Univerzitet u Beogradu
Poljoprivredni fakultet
Institut za poljoprivrednu tehniku
Naučni časopis
***POLJOPRIVREDNA TEHNIKA***
Godina XL
Broj 4, 2015.
Strane: 1 - 8

University of Belgrade
Faculty of Agriculture
Institute of Agricultural Engineering
Scientific Journal
***AGRICULTURAL ENGINEERING***
Year XL
No. 4, 2015.
pp: 1 - 8

*UDK: 626.628*

*Originalni naučni rad*
*Original scientific paper*

# WATER RESOURCES CONSERVATION PLAN FOR RANGAPUR WATERSHED IN MIDDLE KRISHNA BASIN IN RAICHUR DISTRICT OF KARNATAKA USING REMOTE SENSING AND GIS

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***Abstract:*** The study area Rangapur watershed covers an area of about 2079 ha, is one of the drought prone areas in the middle Krishna Basin in Raichur district of Karnataka. An attempt is made to suggest location priority plan for the sustainable development of the area using GIS and remote sensing techniques. The IRS P6 LISS III imagery was used for the preparation of land use/land cover and hydrogeomorphology maps. Geologically most of the watershed is covered by the rocks of Archean age *i.e.* granite gneiss. The major geomorphic units mapped in the area are shallow weathered pediplain, moderately weathered pediplain and structural valley. Among all, shallow weathered pediplain cover most part of the area. Arc Hydrology model of ArcGIS 10 version was used to propose various soil moisture conservation and water harvesting structures. From the results 22 nala bunds, 34 check dams and 141 boulder checks were suggested at different locations across streams. Thus it is recommended that water harvesting should be given importance to increase the groundwater recharge besides providing supplementary irrigation during rabi season.

***Key words****: Check dam, Nala bund, Boulder checks, hydro geomorphology, hand use/land cover, watershed, remote sensing, GIS, water harvesting, groundwater recharge*

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## INTRODUCTION

Land and water resources are limited and their wide utilization is imperative, especially for countries like India, where the population pressure is increasingly continuous. These resource development programs are applied generally on watershed basis and thus prioritization is essential for proper planning and management of natural resources for sustainable development [11]. Land use reefer's to man's activity and various uses which are carried on the land, whereas land cover refers to natural vegetation, water bodies, rock/soil, artificial cover and other resulting due to land formations [13]. Watershed deterioration is a common phenomenon in most parts of the world. In addition, availability of land, erratic and uneven distribution of rains, undulating topography, improper resource management, traditional cropping programs and recurrence of droughts having cumulative effect leading to lower productivity and higher risk particularly in resource planning under dry-land farming.

Watershed approach has been the single most important landmark in the direction of bringing in visible benefits in rural areas and attracting people's participation in watershed programs [8]. The basic objective of the study is to increase production and availability of food, fodder and fuel; restore ecological balance. An attempt is made using remote sensing and GIS techniques to propose various water harvesting and soil conservation measures in order to suggest integrated land and water resource development plan for Rangapur watershed in middle Krishna basin in Raichur district of Karnataka.

## MATERIAL AND METHODS

The study was taken up in Rangapur watershed having an area of 2079 ha which is located in between the villages of Bevinbenchi and Yadlapur in Raichur district of Karnataka (Fig. 1).

