"Generation of Potential Treatment Maps for the Development of Water Resources and Water Conservation Using Remote Sensing & GIS: A Strategy for Jalayukt Shivar Abhiyan, Maharashtra"

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Abstract:

Potential Treatment Map is the Soul of a water conservation project. The maps are being used in '*Jalayukt Shiwar Abhiyan- the flagship programme of water-scared areas in Maharashtra'*as base reference to identify the best suitable sites for water conservation activities.

Main objective of this research is to identify geographically correct sites for the construction of soil & water conservation features. The paper emphasizes the capabilitiesof Remote Sensing and Geographic Information Systems (RS&GIS) technology for the 'Soil &Water Conservation' programme. The study was conducted for entire Maharashtra state considering the following parameters viz. Drainage lines, Elevation/contours, Geomorphology, Slope, Soil erosion, Soil texture, Soil Depth and Lineaments. The layers were amalgamated in RS & GIS platform for the generation of village wise 'Potential Treatment Maps'.

The output map shows the potential sites along 'Drainage Line' and 'Area Treatment'. The drainage line treatments included 'gully plugs/loose boulder structures, earthen/ cement nalla bunds, 'nalla deepening' and recognizes the existing waterbodies that needs de-siltation. The area treatment activities comprisefarm ponds, contour trenching, field /graded bunding, terracing, afforestation,etc.it also helps in finding sites for development of new water resources.

The results helped in developingstrategiesfor the policy makers with minimal human efforts, increase areas under irrigation and crop productivity.

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Introduction

A watershed or basin is an area of land commonly known as hydrological unit that drains rain water and snow into one major waterbody such as a lake, reservoir or river. A typical basin is leaf shaped i.e. broader at ridge and narrowing towards the drain point**.** Based on the size, the hydrological unit is termed as water resource region, basin, catchment, sub-catchment, watershed, sub-watershed and micro-watershed respectively. The smallest hydrologic unit in the hierarchal system is termed as '***Micro watershed'*** having size of 500-1000 ha. Runoff, erosion, human interference and various forms of pollution are the parameters that determine the health of the watershed. A typical watershed consists of three major zones viz. '**runoff zone'** (steep slope with more degree of erosion, high speed of water flow, early stage of a river) '**recharge zone'** (moderate slope, gentle speed of flow and middle stage of river course) and '**storage zone'** (none to gentle slope, silt deposition with thick soil layer and more water percolation).

The present study emphasises on the impact of watershed conservation activities over natural vegetation and agriculture of the study area. The paper emphasizes the capabilities of Remote Sensing and Geographic Information Systems (RS&GIS) technology for the 'Soil & Water Conservation' programme.

2. AIMS & OBJECTIVE

2.1 Aim

The aim of the study is to identify most suitable sites for the construction of structures for Natural Resource Management. This is to restore the ecological balance by conserving and developing degraded natural resources like soil, vegetation and water.

2.2 Objectives

- Identification of appropriate locations for the construction of soil & water conservation features.
- Conservation of degraded natural resources like soil, vegetation and water to support multi-cropping i.e. Sustainable livelihoods to the people residing in the watershed area.

3. STUDY AREA

Maharashtra state in the western region of India and is India's and third-largest state by area. Spread over 307,713 km^2 that stretches between 73°52'2"E -21°53'24"N to 80°23'45"E - 21°30'22" N and 73°37'21"E - 15°41'47"N to 80°56'35"E -19°30'9"N. The state is bordered by the Arabian Sea to the west with a coastline of

720 kilometres. One of the more prominent physical features of Maharashtra is the Deccan plateau, which is separated from the Konkan coastline by The Western Ghats i.e. the Sahyadri Mountain range and the Satpura Hills along the north border.

Maharashtra is divided into five geographic and administrative regions namely Konkan, Paschim Maharashtra, North Maharashtra, Marathawada and Vidarbha.

