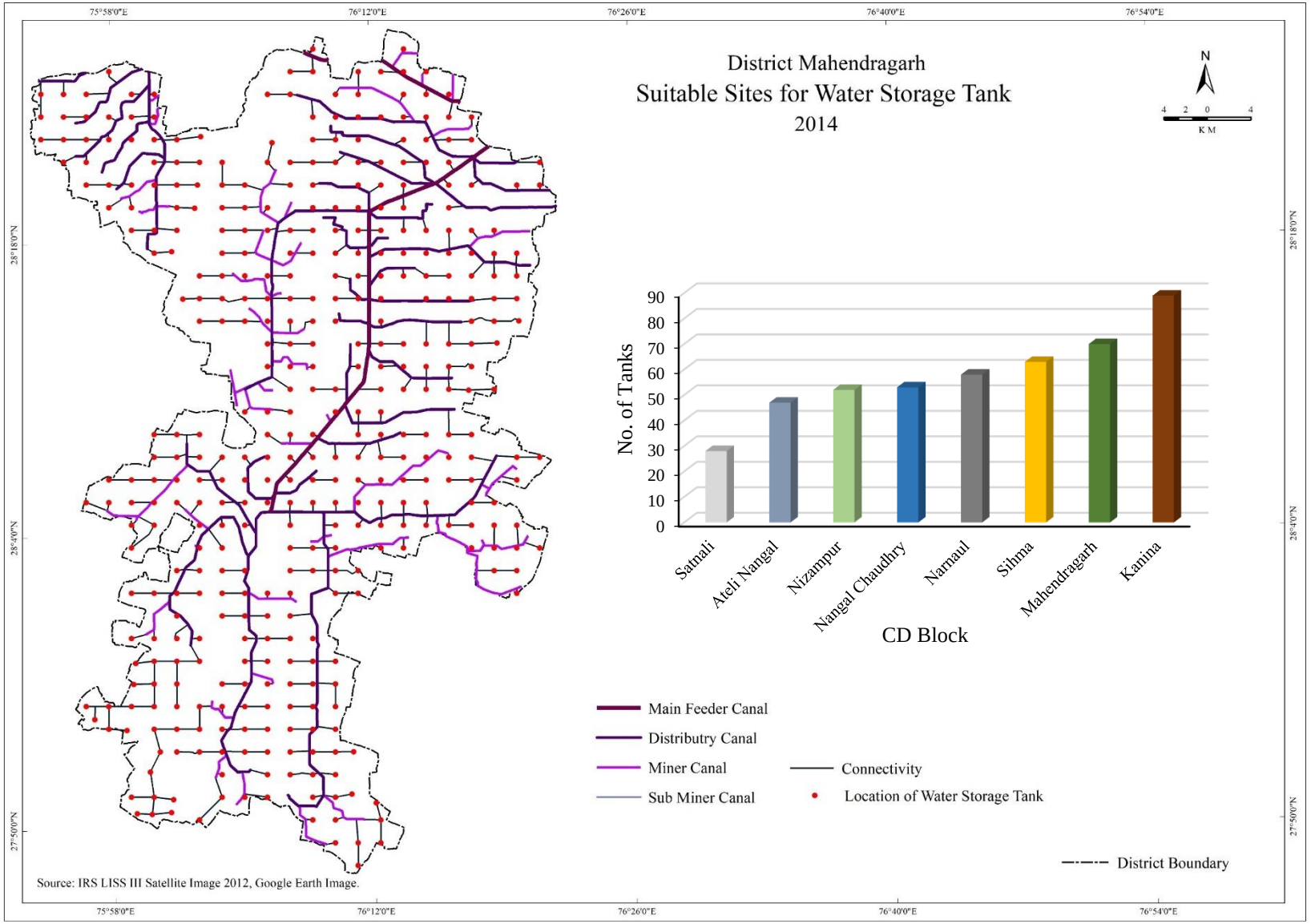
- Potential sites for Rainwater harvesting and Groundwater recharge:

