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# Action plan for efficient land and water use in a mini-watershed near Mysore using remote sensing and GIS

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■ **ABSTRACT :** Developmental planning using integrated approach has been accepted world over for optimal management and better utilisation of natural resources towards improving living conditions of the people and to meet the growing demands of increasing population. Timely inflow information (both the spatial and non-spatial) and its reliability is a pre-requisite for integrated developmental planning. Satellite remote sensing is an ideal tool for generating such spatial information base. In the present paper, preparation of thematic maps like land use/land cover, hydrogeomorphology, slope, base map, soil map and stream network map using the Quick Bird satellite imagery and toposheet from the Survey of India for the Ballahalli mini-watershed near Mysore, Karnataka to generate land and water action plan for optimal land and water use by integrating all the thematic maps and collateral data are presented and discussed.

■ **KEY WORDS :** Watershed, Thematic maps, Land and water resource action plan, Remote sensing and GIS

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Watersheds are natural hydrologic units and the boundaries of which rarely coincide with the administrative boundaries *viz.*, village, taluk etc. Further, watersheds are spatial in nature and delineation of them into a unit such as sub, mini and micro watershed varies from person to person and agency to agency. The pattern of drainage network will decide the shape and size of the above units. Thus the details of watersheds in the form of map/ spatial format are quite essential. Satellite remote sensing data have the advantage of providing up-to-date and comprehensive information needed for systematic and scientific planning of watershed developmental activities. It provides spatial information on drainage, streams, tanks, land-use/land cover, geology, soils, etc. The present study was taken with the objective to delineate the watershed, to prepare thematic layers and to generate land and water resource action plan for their efficient management and use (Praveen, 2006).

## ■ METHODOLOGY

Ballahalli mini-watershed is situated in Mysore taluk of Mysore district and located between $12^0$ 13' and $12^0$17' N latitudes and $76^0$ 30' and $76^0$ 34' E longitudes (Fig. A). The mini-watershed covers an area of 3,319 ha with perimeter of 26.17 km. In the study high-resolution Quick Bird satellite image was used for visual interpretation. The data were used to derive various thematic maps at 1:4000 scales.

GIS software ERDAS (Earth Resources Data Analysis System) IMAGINE 8.5, was used in processing and analysing satellite imagery, incorporating the results into a functional GIS environment and generating maps that can be used to propose the action plan. Auto - CAD 2000 and Arc map were used for smooth digitisation and to integrate the different feature maps in a single layer.

The mini-watershed was delineated and codification was done by using the SOI topographic maps and following the All India Soil and Land Use Survey (AIS and LUS) guidelines upto watershed level along with satellite imagery. The code of the study area was 4B3E3C1 which falls under, region-rivers flowing to Bay of Bengal and others except Ganges and Brahmaputra, Basin-Cauvery, Catchment-Krishnarajasagara to Stanely reservoir, Watershed-Yennehole, sub-watershed-Sindhuhalli and Mini-watershed-Ballahalli.

Roads, settlements, major streams, tanks etc. were

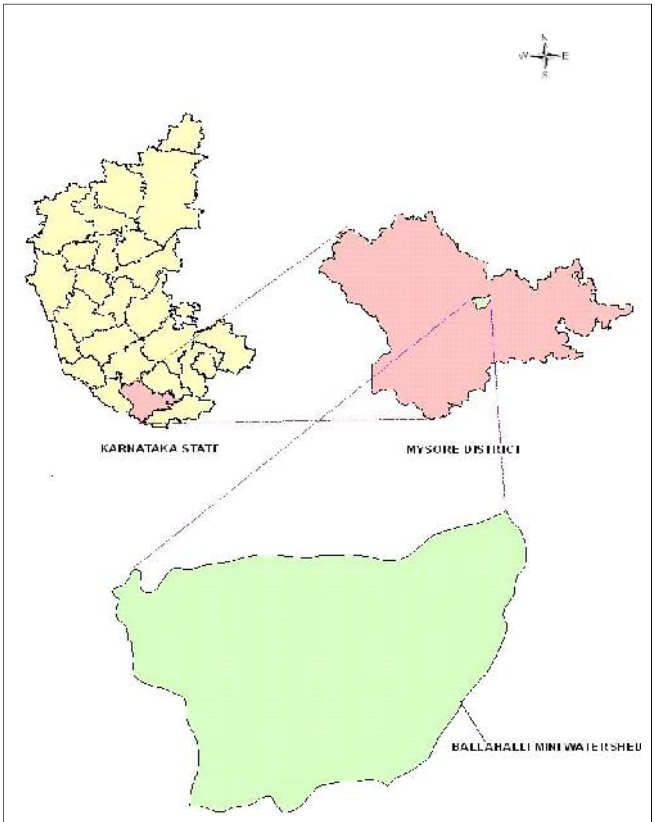


**Fig. A : Location map of Ballahalli Mini-watershed**

digitised online to derive a base map. The SOI toposheets were used to name the settlements and also as reference maps. The base map was used in common for all other thematic maps. All the thematic maps *viz*., land use/land cover, hydro-geomorphology, soils and drainage were generated by visual interpretation of satellite image and on-screen digitisation.