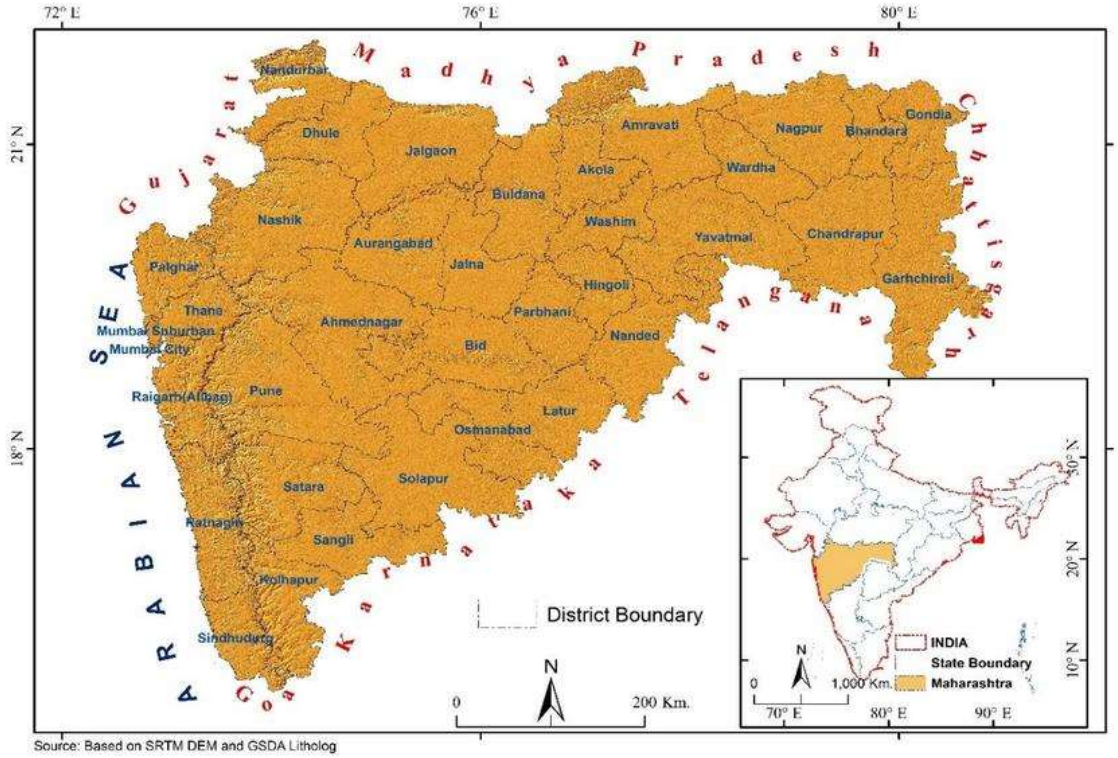

Fig: 1 – Location Map

3.1 Climate

Maharashtra has typical monsoon climate, with hot, rainy and cold weather seasons. Summers are extreme with temperature varies between 22 °C and 39 °C. Monsoon starts with June and retreats with September. Winter season is a cool and generally dry spell, prevails from November to February.

3.2 Major Rivers

The Godavari, Krishna, Bhima, Tapi-Purna and Wardha-Wainganga are the major rivers in the state.

Fig. 2 Major River Catchments- Maharashtra

3.2 Previous conditions

Maharashtra state was facing severe water scarcity problem from past few years. Low rainfall for consecutive years was the major reason behind less crop productivity and severe water scarcity. The following table shows the trend of mean annual rainfall in this region. Farmers were experiencing null to low crop productivity due to acute water shortage and used to harvest rainfed single crops like maize, jowar (sorghum), bajra (pearl millet), etc.(Mahaagri, 2016)

3.3 Beginning of revolution

The micro irrigation project, called 'Jalyukt Shivar', the flagship water conservation scheme of Maharashtra government's began in the year 2015-16 to rejuvenate water bodies and created an additional storage potential, in a state where some parts perennially face a drought-like situation. This involves deepening and widening of streams, construction of cement and earthen stop dams, and digging of farm ponds, to make the state free of drought by 2019.

4. METHODOLOGY

The study was conducted for entire Maharashtra state considering the physical and geographical parameters.

4.1. Use of GIS technology

4.1a. Integration of layers on one platform

The parameters that were used to carry out the study are drainage lines, elevation/contours;geomorphology, Soil data (slope, erosion, texture, depth, etc.); landuse and land cover (LULC) data, lineaments and village wise cadastral cover.

