Trans.Inst.Indian Geographers
ISSN 0970-9851

Watershed Priortization and Impact of Development Programs in Garladinne Mandal, Anatapur Dist. Andhra Pradesh, India.

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Abstract

The Garladinne mandal covering an area about 304.97 km2 of Anantapur district, Andhra Pradesh has been studied with a view to delineate the watersheds using Survey of India Topographic sheets and IRS IB Geocoded data on scale 1:50,000 basing on drainage and relief. About 16 macro watersheds have been identified. The macro watersheds are prioritized basing on intensity of soil removal, sediment yield index and erosion index. The very high watersheds are Kanumpalli, Kotanka-3, Mukundapuram, Eguvapalli and Penakacherla watersheds. The high priority watersheds are Penakacherla-II and P.Kothapalli, the moderate priority of watersheds Budedu, Yerraguntla and Marthadu and the low priority of watersheds are Ramdaspeta, Sirivaram, Obulapuram Kottala, Koppalakonda, and Illuru. The watershed development programs taken up from 2005-2013 are studied to evaluate the impact of implementation of watershed programs.

Keywords: *Watershed, geohydrology, Garladinne mandal, sediment yield, erosion index*

Introduction

The watershed is a geohydrological unit draining at a common point by a system of streams. It is a land area that captures rainfall and conveys the overland flow channel. It has a third dimensional height. It is topographically delineated area draining into a single channel. The size of watershed may vary from a few square meters to thousands of square kilo meters. The size becomes important depending upon the objective of the watershed. For example for major irrigation projects watershed of thousands of square kilometers of size may be considered on the other hand for micro watersheds 500 hectares of size may be considered. Watershed management may be defined as the process of formulating and carrying out a courage of action involving manipulation of natural, agricultural and human resources of a watershed to provide resources that are desired by and suitable to the watershed community without adversely effecting soil and water resources. Watershed management must consider the social, economic and institutional factors operating within and outside the watershed. Watershed management practices are those changes in land use, vegetative cover and other non structural and structural actions that are taken on a watershed to achieve watershed development objectives. It is an integrated and interdisciplinary approach. It requires land use adjustment measurer which contributes to the reducing soil erosion rates, increased agriculture production, generation

of rural employment and balanced growth of economy. Watershed management usually involves the use by the people of the watershed area of the watershed natural resources especially the land, water and vegetation with the active participation of their institutions and organizations and in harmony with ecosystem. It encompasses and incorporates watershed activities into regional or area development plans taking into account the protection and conservation measures, resources and benefits likely to occur to the people living at the watershed outlet. Bali and Karale (1977) worked out sediment yield index for prioritization of watersheds. Karale et al. (1977) has prioritized the watersheds of Matatilla catchment for soil conservation works. Rambabu et al (1980) studied the hydrological behaviohur of small watersheds under different land uses. Dhruva Narayana et al. (1983) discussed about minimum soil erosion and maximum benefits of watershed management. Bali (1983) has narrated the problems watershed management in various river valley projects.Dohare et al.(1985) evaluated the sediment yield index using land sat data and Geomorphic Information System of seven watersheds and 33 sub watersheds of Punpun catchment of Bihar Using erosion potential of individual watersheds. The FAO (1990) has published a field manual of watershed survey and planning, conservation guide of watershed management. Bagchi et al. (1993) described the watersheds in India.). Purendare and Srivastava (1995) and Purendare and Jaiswal (1995) have given the description of challenges of watershed development in India. Tideman (1996) described the guidelines of watershed management for Indian conditions. A study on integrated watershed development of Jhubua model watershed has been carried out by Rajora Rajesh (1997). An integrated study of watershed management with a detailed description of ecological restoration and consumption of watersheds, soil and water conservation practices, surface and ground water harvesting and management, agro forestry, silvi pastoral practices, conservation of agronomic practices, dry land horticulture, grassland management and joint forest management of watersheds has been described by Rajesh Rajora (1998).