The interpretation was done using the interpretation keys like colour/tone, texture, size, accompanying characteristics etc. The maps were finalised after random ground truth survey. The slope map was generated using the SOI topo sheets with 20 m contour intervals. The morphometric analysis was done by using the drainage map.

Land use/land cover mapping of the study area was carried out by visual interpretation techniques developed by National Remote Sensing Agency (NRSA), Hyderabad using Quick Bird satellite imagery (Sharma and Sharma, 2002).

The spatial thematic information was translated into action plans for optimum utilisation of land and water resources for sustainable development and further development of these resources using manual integration method following technical guidelines of Integrated Mission for Sustainable Development, NRSA, Hyderabad.

## ■ RESULTS AND DISCUSSION

The Ballahalli mini-watershed area was demarcated into five categories of slope (Table 1). It was evident from the aspect of slope that the drainage in the watershed was also in that direction with the outlet at 0-1 per cent slope (nearly level) at extreme East.

The different soil series with respect to type of soil, depth of soil, gradient and their erosional status present in the study area were identified and represented as the soil resource map of the mini-watershed (Table 2). Among the different categories, soils present in mini-watershed are moderately shallow with moderate erosion to very deep with

**Table 1 : Different slope categories identified in Ballahalli mini-watershed**

| Slope class | Slope (%) | Area (ha) | Percentage of total geographical area |
|---|---|---|---|
| 1 | 0-1 | 904.55 | 27.25 |
| 2 | 1-3 | 1584.00 | 47.71 |
| 3 | 3-5 | 557.80 | 16.80 |
| 4 | 5-10 | 204.70 | 6.17 |
| 5 | 10-15 | 68.67 | 2.07 |
| Total | | 3319.72 | 100.00 |

**Table 2 : Soil characteristics of Ballahalli mini-watershed**

| Sr. No. | Classification | Area (ha) | Percentage of total area of mini-watershed |
|---|---|---|---|
| 1. | Moderately shallow, well drained, gravelly clay soils with very low Available Water-holding Capacity (AWC) on undulating interfluves, with moderate erosion | 2456.10 | 73.99 |
| 2. | Moderately shallow, moderately drained, gravelly clay soils with very low AWC on undulating interfluves, with moderate erosion | 353.61 | 10.65 |
| 3. | Very deep, moderately well drained, clayey soils of valleys, with problems of drainage and slight salinity in patches | 510.02 | 15.36 |
| | Total | 3319.72 | 100.00 |

**Table 3 : Hydrogeomorpologic units delineated in Ballahalli mini-watershed, their extent and groundwater prospects**

| Sr. No. | Geomorphic units | Groundwater prospect | Area (ha) | Percentage of total area |
|---|---|---|---|---|
| 1. | Pediment | Poor | 838.75 | 25.265 |
| 2. | Pediplain shallow | Moderate | 1715.69 | 51.682 |
| 3. | Pediplain medium | Moderately good | 604.86 | 18.220 |
| 4. | Pediplain deep | Good | 82.93 | 2.498 |
| 5. | Valley | Very good | 11.57 | 0.349 |
| 6. | Percolation pond | | 0.03 | 0.001 |
| 7. | Pond | | 0.67 | 0.020 |
| 8. | Sunken pond | | 0.17 | 0.005 |
| 9. | Tank | | 45.99 | 1.385 |
| 10. | Farm pond | | 2.11 | 0.064 |
| 11. | Others | | 16.95 | 0.511 |
| | Total | | 3319.72 | 100.000 |

**Table 4 : Land use/land cover classification of Ballahalli mini-watershed**

| Sr. No. | Land use/ land cover categories | Area (ha) | Percentage of total geographical area |
|---|---|---|---|
| 1. | Agriculture land (AL) | 1079.215 | 32.51 |
| 2. | Coconut plantation (CP) | 51.670 | 1.56 |
| 3. | Double cropped (DC) | 156.010 | 4.70 |
| 4. | Eucalyptus | 790.170 | 23.8 |
| 5. | Mango coconut (MC) | 35.380 | 1.07 |
| 6. | Mango plantations (MP) | 709.800 | 21.38 |
| 7. | Mud quarry (MQ) | 6.7350 | 0.21 |
| 8. | Water bodies (WB) | 131.550 | 3.96 |
| 9. | Waste land (WL) | 215.490 | 6.49 |
| 10. | Other | 111.670 | 3.36 |
| 11. | Built-up land | 32.030 | 0.96 |
| Total | | 3319.720 | 100.00 |

**Table 5 : Suggested land resources action plan of Ballahalli mini-watershed**

| Sr. No. | Class | Area (ha) | Percentage of total geographic area |
|---|---|---|---|
| 1. | Agro- horticulture | 1138.40 | 34.29 |
| 2. | Brick kiln | 8.20 | 0.25 |
| 3. | Built-up land | 32.03 | 0.96 |
| 4. | Double crop | 169.42 | 5.10 |
| 5. | Dryland agriculture | 170.46 | 5.13 |
| 6. | Dryland horticulture | 33.10 | 1.00 |
| 7. | Fuel and fodder | 88.00 | 2.65 |
| 8. | High density plantation | 186.88 | 5.63 |
| 9. | Afforestation | 572.53 | 17.25 |
| 10. | Intensive agriculture | 150.13 | 4.52 |
| 11. | Plantation | 105.20 | 3.17 |
| 12. | Quarry | 28.74 | 0.87 |
| 13. | Soil reclamation | 0.42 | 0.01 |
| 14. | Water bodies | 131.55 | 3.96 |
| 15. | Other | 504.66 | 15.21 |
| | TOTAL | 3319.72 | 100 |

problems of drainage and slight salinity in patches occupied a significant part (Sidhu *et al.*, 2000).

