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Research paper

Integrated Management of Kovvada Kalva Watershed, West Godavari District, A.P., India using Remote Sensing & GIS

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Abstract

Watershed management is an integrated approach where a balanced utilization of land and water resources for optimal production with least menace to natural resources. Geospatial Technologies can be played an important role for the organization of various natural resources in a watershed. For sustainable development of land and water resources, the Andhra Pradesh State Government is implementing development of watershed programmes on priority basis. The watershed management activities include construction of rainwater harvesting structures, soil conservation measures and environmental protection measures (TAWDEVA). The selected watershed area was Kovvada Kalava Watershed which is a part of West Godavari District of Andhra Pradesh and was identified as drought and flood effected area because of sparse and variable rainfall. Collection of resource data includes digital imageries of study area for two seasons, Survey of India toposheets on 1:50000 scale, and other ancillary data / maps were conceded along with socio-economic data. The other datasets include levels of groundwater from concerned departments etc was collected. Various thematic maps on Settlements and Transport Network, Contours, Drainage Network, Slope, Geomorphology, Lithology, Structure and Land Use / Land Cover were generated by employing Arc GIS platform. After analyzing all maps integrated watershed analysis has been made aiming at generating sustainable developmental measures of land and water resources in the area.

Keywords: *Watershed, Remote Sensing & GIS, Lithology and Structure, Geomorphology, Land Use Land Cover*

1. Introduction

Watershed is a geohydrological unit draining at a common point by a system of streams (T. Rambabu et al., 2017). It is an ideal and accepted unit for approach planning, development and management of land and water resources which requires the understanding of relationship among land use, soil and water. Existence on earth depends on water and it is one of the most important natural resources available to mankind (Nihal Baloglu Ugurlu and Elif Aladag, 2016). It is a driving force for all developmental activities and of great importance for people and environment. Supplying water in preferred amount with excellence has been a constant endeavor of all the countries. The requirement of water has increased many folds due to its multiple uses-irrigation, domestic, electricity generation, engineered organizations, navigational, recreational etc. with the growth of human civilization. Intensive agricultural practices, unplanned industrial development and urbanization have all shaped time to time. Haphazard utilization of exterior/surface and interior/subsurface water has led to rigorous water shortage and ecological deprivation. The variations in rainfall have further provoked the hitch. Watershed management is a continuous process of integrated decision-making regarding use and alteration of natural resources in a watershed. This practice offers an opportunity for stakeholders to poise varied goals and uses for natural resources and to judge how their collective measures may shape long term sustainability of these natural resources. Watershed management practices are those changes in land use, vegetation cover, and other non-structural and structural actions that are taken on a watershed for the holistic development of the watershed.

2. Study area

The study area Kovvada Kalva watershed lies geographically between latitudes N16º55' to 17º24' and longitudes E81º23' to 81º44' is covered in the survey of India toposheet numbers 65G/7, 65G/8, 65G/11, 65G/12, 65H/9. The major crops grown in the study area are rice, groundnut, maize, chillies etc. Because of erratic distribution of rainfall and fewer rainy days, the Kovvada Kalava watershed area suffers from deprived soil dampness resulting in frequent droughts and famines.

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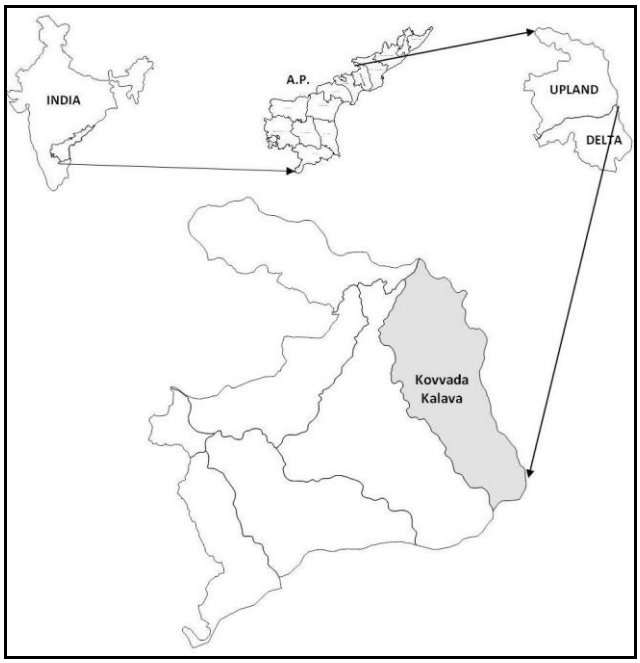