Study Area

Garladinne mandal covers an area of about 304.97 sq km and lies in the Anantapur district of Andhra Pradesh in between 14^0 49" 14' to 14^0 57"20' North latitudes and 77^0 35" 48' to 77^0 43" 43' East longitudes **(Fig.1).** There are 18 revenue villages in Garladinne mandal. The total population of Garladinne mandal is about 53,882 (2011 census). Geologically, it is mainly comprised of Archean rocks consisting of granitic gneisses with dolerite and quartzite intrusions. The annual rainfall is about 568 mm. The average annual minimum temperature of 14^0 c is noticed in January and the annual maximum temperature of 42^o c is noticed in the month of April. Climatologically the mandal is located in dry sub-humid type of climate. The NH-44 is major a North-South National Highway in India and it is connecting Varanasi-Kanyakumari and the Broad gauge Railway line connecting Bangalore - Mumbai and Bangalore - Hyderabad pass through the centre of the Garladinne mandal of Anantapur district.

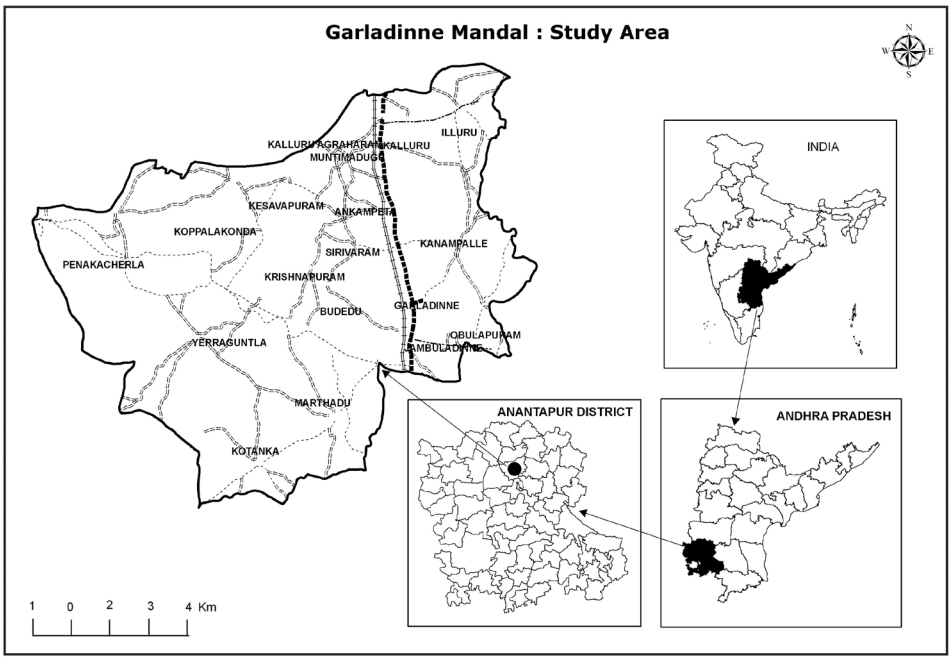

Fig. 1 :

Objectives

The main objectives of the study are

1. to determinate the watersheds of the Garladinne mandal,
2. to work out the intensity of soil removal, sediment yield index and erosion index,
3. to prioritize the watersheds and to study the watershed programs of Garladinne mandal and
4. to bring out the impact of watershed development programs in the Garladinne mandal.

Methodology

The watersheds of the Garladinne mandal has been delineated based on drainage and altitude using Survey of India topographic sheets and IRS IB Geocoded data on scale 1:50,000. The intensity of soil removal is worked out at watershed level using Flaxman (1971) method and the sediment yield index method given by Bali and Karale (1977) and Flaxman (1971). The erosion index is worked out at watershed level adopting Zachar (1982) method. The data pertaining to watershed development programs has been collected from District Water Management Agency from 2005 to 2013 under different schemes. The impact of watershed programs implemented is studied through field surveys in each watershed and overall impacts of watershed development programs are described.