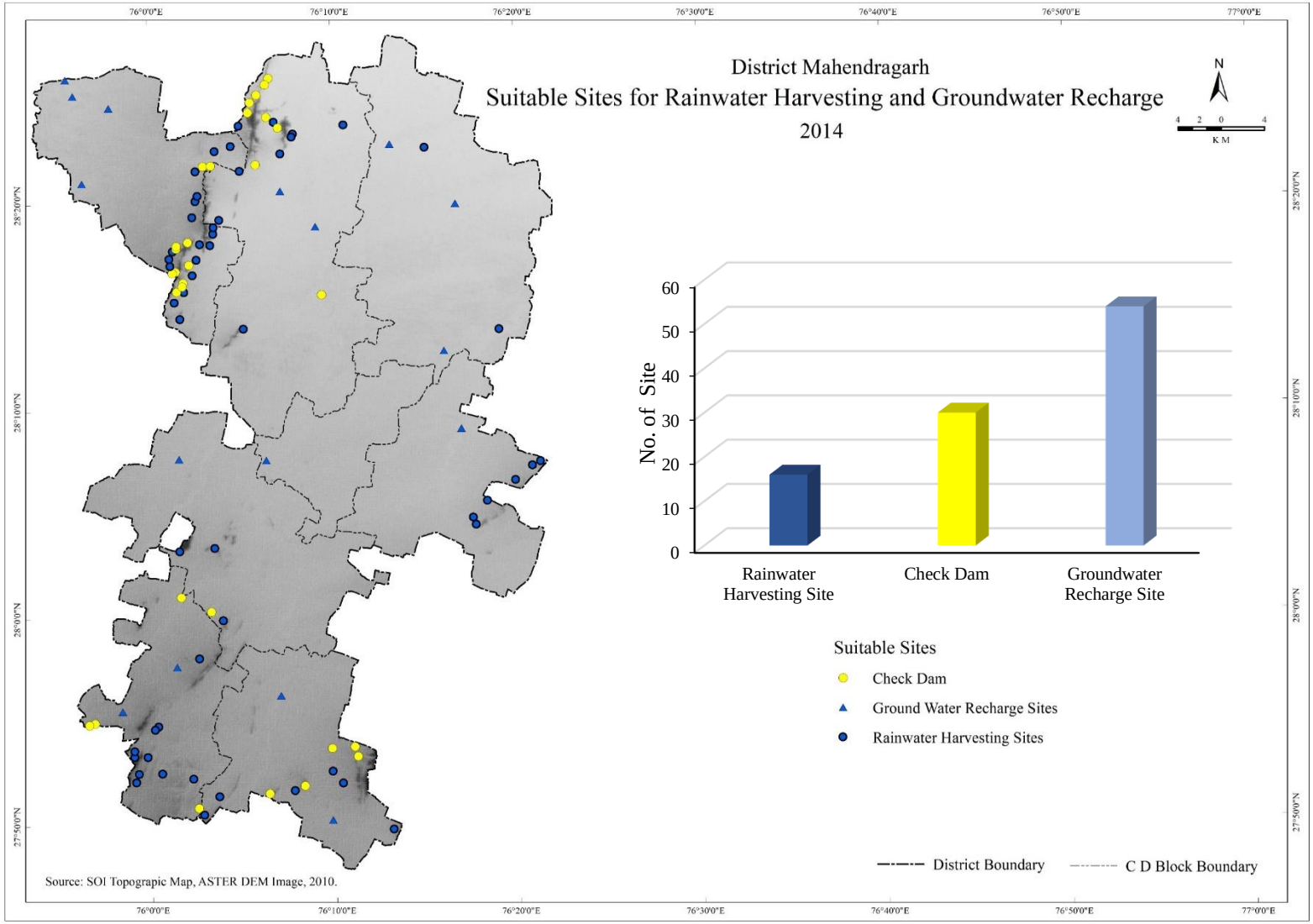
In the Mahendragarh District, using multi criteria analysis suitable sites for rainwater harvesting and groundwater recharge were found out. There are 30 suitable sites for construction of check dams, 16 suitable sites for groundwater recharge and 54 suitable sites for rain water harvesting.

Most of Rainwater harvesting sites are found in the area with hills. Border of Satnali and Mahendragarh block have most suitable sites for above purpose. Southern parts of Nizampur and Nangal Chaudhary also have many suitable sites for rain water harvesting. Likewise for construction of check dams hilly areas are found more suitable than other part of district. For construction of ground water recharge sites many places find suitable all ovr the district and many sites are found in Satnali block. All the development blocks have one to four sites for said purpose. For site suitability analysis most weight is assigned to rainfall which show dependency for water purpose on rainfall.

Many places have these type of construction but there is a need for rejunavate the old structure. Therefore, through rainwater harvesting and groundwater recharge, water stress will be managed and using canal water, dependency on groundwater reduced which will help to check water table decrease in district.