Figure 1: Location map of the Study Area

3. Need of the Study

The upland area of West Godavari district in Andhra Pradesh in which study area is situated forms of part of semi-arid zone in peninsular India with sparse and unreliable rainfall. These areas have been acknowledged as persistently drought affected areas in the state. Famines have affected the area frequently in the past and their frequency of occurrence has increased during the last five decades (Agriculture Dept, Govt. of A.P., 2006). It is unanimously recognized that the most effective way to eradicate drought and famine and to reverse the desertification process in an area is by enhancing water supplies to the area to optimally cater to the basic needs of drinking and sustaining the agriculture on which majority of the population depends (ICID, 2017).

Satellite Remote Sensing coupled with computer based Geographical Information Systems (GIS) offers an advantage for environmental planners to have correct overall perspective with least investment of time and money (Sabins F.F., 1978). Keeping these in view, the current study employs geospatial technologies for maximum possible utilization of water resources and watershed management programmes which will culminate in the overall socio-economic progress and poverty mitigation in the Kovvada Kalava watershed region.

4. Objective of the Study

The prime objective of the current research topic involves generation of updated information on various parameters which include settlements and transport network, climate, drainage and surface water resources, land use / land cover, slope, lithology and structure, geomorphology ground water resources for the entire study area. The integrated analysis of all the above parameters provided information for optimal utilization of land and water resources. The proper implementation of the suggestions/ recommendations on land use practices and water resources management achieves the objective of sustainable agricultural production and restoration of ecological balance in the area.

5. Methodology

The wide-ranging methodology was adopted to attain the objectives of the present research topic is as follows:
Source data like satellite data of the study area for two seasons and SOI toposheets were collected. Basic themes like settlements and transport network map and drainage network map were prepared from the collateral data. Later settlements and transport network map and drainage network map were updated from the satellite imageries by visual interpretation. Watershed map and slope map were prepared from the drainage map and contour map respectively. Thematic maps like land use/ land cover and geomorphology map were prepared by visual interpretation of the satellite imagery (P. Srinivas et al., 2007). Field observations were incorporated into the related thematic layers. All thematic maps were integrated and after analyzing. Action plan was generated for the soil and water conservation in the study area.

5.1 Details of the data used

In the study area for the preparation of different maps of the following data was collected:

SOI toposheets, IRS P6 Resourcesat LISS-III & LISS-IV Data and other conventional data sets.

Various thematic maps like base map, slope map, drainage & surface water bodies map, lithology & structural map, geomorphology map, ground water prospects map, land use / land cover map of the study area were prepared by using survey of India topographic maps and satellite imageries are shown in the figure 2, Figure 3, Figure 4, Figure 5, Figure 6, Figure 7 and Figure 8.