Results And Discussions

Macro Watersheds Of Garladinne Mandal

Based on relief and drainage the Garladinne mandal has been divided into sixteen macro watersheds (Fig.2, Table.1). The lowest area of the watershed of 732 hectares is noticed in P. Kottapalli watershed and the maximum area of 3139 hectares is found in Marthadu watershed. The watersheds which exceed 3000 hectares of land in area are Budedu and Marthadu watersheds. The watersheds which range in area from 2000 to 3000 hectares are Kanumpalle, Kotanka-3, Mukundapuram, Ramdaspeta and Penakacherla. The watersheds which range from 1000 to 2000 hectares are Penakacherla-II, Yerraguntla, Yeguvapalli, Illuru and Kesavapuram. The watersheds which are less than 1000 hectares of land area are P. Kothapalli, Sirivaram, Obulapuram kottala and Koppalakonda.

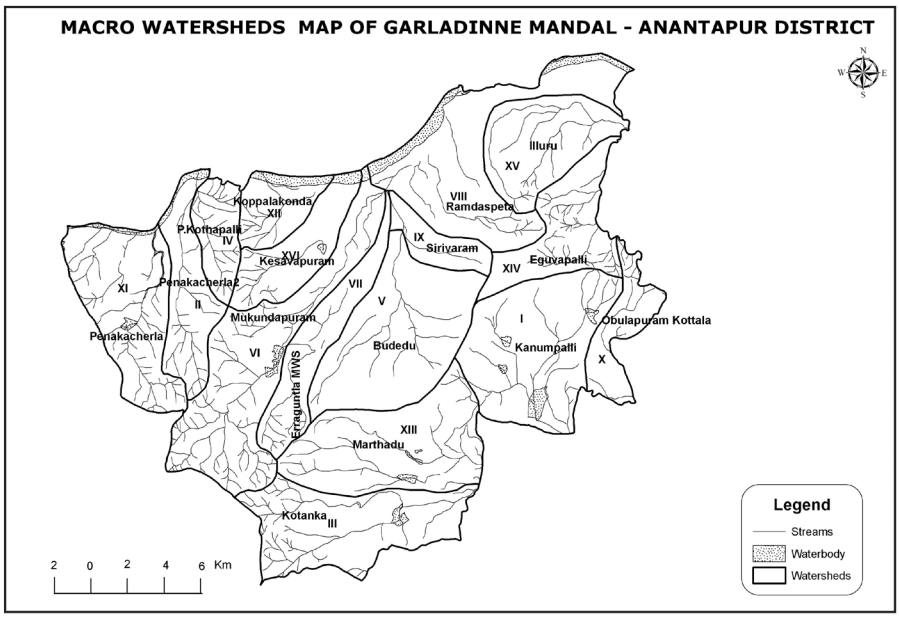

Fig. 2 :

Prioritization of Watersheds

The prioritization of watersheds has been carried out basing on the intensity of soil removal, the sediment yield index, and erosion index, acute storage of water and preponderance of waste lands

Table 1 : Prioritization of watersheds of the Garladinne mandal

S. No	Watershed name	Area in hectors	Sediment yield index	Erosion index	Intensity of soil removal m^3/ha	Prioritization of watersheds
1	Kanumpalli	2877	1380	0.87	54	Very high
2	Penakacherla -2	1308	1255	0.75	40	High
3	Kotanka -3	2615	1390	0.95	58	Very high
4	P.kothapalli	732	1245	0.72	38	High
5	Budedu	3034	1145	0.52	10	Moderate
6	Mukundapuram	2825	1370	0.85	52	Very high
7	Yerraguntla (MWS)	1203	1155	0.56	12	Moderate
8	Ramdaspeta	2406	1055	0.34	2.5	Low
9	Sirivaram	942	1045	0.30	1.5	Low
10	Obulapuram kottala	889	1050	0.32	2.0	Low
11	Penakacherla	2406	1398	0.99	60	Very high
12	koppalakonda	785	1060	0.36	3	Low
13	Marthadu	3139	1165	0.58	14	Moderate
14	Eguvapalli	1988	1397	0.97	59	Very high
15	Illuru	1988	950	0.18	0.45	Very Low
16	Kesavapuram	1360	1070	0.38	4	Low