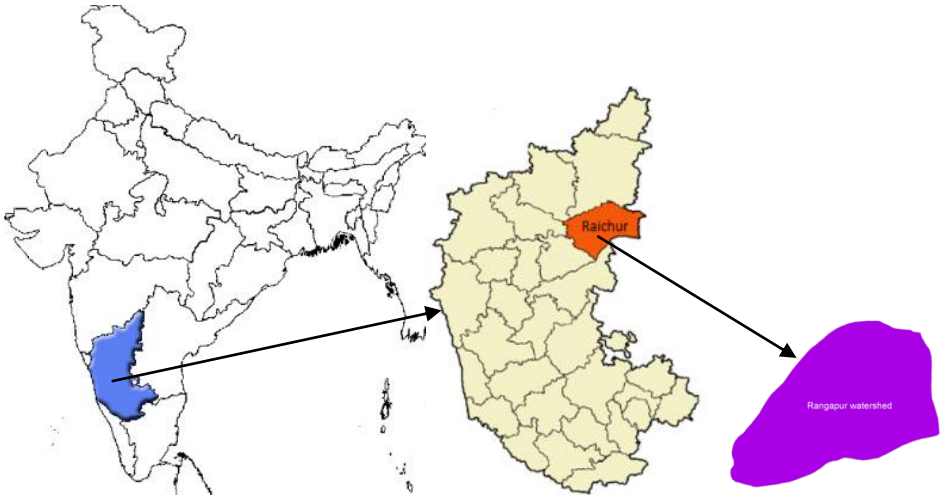


*Figure 1. Location map of study area*

The study area is situated in the North-Eastern dry zone of Karnataka at 16˚20'20" to 16˚23'5" N latitude and 77˚17'21" to 77˚20'58" E longitude and elevation is from 338 to 382 m above mean sea level (MSL). The Survey of India toposheet 56 H/7 of 1:50,000 scale was used for development of maps and for the analysis of watershed characteristics.

The different maps like watershed base map, drainage map, contour map, DEM (Digital Elevation Model), slope map, aspect map and hydro geomorphology map were prepared from the toposheet and remote sensing image. The land use/land cover classification was done with IRS-P6, LISS III image pertaining to crop season (16$^{th}$ Nov 2011) [14] by using ERDAS 2010 imagine. These thematic maps were calculated using raster calculator in spatial analyst of ArcGIS 10, based on the weightages decided. The formula for this raster calculation is as follows: ((Hydrogeomorphology)·0.2+(Land Use/Land cover)·0.2 + (Soils)·0.1 + (Slope)·0.2 + (Drainage)·0.3).

## RESULTS AND DISCUSSION

The study emphasizes on prioritization of watersheds for their development and management on a sustainable basis, based on available natural resources.

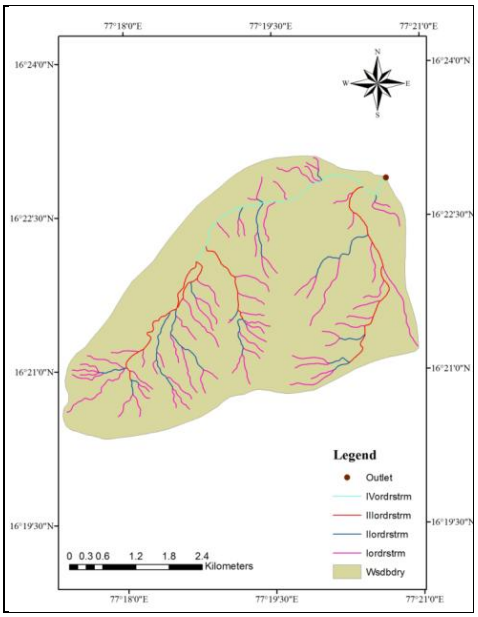


*Figure 2. Drainage map of Rangapur watershed*

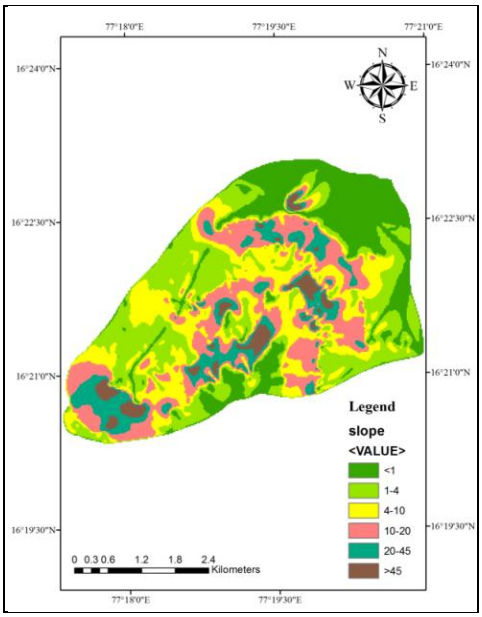


*Figure 3. Slope map of Rangapur watershed*

The various themes, which include drainage, slope, hydro geomorphology, soil and land use/ land cover were considered for prioritization. These maps were integrated and finally water resources conservation maps were prepared.