Figure 2: Base map of the Study Area

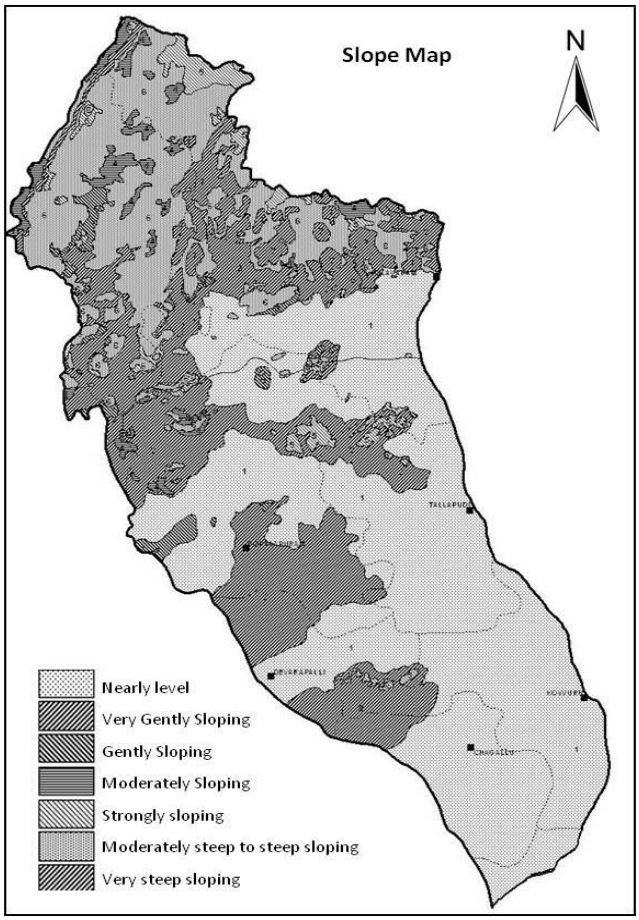

Figure 3: Slope map of the Study Area

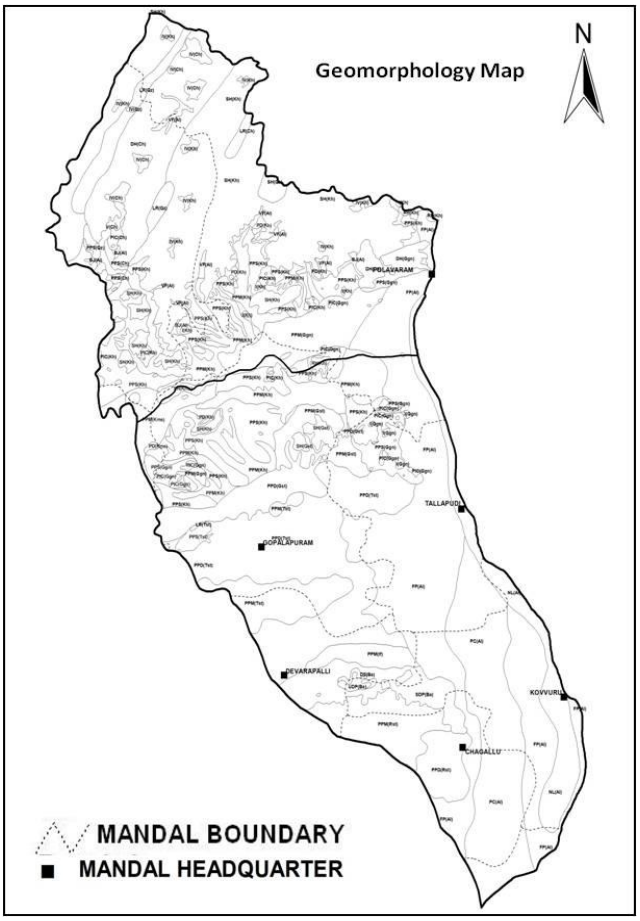

Figure 4: Geomorphology map of the Study Area

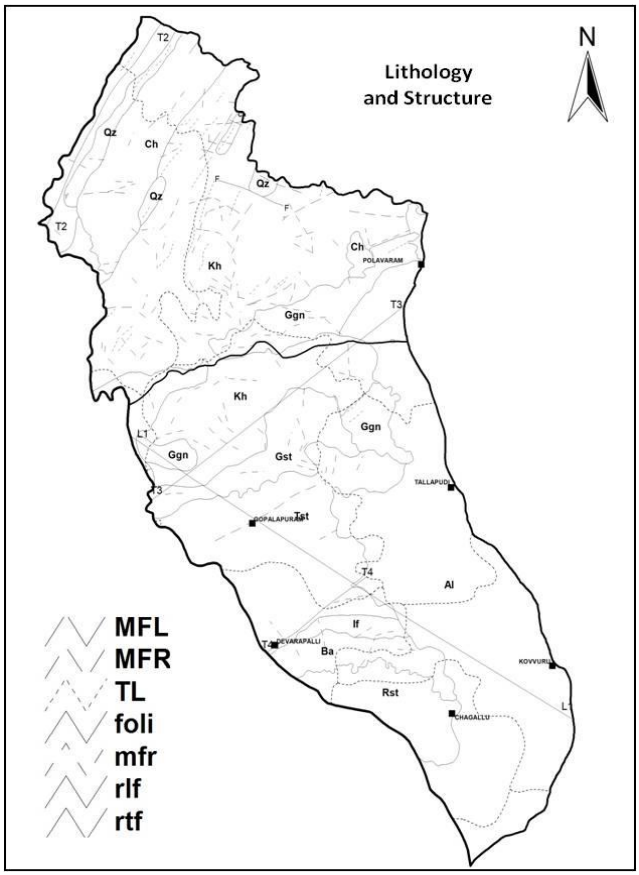

Figure 5: Lithology and Structure map of the Study Area

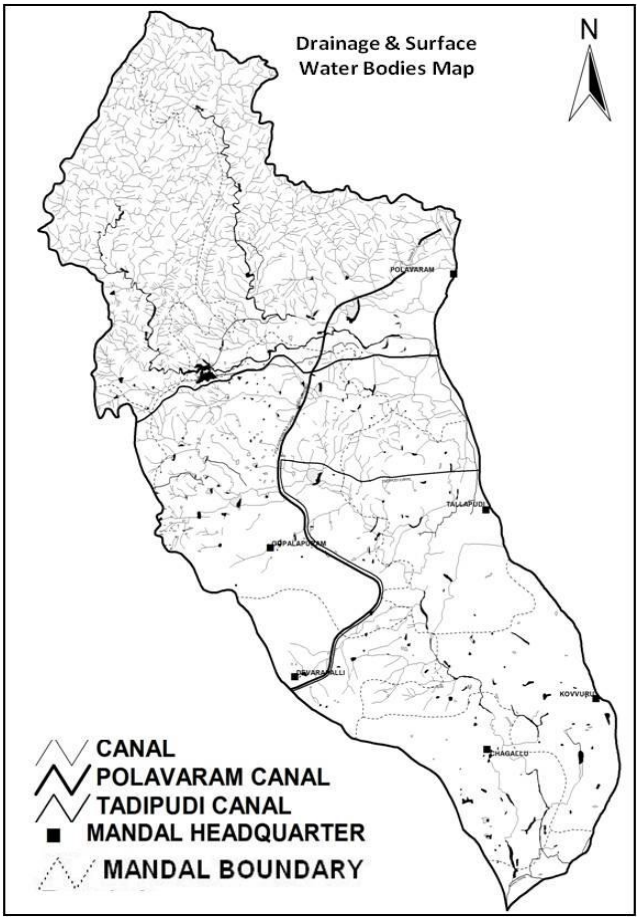

Figure 6: Drainage and Surface Water Bodies map of the Study Area

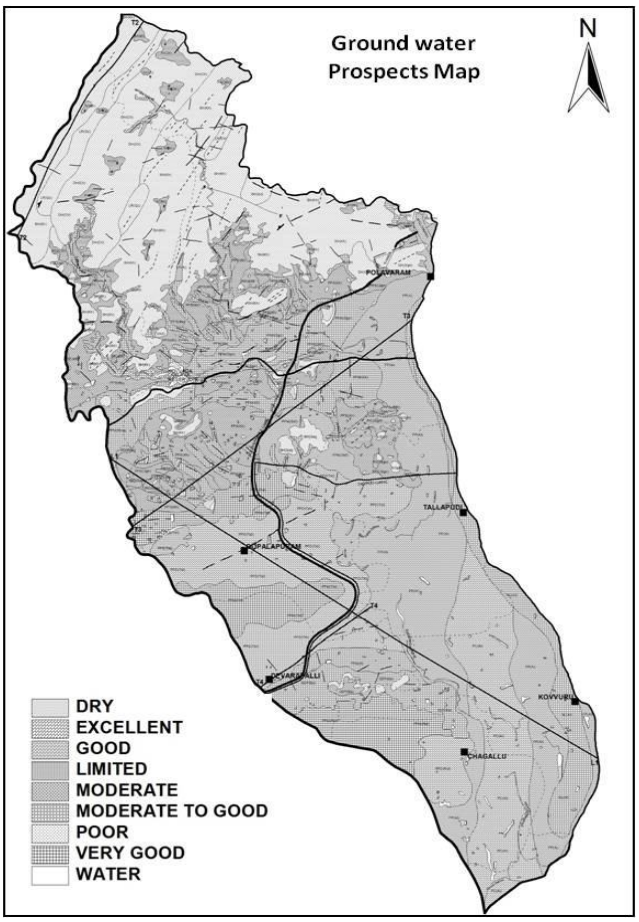

Figure 7: Ground Water Prospects map of the Study Area

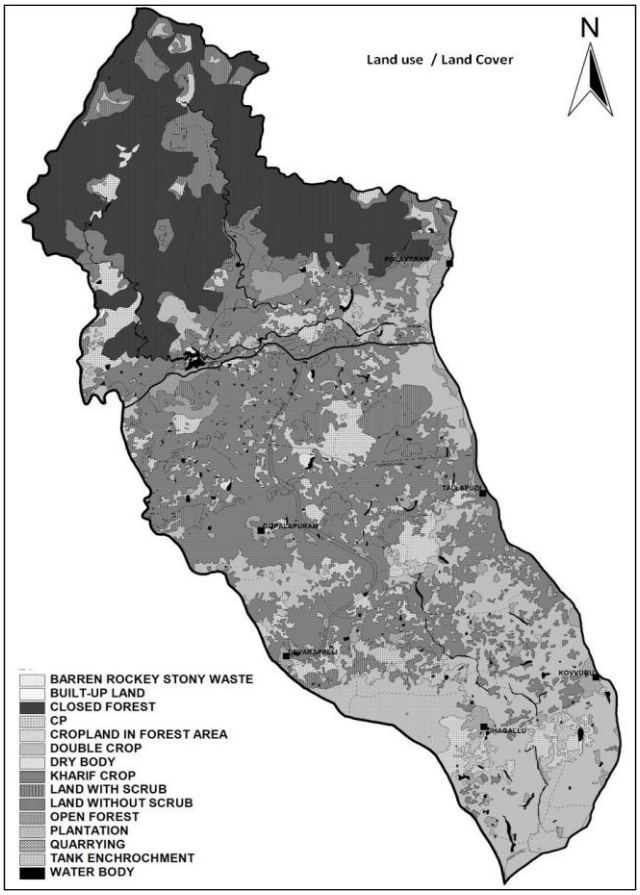

Figure 8: Land Use Land Cover map of the Study Area

6. Integrated Watershed Analysis and Management

The integrated watershed analysis is aimed at generating sustainable developmental measures of land and water resources in the area. The underlying concept of sustainability is the sustenance of agricultural productivity and geo-environment (P. Srinivas et al., 2008). This can be achieved through a set of agricultural production activities, which mutually balance the impact of depletion and replenishment of the producing potential with the capacity of available land and water resources. Beyond this limit, the set-up starts degrading. Though in the initial years higher productivity may be recorded but in the long run the degradation is inevitable. Through the intervention of innovative technologies, the limit of production can be enhanced and rest at higher level of production with a new set of production activities, which should again bring the mutual balance as stated above. But, within a given set of technology, the production level is fixed at definite limit. When stretched beyond such limit the degradation sets in.