Intensity Of Soil Removal

The intensity of soil removal has been worked out adopting Flaxman (1971) method. It ranges from 52 to 59 m^3/ha in the very high sediment yield and erosion index watersheds. The intensity of soil removal varies from 38 to 40 m^3/ha, in the high sediment yield and erosion index watersheds. The intensity of soil removal varies from 10 to 14 m^3/ha in the medium or moderate sediment yield index and erosion index watersheds. The intensity of soil removal varies from 1.5 to 4 m^3/ha in low sediment yield index and erosion index watersheds. In the very low sediment yield index watersheds the intensity of soil removal is 0.45 m^3/ha. The very high intensity of soil removal watersheds are Kanumpalli, Kotanka-3, Mukundapuram and Penakacherla watersheds. The high intensity of soil removal watersheds are Penakacherla-II and P.Kothapalli. The moderate priority watersheds are Budedu, Yerraguntla and Marthadu. The low intensity of soil removal watersheds are Ramdaspeta, Sirivaram, Obulapuram, Kottala, Koppalakonda and Eguvapalli. The very low priority watershed is Illuru.

Sediment Yield Index

The sediment yield index has been carried out using Bali and Karale (1977) and Flaxman (1971) methods taking mean annual temperature, average slope and ph value of the soil. Based on the values of sediment yield index the watersheds are classified into very high sediment yield index with more than 1300, high sediment yield index with 1200 to 1299, medium sediment yield index with 1102 to1199, low sediment yield index with 1000 to 1099 and very low sediment yield index with less than 1000.

Erosion Index

The erosion index is worked out using Zachar (1982) method. The erosion index value varies from less than 0.20 to more than 0.80. In the very high sediment yield index watersheds the erosion index is more than 0.80. They are categorized under very high erosion index. In the high sediment yield index watersheds the erosion index ranges from 0.60 to 0.80 which is categorized under high erosion index watersheds. In the moderate sediment yield index the erosion index value varies from 0.40 to 0.60. In the low sediment yield index watersheds the erosion index varies from 0.20 to 0.40. In the very low sediment yield erosion index watersheds the erosion index is less than 0.20.

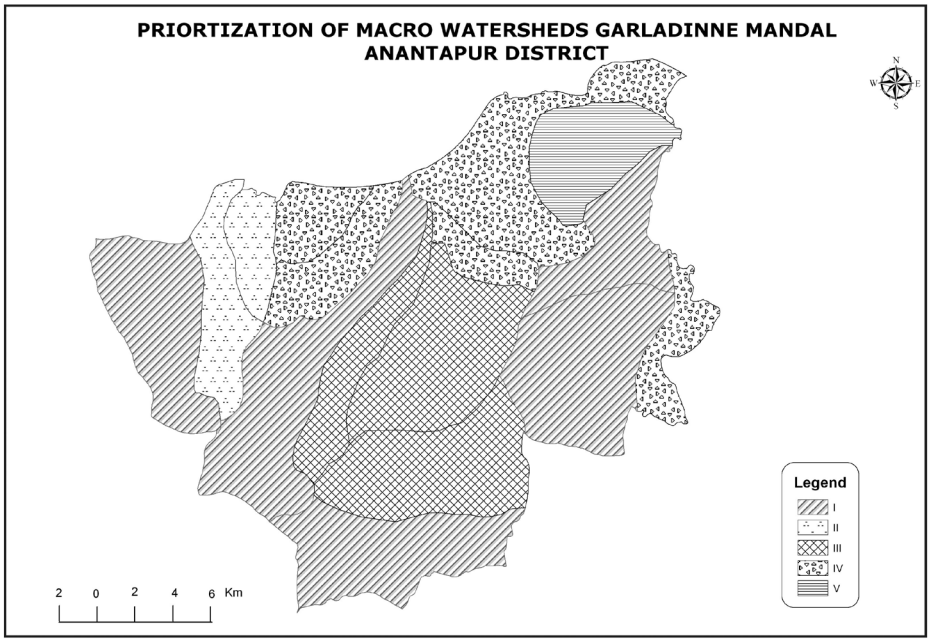

Fig. 3 :