*Drainage.* The drainage map was prepared from the SoI toposheet forms the base map for the preparation of thematic maps related to surface and groundwater. Drainage

map includes all the streams, tributaries and small stream channels and depicts flow pattern of drainage lines in the study area (Fig. 2). The lengths of all stream orders were obtained from drainage map using ArcGIS 10 software. The drainage pattern observed in the study area is *dendritic*. The highest stream order is of fourth order.

*Slope*. Slope is the most important terrain characteristics plays a vital role in hydro geomorphological and runoff processes, soil erosion, infiltration and land use/land cover [1,2]. The slope map was derived using the DEM which was prepared using contour lines and spot elevations from the toposheet [3,4] [6]. About 32.54% of the total study area fell into slope class 1 (< 1%) while 35.98 % of the study area having a slope class of 2 fell in the range of (1 - 4%). In similar way slope classes of 3 (4-10%), 4 (10-20%), 5 (20-45%) and 6 (>45%) were covered an area about 14.22%, 8.76%, 5.29% and 3.21 % (Fig. 3).

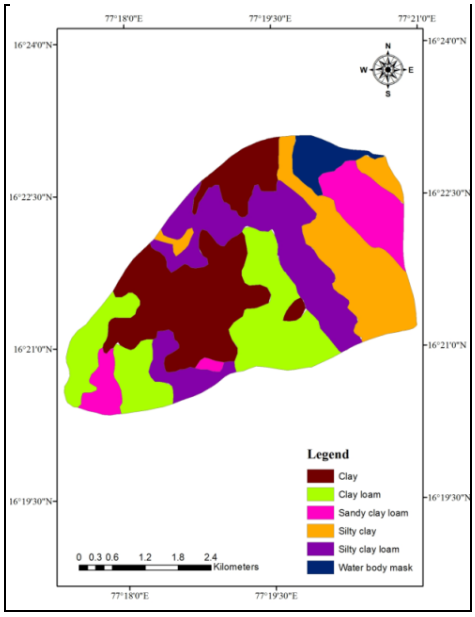


*Figure 4. Soil map of Rangapur watershed*

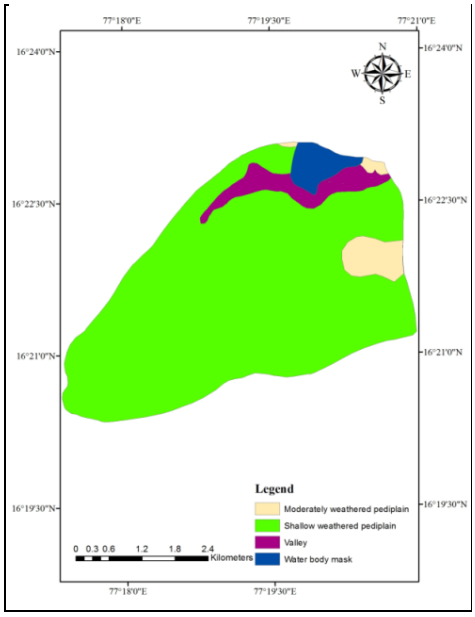


*Figure 5. Hydro geomorphology map of Rangapur watershed*

*Soil.* The soils of watershed occur on basaltic and lateritic parent materials and are characterized by different physiographic units [5,7]. Soil mapping has been carried out with the help of satellite imagery and field study to determine the soil texture. In the study area mainly five textural classes were found (Fig. 4). The most of the study area is composed of clayey soils which can erode and transferred by heavy rain and moderately percolated the water in to the ground. The other characteristic features of the soil are silty clay, silty clay loam, clay loam and sandy clay loam were observed in the watershed.

*Hydro geomorphology.* An integrated approach was adopted using remote sensing and GIS techniques in the study area for evaluation of groundwater potential zones based

on the characteristics of geomorphic units together with slope, geology and lineaments. The area has been classified into shallow weathered pediplain, moderately weathered pediplain and valley fill, which were observed in the granite gneiss. They are classified for groundwater prospective zones as valley fills and moderately weathered pediplains forms very good to good; good to moderate and shallow weathered pediplains as moderate to poor (Fig. 5). Similar observations were made in different sites [9] [10] [12].

