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SITE SUITABILITY ANALYSIS FOR WATER HARVESTING IN SHIVALIK HILLS, HARYANA

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Abstract- Study was carried out for Morni Subwatershed in panchkula District, a part of Shivalk hills consisting highest elevation of Haryana. The aim of the study is to identify suitable water harvesting sites using RS and GIS techniques by integrating various thematic information. A very high resolution satellite data was used to carry out this research work. The sub watershed comprises of rocky surface and several types of faults and fractures. Use of remote sensing data along with GIS, topographical maps, collateral information and limited field checks, has opened new avenues and made it easier to establish the base line information for water harvesting zones. ARCGIS 10 and ERDAS IMAGINE 11 software's were used for analysing and interpretation of remote sensing data. Based upon the specific criteria provided in the literature , about 88 water harvesting (WH) sites were identified by overlaying several maps viz. LU/LC, contour, slope, geology and geomorphology, drainage network, stream order, road network and groundwater quality. Different water conservation structures were suggested to conserve water for domestic and commercial purpose.

Key Words: DEM, Land use/land cover, stream order, WH site, Contour

1. INTRODUCTION

Fresh water scarcity is not limited to the arid climate regions only, but in areas with good supply the access of safe water is becoming critical problem. The most important natural source of water is rainfall. Despite its scarcity, rainfall is not generally managed and much of it is lost through runoff and evaporation. Increasing trend of population and economy in India is increasing the demand of water for domestic, agricultural and industrial uses. Capturing the rainwater and making an efficient use of it is crucial for any integrated research and development project to meet these demands. Water harvesting can play an important role in meeting the objectives of such projects. Reduction of surface runoff can be achieved by constructing suitable structures which automatically helps to manage the other natural land resources like soil and vegetation. For the efficient management, one has to take suitable unit of management. By taking watershed as a unit, water, soil, and vegetations can be managed efficiently, collectively and simultaneously.

Water harvesting is the process of collecting rainfall as runoff from a larger catchment for use in a smaller target area. Different traditional and innovative techniques can be adopted for runoff farming water harvesting, surface storage water harvesting and groundwater recharge. Rain is the first form of water that we know in the hydrological cycle, hence is a primary source of water for us. Rivers, lakes and groundwater are all secondary sources of water. In present times, society depends entirely upon such secondary sources of water. In the process, it is forgotten that rain is the ultimate source that feeds all these secondary sources and remain ignorant of its value. Water harvesting means to understand the value of rain, and to make optimum use of the rainwater at the place where it falls. Water harvesting is a national priority as water supplies are being depleted by intensive pumping.

Formulation of a proper watershed management plan requires reliable and up-to-date information about various factors such as morphologic (size and shape of the watershed, drainage parameters, topography), soil and their characteristics, land use, and land cover, etc. that affect the behaviour of a watershed (Pandey et al.. 2011).

2. STUDY AREA

The present study was carried out for Morni sub-watershed in Panchkula district. It is located at latitude 30°40'17"-30°46'10"N and longitude 77°00'01"-77°09'52"E. It covers an area of about 6551.40 ha. The study area is divided in 7 micro-watersheds named as M1, M2, M3, M4, M5, M6 and M7. The study area has climate having, hot summers, cool winters and good monsoon rainfall. It has great variation in temperature (-1 °C to 43 °C). The average annual rainfall of the area is 720.68 mm, out of which 80% of annual rainfall is received in June to September months. It also receives some rainfall in winter months due to western disturbances. Despite heavy rains in the area, water retention is very low because of steep slope which develops high surface runoff. Generally, the slope of the district is from north east to south west and most of the seasonal streams flow down and while spreading gravels/pebbles on its way. Morni hills constitute the highest point of Panchkula as well as of Haryana.

3. DATA AND TOOLS USED

Survey of India (SOI) Toposheet No. 53F/03 on 1:50,000 scale were used to delineate the study area. Very high resolution data from WORLDVIEW-2 satellite with 8 band multispectral capabilities of April 11, 2012, June 11, 2012 and June 12, 2012 on 1:2500 scale were used for digitization of land use/land cover map. Specification of satellite data is given in Table 3.1.

Table-3.1 Specification of Satellite Data

Satellite	Mode	Spectral Resolution (µm)	Spatial Resolution (m)	Path No.	Row No.
Worldview-2	Multispectral	Coastal band: 0.400 – 0.450 Blue: 0.450 – 0.510 Green: 0.510 – 0.580 Yellow: 0.585 – 0.625 Red: 0.630 – 0.690 Red-edge: 0.705 – 0.745 Near IR1: 0.770 – 0.895 Near IR 2: 0.860 – 1.040	1.84	95	49

4. MAPPING OF DIFFERENT FEATURES

4.1 Delineation of Study Area

The Survey of India Toposheet No. 53B/13, 53/14 and 53F/02 on 1:50,000 scale were used to delineate the study area.