Watershed Development Programs Under Different Schemes In Garladinne Mandal

During the period from 2005-2013 watershed programs have been implemented in the macro watersheds of the Garladinne mandal. The total amount allocated is about Rs.5, 46, 06,048 by the central and state government funds (Table.2). Out of the this total amount a sum of Rs 3,09,14,454 has been allocated to koppalakonda watershed under IWMP program during 2010-11. The various works carried out under different categories are horticulture plantation, livelihood activities, construction of rock fill dams, check dams, farm ponds, avenue plantation, gully control works, block plantation, restoration of kuntas, productivity enhancement and other works. The maximum amount of Rs.72, 48,290 is spent towards construction of check dams. Each check dam costed about Rs.151, 000. About 48 check dams have been constructed in the Garladinne mandal. About Rs.36, 07,915 have been spent towards other works. For gully erosion control works at local vankas and restoration of kuntas about Rs.35, 50,569 has been spent. A sum of Rs.22, 23,700 has been utilized for increasing agriculture productivity of various crops cultivated in the Garladinne mandal. For development of livelihood activities a sum of Rs.18, 00,000 has been spent in Kanumpalli, Penakacherla-II, Kotanka-3, P.Kothapalli, Budedu and Mukundapuram watersheds. About Rs.16, 00,000 has been spents towards avenue plantation in all the watersheds. A sum of Rs.14, 74,630 has been utilized for construction of farm ponds. Each farm pond costed about Rs.49, 155. About 30 farm ponds have been constructed in the Garladinne mandal. A sum of Rs.9, 76,666 has been used for horticulture plantations like sweet orange, pomegranate, papaya, banana etc. A sum of Rs.8, 87,222 has been utilized for construction of rock fill dams. Each rock fill dam costed about Rs.19, 716 and about 46 rock fill dams have been constructed to minimize soil erosion. A sum of Rs.3, 22,512 has been spent towards development of block plantation in the watersheds of the Garladinne mandal. The allocation of funds for each watershed varied from Rs. 18, 13,638 to Rs.23, 26,730 towards carrying out works in the Garladinne mandal.

Table 2 : Money spent towards watershed development programs under different schemes in Garladinne mandal from 2005-2013.

S. No.	Watershed name	Horti-culture planta-tion	Liveli-hood activi-ties	check dam	Farm pond	Avenue planta-tion	Gully control works at local vanka & Restora-tion of Kuntas	Block plantation	Produc-tivity enhance-ment	Rock fill dams	Other works	Total
1	Kanumpalli	95000	300000	758529	114000	139000	224358	45000	450000	-	101800	**2227687**
2	Penalacherla-II	180000	300000	785387	204000	201500	31000	-	315000	-	396500	**2413387**
3	Kotanka -3	-	300000	675630	47500	215800	85000	-	206500	150000	646300	**2326730**
4	P.kothapalli	125000	300000	678253	30000	194900	100650	-	352200	190010	283100	**2254113**
5	Budedu	-	300000	947756	-	50000	140000	92561	450000	259683	-	**2240000**
6	Mukundapuram	-	300000	921287	-	100000	140000	-	450000	222601	-	**2133888**
7	Yerraguntla (MWS)	199200	-	291247	91898	-	471049	34500	-	10928	600000	**1698822**
8	Ramdaspeta	145500	-	422737	167527	-	1155512	55100	-	6000	490376	**2442752**
9	Sirivaram	105200	-	210033	337776	253400	392741	95351	-	-	477696	**1872197**
10	Obulapuram kottala	126766	-	858671	216863	445400	291191	-	-	-	329489	**2268380**
11	Penakacherla	-	-	698760	265066	-	519158	-	-	48000	282654	**1813638**
12	Koppalakonda IWMP-2010-11	-	-	-	-	-	-	-	-	-	-	**30914454**
	Total	**976666**	**1800000**	**7248290**	**1474630**	**1600000**	**3550659**	**322512**	**2223700**	**887222**	**3607915**	**54606048**

(in Rupees)

Impact Of Watersheds

An intensive field study has been carried out to assess the implementation of watersheds development programs in the Garladinne mandal. The watershed works are carried out at macro level. The various works like construction of rock fill dams, check dams, percolation tanks, farm ponds, farm bunding, and restoration of kuntas do show changes in the cultivated area of macro watersheds. In small pockets near to the check dams and percolation ponds there is a slight increase in the ground water levels. The increase is about 0.2 meters to 0.50 meters. During the field studies it is found that in majority of the watersheds there is acute drinking water shortage. The dry lands of the watersheds are left fallow due to steep fall in the ground water resources. Only in a few pockets the crops are cultivated during rabi season. Fortunately the Garladinne mandal is provided with Mid Pennar South canal. Under this canal paddy is cultivated. In black soil plains where water resources are drawn from deeper depths the ground water is utilized for cultivation of banana and sweet orange. The watershed located in the fluvial plains of Pennar River is used for cultivation of paddy under bore wells and canal irrigation. **The major impact of watershed development programs in the Garladinne mandal are**