District Mahendragarh
Bio and Land Rehabilitation Centre
2014
N
4 2 0 4
K M
Jarwa
Bassai
Jharli
Sureti Pilania
Ushampur
Bhagdana
Bharnf
Gudha
Bhojawas
Mundam
Budin
Bhandor Nichi
Deroli Ahir
Chandpura
Bhori
Jakhni
Mirjapur
Bihali
Dochana
Thana
Faizalipur
Mukandpura
Akbarpur Shirohi
Narheri (Nenhari)
Gangutana
Kalba
Bio and Land Rehabilitation Centre
No. of B&LR Center
0
1
2
3
4
5
6
7
8
< 10
10-15
15-20
> 20
No. of Village
Source: Google Earth Image, ASTER DEM 2010, Topographic Map 2005.
District Boundary
C D Block Boundary
Village Boundary
76°0'0"E
76°10'0"E
76°20'0"E
76°30'0"E
76°40'0"E
76°50'0"E
77°0'0"E
28°20'0"N
28°10'0"N
28°0'0"N
27°50'0"N


75°58'0"E
76°12'0"E
76°26'0"E
76°40'0"E
76°54'0"E
28°18'0"N
28°4'0"N
27°50'0"N
District Mahendragarh
Suitable Sites for Water Storage Tank
2014
N
4 2 0 4
K M
No. of Tanks
0
10
20
30
40
50
60
70
80
90
Satnali
Ateli Nangal
Nizampur
Nangal Chaudhry
Narnaul
Sihma
Mahendragarh
Kanina
CD Block
Main Feeder Canal
Distributry Canal
Miner Canal
Sub Miner Canal
Connectivity
Location of Water Storage Tank
District Boundary
Source: IRS LISS III Satellite Image 2012, Google Earth Image.


District Mahendragarh
Suitable Sites for Rainwater Harvesting and Groundwater Recharge
2014
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4 2 0 4
K M
76°0'0"E
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76°30'0"E
76°40'0"E
76°50'0"E
77°0'0"E
28°20'0"N
28°10'0"N
28°0'0"N
27°50'0"N
No. of Site
60
50
40
30
20
10
0
Rainwater Harvesting Site
Check Dam
Groundwater Recharge Site
Suitable Sites
Check Dam
Ground Water Recharge Sites
Rainwater Harvesting Sites
District Boundary
C D Block Boundary
Source: SOI Topograpic Map, ASTER DEM Image, 2010.

Contribution to Society:

Farmers constitute a large part of the community, and good agricultural production brings this group happiness and social wellbeing. This study attempts to find the truth about various problems related to agrarian society, e.g. water scarcity, soil health, monoculture, use of chemical fertilizers etc. It helps planners and administrators make a suitable plan for society's wellbeing. Besides that, solutions to different problems are also proposed, like Identifying rainwater harvesting, groundwater recharge sites and bio and land rehabilitation centres. Attempts should be made to bring these proposals into reality at the district level.

The local community will benefit from proper utilization of natural resources, leading to sustainability in the study area if proposed plans are implemented properly. Implementing organic farming and crop diversification in the district will reduce the input cost of farming per acre and the use of chemical fertilizers. This will help farmers sustain agriculture practices without harming the natural ecosystem on a large scale. In this way, pressure on land for livelihood will reduce, and the migration of people for work will also decrease.

Soil health of district was in deteriorating condition. Using organic farming practices, soil health will also improve, and agriculture per unit will increase. Also, good agriculture production will incentivize the market for organic products, and poverty will reduce. By reducing dependence on chemical fertilizers, the local community will achieve good health conditions of individuals and pressure and health system will also reduce.

Water is under severe stress throughout the district. Dependence on groundwater for agriculture and other usages will be reduced if the water storage tank is properly constructed and connected to the canal network for recharge. Farmers will benefit, and the drinking water supply will also be regulated in an equitable manner all over the district.

The Bio and Land Rehabilitation Centres (BLRC) being proposed to be set up in every cluster on a community-centric, eco-centric model is one of the contributions of this study that can have immediate short-term and long-term sustainable benefits. They can potentially become the focal point of holistic change in the integrated development of clusters and, subsequently, Mahendargarh District. The wide-ranging impact of this idea encompasses farmers, youth in the region, common citizens, and stray animals.

As there is improvement in the indicators of the sustainable environment such as soil health, groundwater recharge, water quality and scarcity etc; there will be positive ripple effects on health parameters of society such as reduction in diseases, economic factors such as improvement in average income etc. This, in turn, will improve the happiness index of society in Mahendargarh.

This study will benefit all sections of the local community and help utilize natural resources sustainably. Poverty reduction and upliftment of poor people are also achieved through proposed plans.