4.2 Geo-Referencing

Satellite data which is available in raster form needs to be geo-referenced to a map coordinate system so as to generate special information to be used subsequently in GIS environment. The process of geo-referencing spatial coordinate system WGS 1984 UTM zone 43N was assigned to raster image for the transformation of raster image to input coordinate system. All required images were rectified and then subjected to mosaicing and image enhancement.

4.3 On Screen Digitization

On screen digitization was done on WORLDVIEW-2 satellite data imagery on 1:2500 scale. The False Color Composite (FCC) (Blue, Green and Near IR1 band) of study area was prepared for preparation of land use/land cover maps. Land use/land cover was categorized in to different classes of built up area/settlement, agricultural land, wasteland, water bodies and forest.

4.4 Interpretation of Data

On screen visual interpretation technique was used for the preparation of land use/land cover maps of study area. The interpretation used for identifying the classes was based on the standard visual interpretation elements such as shape, size, color, tone, texture and pattern. Interpretation key for each land use/land cover class is given in Table 4.1.

Table-4.1 Land Use/Land Cover Class Interpretation Key

Land use/land cover	Tone	Size	Shape	Texture	Association
Built-up area/settlements	Whitish	Varying	Definite	Coarse	Streets
Agricultural land ➢ Cropped land ➢ Terrace cultivation ➢ Old agricultural plantation ➢ Young agricultural plantation	 Greenish Greenish Dark red Light red	Varying	 Definite Definite Regular Regular	 Fine to medium Fine to medium Coarse with mottling Coarse with mottling	 Outskirts of settlements Foothill/Rocky slope Agricultural land Agricultural land

Scrub (Wasteland)	Brown/Dull red	Varying	Irregular	Coarse	River/Rocky area
Water bodies ➢ River course ➢ Pond • Natural pond • Artificial pond	Dark blue Light blue Light blue	Varying	Irregular Irregular Regular	Smooth	Built up area/agricultural land/scrub/forest Built up area
Forest ➢ Dense forest ➢ Open forest ➢ Scrub Forest	Bright red Red Dull red/Brown	Varying	Irregular	Coarse with mottling Coarse with dark mottling Coarse with dark mottling	Outskirt of agricultural land

4.5 Ground Truth Verification

Ground truth refers to information that is collected "on location". It is important to relate image data with real features on ground. Collection of ground truth data enables calibration of remote sensing data, aids in interpretation and analysis of what is being sensed. The preliminary interpreted maps were taken to ground truth verification. Doubtful areas were checked in field and modifications were done as per ground verification. Various photographs of study area including land use/land cover features such as scrubland, agricultural land, forest land etc. were also taken.

4.6 Generation of Contour

Contours were generated using stereoscopic data of WORLDVIEW-2 satellite data.

5. IDENTIFICATION OF POTENTIAL WATER HARVESTING SITES

Different parameters were used for the identification of potential water harvesting sites such as land use/land cover, drainage network, contour, Flow direction, Stream Order, Groundwater quality, Road network, Geology, Geomorphology and Fault/Fracture to identify potential water harvesting sites.

6. CRITERIA FOR SITE SELECTION TO SUGGEST DIFFERENT WH STRUCTURES

In general, the locations for recharge structures are to be identified about 200-300 m upstream of the problem habitation. They have to be located mainly on 1st and 3rd order streams and at the most up to the initial stages of 4th order stream. No recharge structure is located on major streams/rivers occupying large area and forming polygons. The criteria's for the selection of location for various recharge structures is given below:

Check Dam: On the 1st and 3rd order streams along the foot hill zones and in the areas with 0-5%.

Percolation Tank: on the 1st and 3rd order streams located in the plains and valleys having sufficient weathered zone/loose material/fractures.

Nala Bund: On the 1st and 4th order streams flowing through the plain and valleys where acquisition of land inundation of large areas is not possible. In this case, limited water will be stored in the river bed for some time which increases recharge.

Invert Well/Recharge Well: in the areas where transmissivity of the upper strata is poor e.g. in shales underlain by sandstones, in buried pediplains with top soil having low permeability, in Deccan Traps where vesicular basalt is overlain by massive basalt or thick black cotton soil or impervious zone.