The different hydrogeomorphic units were delineated and their extent of groundwater prospects are also presented (Table 3). Barring the pediments, most part of the mini-watershed had moderate to good groundwater potential. Shallow Pediplain comprises of 51.68 per cent of the total geographical area of the mini-watershed and is scattered throughout. Medium Pediplain and deep pediplain comprise 18.22 and 2.49 per cent of the area, respectively having moderate to good groundwater potential (Murthy *et al.*, 1999).

Land use/land cover map showing the distribution of different land use/land cover categories are described (Table 4). Most part of about 61.21 per cent of the study area was under the crops. Out of these only 4.70 per cent was under double cropped area and rest under *Kharif* land, mango, coconut and mango-coconut plantations.

The water resource management plan (Fig. 1) was generated to make judicious and effective use of water resources of the mini-watershed and to enhance the productivity and mitigate the drought, keeping in mind the ecology and overall conditions of the watershed. The plan indicates the sites for surface water development and for groundwater exploitation. For surface water development different soil and water conservation structures were proposed. The water bodies to be renovated are also indicated in the map. Number of proposed structures for water resource action plan in the Ballahalli mini-watershed were Boulder checks 261, Check dam 96, Diversion canal 1, Desiltation of tank 18, Existing check dam 11, Nala bund 26, Percolation tank 12, and Vegetative checks 270. An action plan for water resource development was suggested for the mini-watershed integrating the information on slope, land cover, geomorphology, drainage network etc.

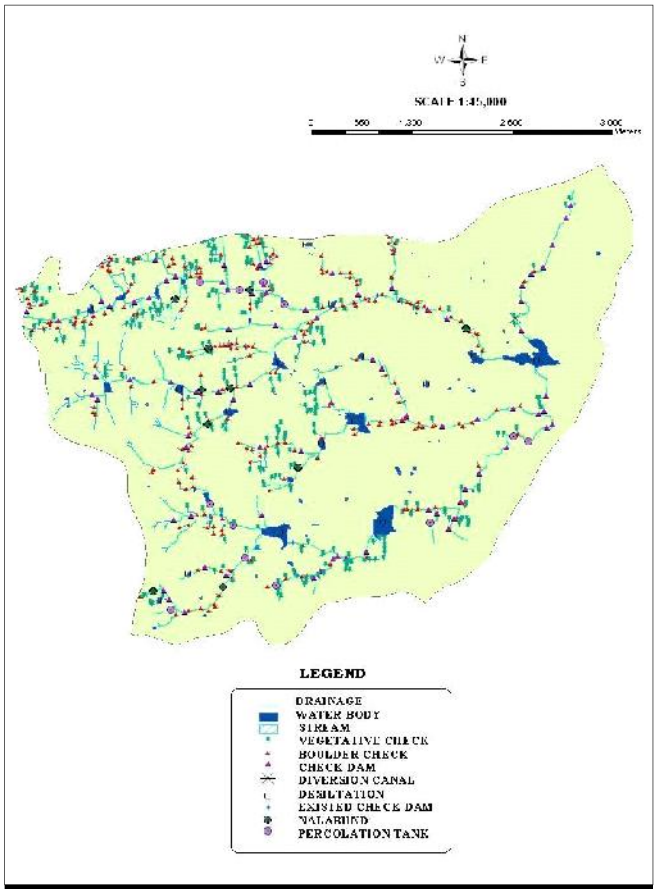


**Fig. 1 : Water resouorce plan map of Ballahalli Mini-watershed**

After examining the soil resource potential, land gradient and the groundwater prospects depending on the suitability and exploitation of the present resources in comparison with the present land use, alternate cropping system like double crop in 169.42 ha, agro-horticulture in 1,138.40 ha, dryland agriculture in 170.46 ha, dryland horticulture in 33.10 ha, afforestration in 572.53 ha etc (Table 5) were suggested by integrating thematic maps like soil, slope, hydrogeomorphology and present land use/land cover for optimal utilization of the scarce potential resources in the area for productive agriculture.

The agricultural/land resources utilization plan reflects the approach of use of the physical environmental condition in a judicious manner for sustainable development. Alternate land use practices taking into consideration all the thematic information on soil, groundwater prospects and drainage compared with the present land use in practice and considering the local specific problems and needs of people were suggested for the mini-watershed area (Sena and Kurothe, 2004).

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