Contour / Elevation: Contours with 5 meter interval (using Digital Elevation Model)

Slope :

1 - 3 %	3 - 5 %	5 - 10 %	10 - 15 %	15 - 35 %	35 - 50 %

Groundwater

Good	Moderate	Poor

Soil Drainage

Excessively drained	Well drained	Moderately well drained	Moderately drained	Waterbody Mask	Habitation Mask

Soil Depth:

Very deep	> 100 cm
Deep	50 to 100 cm
Moderately deep	25 to 50 cm
Shallow	10 to 25 cm
Very shallow	< 10 cm

Soil Erosion

None to slight	Slight to moderate	Moderate	Moderate to severe	Severe	Severe to very severe

Soil Texture

Clayey	Clay loam	Gravelly clay loam	Gravelly sandy loam	Gravelly sandy clay loam

Soil landcapability

IIs	IIes	IIIs	IVes	IVs	VIes	VIIes

Landuse Land Cover

Rural	Cropped in two seasons	Evergreen/ Semi Evergreen - Open	Lakes/ Ponds - Permanent
Kharif	Cropped in more than two seasons	Scrub Land - Dense/ Closed	Lakes/ Ponds - Seasonal
Rabi	Fallow Land	Scrub Land - Open	Reservoir/ Tanks - Permanent
Zaid	Evergreen/ Semi Evergreen - Dense/ Closed	Tree Clad Area - Dense/ Closed	Reservoir/ Tanks - Seasonal

4.1b. Assigning the weights

Weighted overlay analysis:

The Weighted Overlay tool applies one of the most used approaches for overlay analysis to solve multi-criteria problems such as site selection and suitability models. It is a technique for applying a common scale of values to diverse and dissimilar inputs to create an integrated analysis. Suitability models identify the best or most preferred locations for a specific phenomenon.

In present study, the weighted overlay analysis carried out drainage line, slope, soil erosion and LULC layers on the scale of 0 to 10.As the study is based on water conservation activity, the prime weight was assigned to the drainage line layer.

5. DATA ANALYSIS/DISCUSSION:

The layers were amalgamated in RS & GIS platform for the generation of village wise 'Potential Treatment Maps'.

5.1 The Potential Treatment Map (PTM):

The main objective of the Potential Treatment Map is to identify the probable zones for the sustainable increase in soil moisture and water conservation using scientific approach with local physical geography that may lasts in long dry spells at micro level.

It is the output of weighted overlay analysis that determines suitable zone locations as per the elevation and stream order for implementation of water conservation activities. Considering the 'Ridge to Valley' concept of watershed and the major factors like slope, aspect, soils and the underneath topographical features viz. Lineaments, the suitable locations for water conservation, following treatments were determined.

5.2 Drainage line Treatment:

In a watershed, the activities like construction of 'loose boulder structure', 'gully plugs' are planned in the 'Runoff zone' with early stream orders. The 'Earthen and Gabian bunds' are planned in the recharge zone with secondary streams and all the major water conservation structures like check dams, 'river rejuvenation' are in 'Storage zone with three and above stream order.

5.3 Area Treatment

The activities like construction of 'Contour trenching', Tree Plantation are planned in the 'Runoff zone'. The 'pasture development, afforestation, Water Absorption Trenches (WAT) activities are planned in the recharge zone. The 'Storage zone' comprises activities like 'bund repairs', farm ponds, artificial well recharge, etc.