Desilting of Tanks: The desilting is recommended in small tanks which are partially silted up. Siltation in the tanks is found by study of the image and ground truth.

Recharge pit: around the habitations where drainage does not exist e.g. water divide areas, hill/plateau tops etc. the recharge pits are preferred in the existing tanks also.

7. RESULTS

Water harvesting is based upon the fact that there is a huge amount of monsoon water flow, which remains uncaptured and eventually ends up in natural sinks. Based upon the specific criteria provided in the literature , about 88 water harvesting (WH) sites were identified by overlaying several maps viz. LU/LC, contour, slope, geology and geomorphology, drainage network, stream order, road network and groundwater quality. Considering the runoff potential of sub-watershed, WH structures such as Nala bunds (17), Check Dams (12), Inverted/Recharge Wells

(18), Desilting Tanks (2), Recharge Pit (1), Storage Tanks (38) were suggested on identified WH sites as shown in fig. 7.1. The impounded water could be used for different purposes during scarce rainy months in their associative land units.

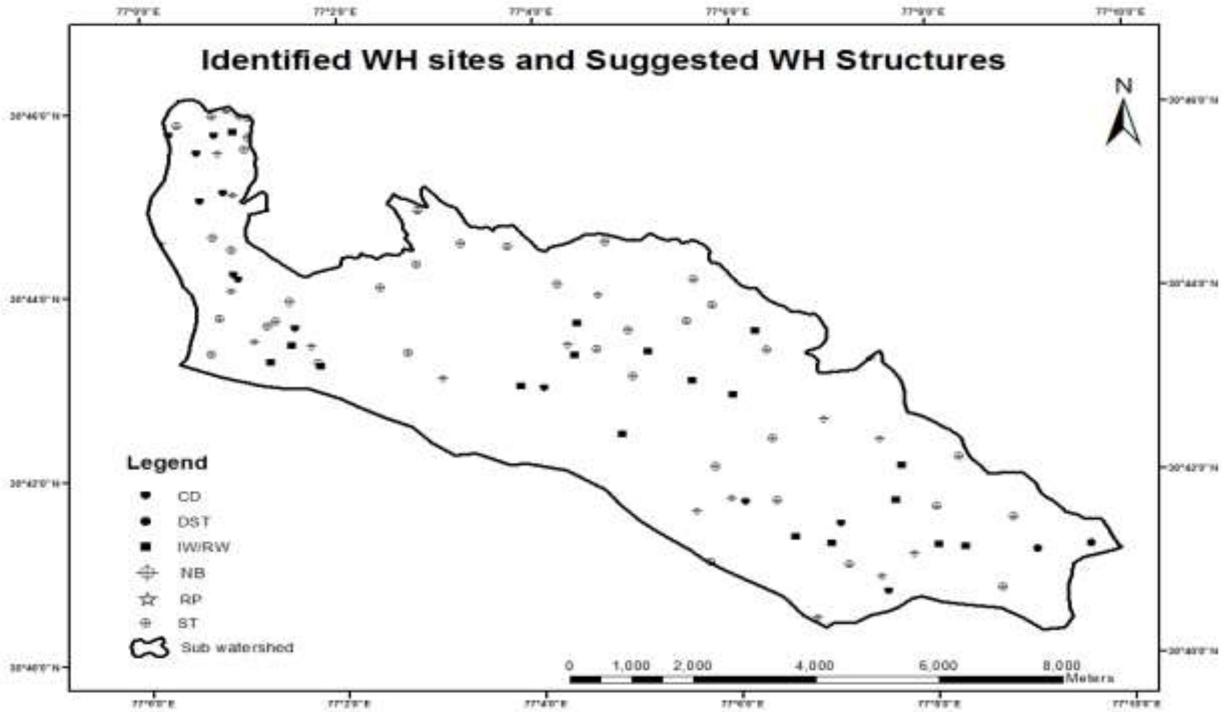

Fig. 7.1 Location Map of Identified Potential Water Harvesting Sites/Structures

CONCLUSION

To meet the requirement of increasing water demand, water storage structures (pond, check dam) and groundwater recharge structures (percolation tank) are proposed to augment both surface and sub-surface storage. Percolation tanks are having low efficiency in hard rock area. Inefficient recharging in hard rock is due to lack of integration of groundwater and surface water use. In such regions, surface water impoundment of all available excess flow should be considered rather than recharge. Hence, efficiency and performance of these structures depend on appropriate structural design and site selection criteria. Remote sensing coupled with the use of Geographical Information Systems (GIS) can be used to identify potential zones and location of suitable sites for water harvesting.

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