1. Increase in the ayacut area under check dams to an extent of about 30 hectares under each Check dam. About 1440 hectares of land has been brought under cultivation because of cultivation of 48 check dams during 2005-2013.
2. There is increase in ground water level under each check dam by about 0.5 to 1 meter due to recharge to an extent of 100 meters in the downstream.
3. Block plantation is increased in about 1,610 hectares with tamarind, and mango plantation.
4. In about 2,441 hectares of land is increased for the growth of sweet orange, pomegranate, banana and papaya. There is increase in avenue plantation along the roads of Garladinne mandal.
5. Modern irrigation methods like sprinkler and drip irrigation methods are adopted by the farmers for cultivation of plantation crops.
6. Agriculture productivity has been increased.
7. Due to increase in agriculture production the socio-economic conditions of the farmers are improved.
8. Soil erosion is controlled by construction of rock fill dams and farm bunding.

Suggestions

1. There is acute shortage of water in very high and high prioritized watersheds. They are Kanumpalli, Penakacherla -2, Kotanka -3, P.kothapalli, Mukundapuram, Penakacherla and Eguvapalli watersheds. These watersheds need developmental activities at micro level to minimize soil erosion and increase crop yield in agriculture. About 9435 hectares of land area falls under high and very high prioritized mega watersheds. These mega watersheds could be sub divided into 19 micro watersheds of about 500 hectares each. Micro watershed development programs should be

implemented. These programs should be carried out for a minimum period of ten years with the financial support from Central and State governments.

2. Under moderate prioritization there are three mega watersheds. They are Budedu, Yerraguntla (MWS) and Marthadu watersheds. The area covered is 3465 hectares. Field studies in these watersheds reveal that there is high water shortage for drinking and irrigation purposes. They are centrally located in Garladinne mandal. They are covered with moderately weathered pediplains. The ground water potential is low due to low recharge and hard rock nature of the granitic terrain. These three moderate watersheds could be divided into seven micro watersheds for development of land, water and vegetation resources. Watershed development activities at micro level have to be carried out for about ten years with the financial support from both Central and State governments.

3. There are about five low prioritized watersheds. They are Ramdaspeta, Sirivaram, Obulapuram Kottala, Koppalakonda and Kesavapuram watersheds. These watersheds cover an area about 5280 hectares. They could be divided into about 11 micro watersheds. The field study reveals that there is good ground water potential along the Pennar river valley and in the wash plains. During the field studies in the rabi season paddy, jowar, maize and vegetables are cultivated in these mega watersheds. Watershed development activities can also be carried out in these mega watersheds with financial support from State and Central governments for about ten years for cultivating fruits & vegetables, horticulture and floriculture crops, paddy, jowar, maize and groundnut.

4. The very low priority watershed is Illuru watershed which covers an area of about 1988 hectares of land. This mega watershed could be divided into four micro watersheds for stabilization of land, water and vegetation. Field study revealed that in this watershed paddy is the predominant crop under bore well irrigation. The intensity of erosion, sediment yield index and intensity of soil removal is very low. However to improve the land and water resources and vegetation micro watershed development activities should be carried out.

Conclusions

About 16 macro watersheds have been identified basing on relief and drainage through the study of SOI toposheets and IRS IB Geocoded data on scale 1:50,000. Basing on intensity of soil removal, sediment yield index and erosion index values the watersheds are divided into five very high priority watersheds, two high priority of watersheds, three moderate priority of watersheds, six low priority of watersheds and one very low priority of watershed. The watershed development programs implemented from 2005-2013 showed positive results like increase in ground water levels, increase in ayacut area, and increase in production of agriculture crops, increase in block plantation, avenue plantation, horticulture crops and decrease in soil erosion.

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