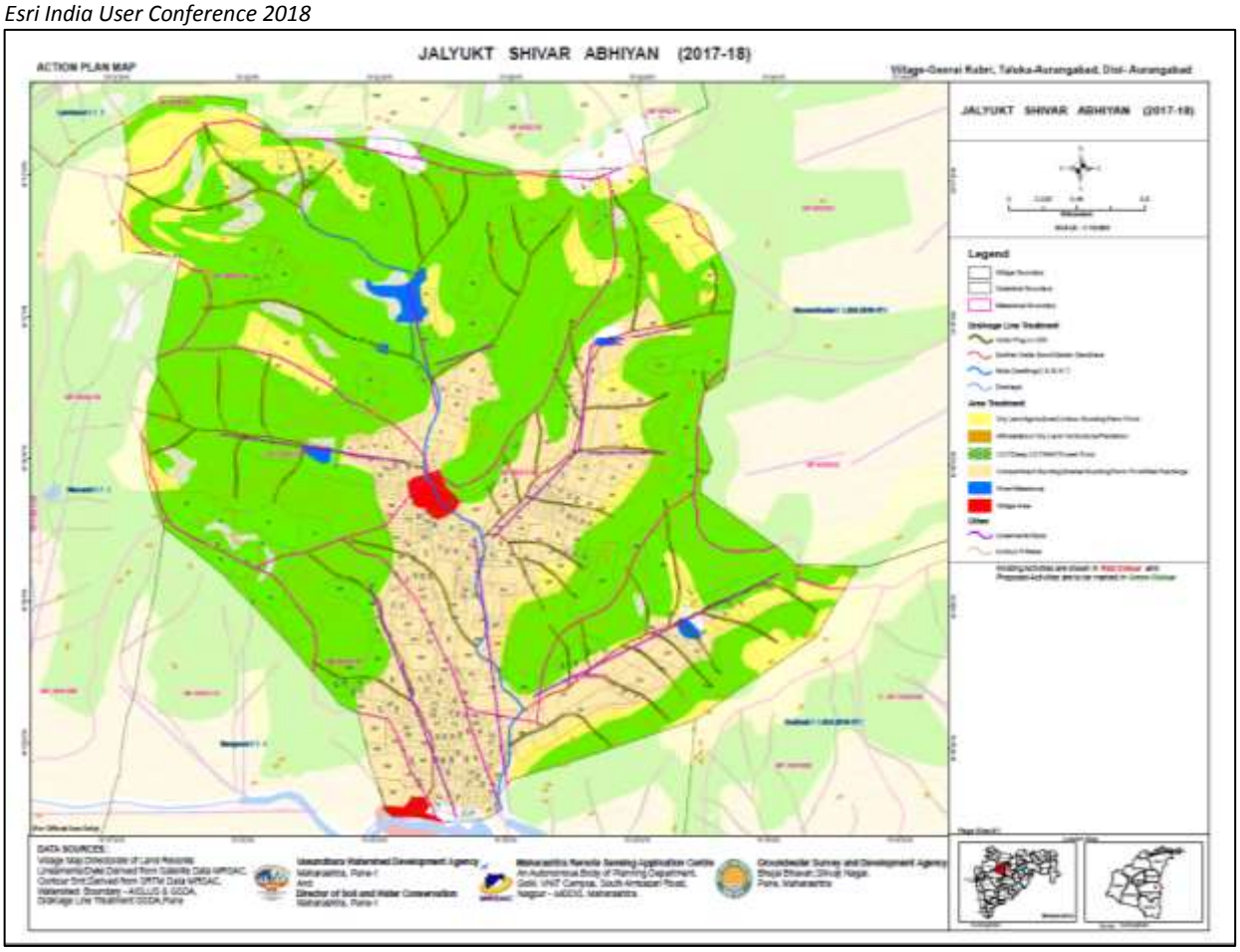

Fig. 3 Potential Treatment Map

The detailed PTMs were generated for each selected village in Maharashtra. The local water conservation team surveyed the ground using these PTMs and marked the existing water conservation structures on the map. Considering the village wise water budget, the required structures are proposed with the help of PTM accordingly.

6. CONCLUSION

With the help of this study, we have been able to reduce the number of tankers (for water supply in districts facing scarcity), double crop cultivation and potential irrigation of farms even during rain gaps.

The successful implementation of Potential Treatment Maps will lead to practicing transparency in scheme execution, generating awareness about water utilization amongst farmers and absolute increase in ground water level taht sustain for a long duration.

References

1. ESRI. (2010). Understanding RC-GIS/INFO Model. *ESRI* . USA: ESRI Pvt. Ltd.
2. Harrison, B. A., & Jupp, D. L. (1993). *Remote Sensing: Image Rectification and Registration.* Australia: CSIRO Publishing.
3. Hill, L. L. (2006). *The geographic associations of information.* Cambridge: MIT Press.
4. Hoogendoorn, S. P. (2005). Parametric Estimation and Analysis of Car-Following Models. *Proceedings of the 16th International Symposium on Transportation and traffic Theory* (pp. 245-265). Amsterdam, The Netherlands: Elsevier B.V.
5. Isobel W. Heathcote (2009). *Integrated Watershed Management : Principlies and Practice, 2nd Edition (pp. 194-196).* John Wilkey & Sons, USA
6. Korte, G. (2003). *The GIS Book: 5th Edition.* U.S.: OnWords Press.
7. **http://pro.arcgis.com/en/pro-app/tool-reference/spatial-analyst/weighted-overlay.html**
8. **Esri Documents/ArcGIS/help/**
9. **http://mrsac.maharashtra.gov.in/jalyukt/**