*Land use/ land cover*. The land use/land cover map was prepared from the satellite image. Supervised and unsupervised classification techniques were used in ERDAS imagine 2010 (Fig. 6). The satellite image was visually interpreted for the information of land use activities and land cover by making use of the interpretation keys. According to supervised classification, the watershed was classified in to five major types and accuracy of unsupervised and supervised classifications was found as 84.24% and 87.63% respectively. The study indicated that the supervised classification method was more accurate as the accuracy was higher compared to the unsupervised classification.

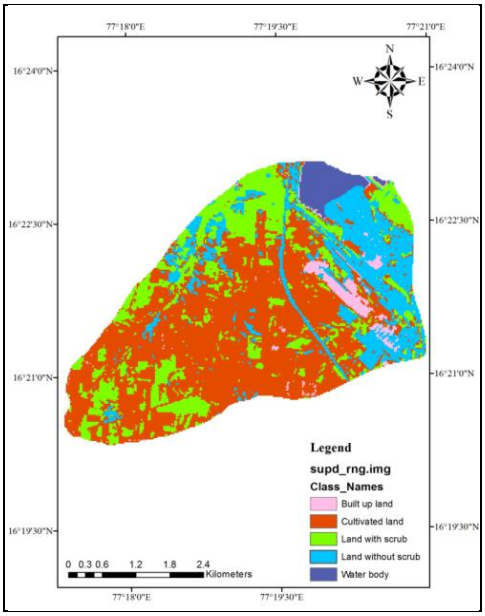


*Figure 6. Land use/land cover map of Rangapur watershed*

**Development of water resources conservation plan based on priority**

Watershed prioritization is one of the most important aspects of planning for implementation of its development and management of water resources. The present study demonstrates the usefulness of remote sensing and GIS for prioritization of the Rangapur watershed. The raster thematic maps like drainage, slope, hydro geo-morphology, soil and land use/land cover were considered for the prioritization. In the drainage network, high priority was found to 1$^{st}$ and 2$^{nd}$ order streams because of steeper slopes, the runoff generation will be more and low priority was found to 3$^{rd}$ and 4$^{th}$ order

streams because of gentle slope and nearly flat slope. In case of slope of the watershed, high priority was found to 10 to 20%, 20 to 45% and more than 45% slope. Whereas, low priority was considered for the slope range of <1% and 1 to 4%. For hydro geomorphology, low priority was found to valley and high priority was found to shallow weathered pediplain because of poor ground water status. In case of soil, high priority was found to clay soils, in this type of soils runoff expected is more because of low infiltration and low priority was found to sandy clay loam and clay loam because of higher proportion of sand and expected infiltration will be more. Lastly for land use/land cover, high priority was found to cultivated land and land without scrub because of no vegetation and most of the soils are rich in clay content so runoff in these areas are more and low priority was found to water body and land with scrub, it obstruct the runoff water to flow as runoff and make it to infiltrate in to the soil. All these features were calculated in raster calculation and finally water resources conservation map (Fig. 7) was prepared using the criteria given by NRSA under Integrated Mission for Sustainable Development.

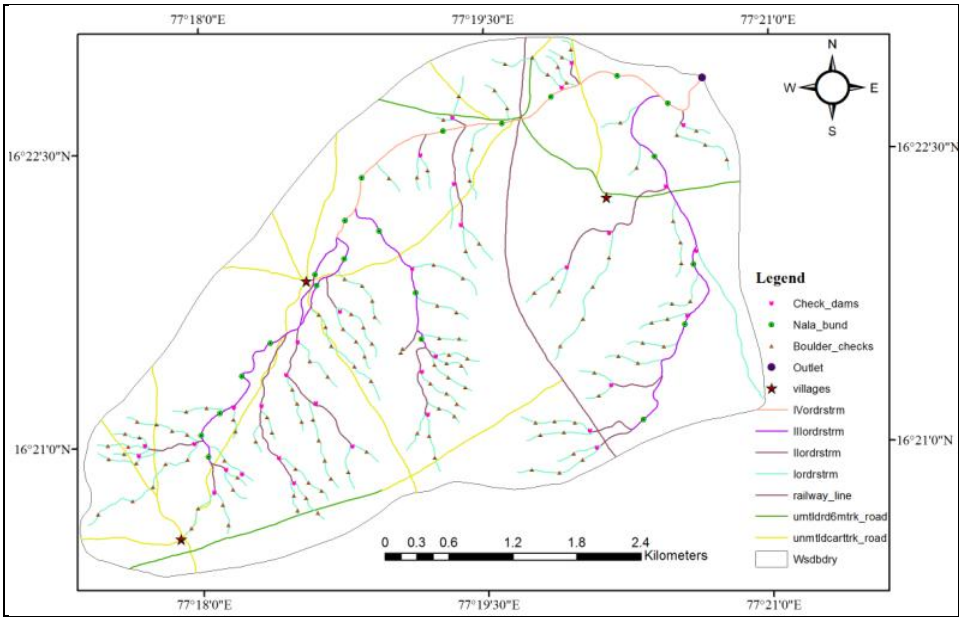


*Figure 7. Water resources conservation plan of Rangapur watershed*

The water resources conservation plan consists of 34 check dams (up to 3% bed slope where water table fluctuation is high, stream is influent & intermittently effluent, minimum of 25 ha of catchment is desirable, the crest wall of the dam should be strong and well defined), 22 nala bunds (< 3.5% bed slope, recommended up to 4$^{th}$ order and higher streams, deeper nala facilitates more water-spread area, reduce the velocity of flow) and 141 boulder checks (provided at first order streams, areas where boulders and stones are available, the bund is sprinkled with grass seeds, planted with euphorbia, khus, agave, lantana plantings in the fence and non browsable plants are preferred).

## CONCLUSION

The study concludes that remote sensing and GIS technologies can be used for scientific planning and management of natural resources. The generation of alternative land use/land cover practices for natural resources management involves careful study of thematic maps both individually and integrated basis as well. Keeping in view the conservation plans are generated on systematic assessment of physical capability, economic viability and technical feasibility. The thematic maps *viz*. drainage, slope, hydro geomorphology, soil and land use/land cover were prepared and integrated to generate location priority raster to locate water conservation structures like 42 check dams, 22 nala bunds and 141 boulder check dams were proposed at high priority location to reduce the velocity of flowing water by obstruction and thereby increase the percolation of water for ground water recharge.

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## PLAN KONZERVACIJE VODENIH RESURSA SLIVA RANGAPUR U BASENU SREDNJEG KRISHNA UPOTREBOM DALJINSKE DETEKCIJE I GIS

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***Sažetak:*** Istraživanje je sprovedeno u oblasti sliva Rangapur površine 2079 ha, sušne oblasti u sredini basena Krishna. Predložen je plan prioriteta za održivi razvoj ove oblasti pmoću GIS i daljinske detekcije. The IRS P6 LISS III snimci su korišćeni za pripremu mapa pokrivenosti i namene zemljišta i hidrogeomorfologije. Geološki, veći deo sliva je stenovit. Glavne geomorfne jedinice su mapirane. Arc Hydrology model programa ArcGIS 10 je upotrebljen da se predlože različite structure za konzervaciju zemljišne vlage i skupljanje vode. Iz ispitivanih uzoraka predložene su različite lokacije duž tokova. Tako je preporučeno da je sakupljanje vode posebno važno za povećanje punjenja podzemnih izvora vode, uz obezbeđenje dopunskog navodnjavanja.

***Ključne reči****: Check dam, Nala bund, Boulder checks, hidro geomorfologija, pokrivenost, sliv, daljinska detekcija, GIS, skupljanje vode, punjenje podzemnih izvora*

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|---|---|
| Prijavljen: *Submitted*: | 02.03.2015. |
| Ispravljen: *Revised*: | 30.07.2015. |
| Prihvaćen: *Accepted*: | 02.10.2015. |