This watershed is located in the eastern part of the study area covering Polavaram, Tallapudi, Kovvuru, Buttayagudem, Gopalapuram, Devarapalli, Chagallu and Nidadavolu mandals. It is bounded in the east by Godavari river, west by Godavari basin divide and south by Right bank canal of Sir Arthur Cotton Barrage on Godavari. The total area of the watershed is about 879.33 sq. km. This watershed includes the drainage systems of Kovvadakalava, Pedralakalava and Rallamadugu. The average annual rainfall in the watershed is about 979.14 mm. This watershed has been divided into two sub-watersheds namely Upper Kovvadakalava and Lower Kovvadakalava occupying northern and southern parts respectively.

6.1 Land and Water Resource Analysis

Most of the northern Upper Kovvadakalava sub-watershed is occupied by Easternghats hilly terrain. The southern Lower Kovvadakalava sub-watershed represents a very nearly level to very gently sloping area except in the northern part where some isolated hills are present. The density of drainage is high in the entire northern Upper Kovvadakalava sub- watershed, which is covered by hilly terrain and occupied by crystalline rocks. The drainage is moderate in the northern part and very sparse in the southern part of Lower Kovvadakalava sub-watershed covered mostly by sandstones and alluvium.

The surface water resources in the watershed have been developed by the construction of tanks of varying sizes. These tanks are unevenly distributed with moderate density in the northwestern and southern parts of Lower Kovvadakalava sub-watershed. The Upper Kovvadakalava sub-watershed is mostly devoid of any surface water resource development since most of the area is covered by hilly terrain and forest. However, a few tanks have been constructed in the southern part of this sub-watershed. Also, a medium irrigation project has been constructed on Kovvadakalava near Sagipadu of Gopalapuram mandal in the Upper Errakalava sub-watershed. The total irrigated area under this project is about 4175 ha.

The entire Upper Kovvadakalava sub-watershed and northern part of Lower Kovvadakalava sub-watershed is subjecting to strong water erosion. Also, the northwestern and southeastern parts of Lower Kovvadakalava sub-watershed experience slight to moderate water erosion. Hence, the tanks in the area have been silted up and resulting in reduction of water holding capacity. Also, the Kovvadakalava reservoir situated in Upper Kovvadakalava sub-watershed will get silted up in due course of time unless some soil erosion measures are taken up in its catchment. Most of the tanks are encroached with agricultural activities in the foreshore areas.

The lift irrigation schemes on river Godavari at Gutala, Vegeswarapuram, Tadipudi and Kumaradevam provide irrigation facilities for kharif crop in Kovvur, Tallapudi, Polavaram, Devarapalli, Chagallu and Gopalapuram mandals covered under Lower Kovvadakalava sub-watershed. This helps in ground water recharge in the major portion of Lower Kovvadakalava sub-watershed. Also, the right bank canal of major multi-purpose project on river Godavari at Polavaram which is under construction passes through the northern central part of this sub-watershed.

The ground water in the watershed is developed by tapping the pediplain with moderate and deep weathered zones of sandstones and pediplain with moderately weathered zone of crystalline rocks. In the eastern part of Lower Errakalava sub-watershed covered by flood plain and paleo-channels, ground water is tapped by sinking tube wells and filter points. The shallow alluvial and multi-aquifer sandstone formations occupying mostly southern, eastern and western parts of Lower Kovvadakalava yield very good quantities of ground water. The ground water prospects are limited to moderate in crystalline rocks, which are mostly occupying Upper Kovvadakalava sub-watershed. In respect of ground water development, the entire Kovvadakalava watershed falls under semi-critical stage with 70-90% draft. At present most of the area is irrigated by using ground water. The eastern part of the watershed receives good recharge from the river Godavari.

The landuse / land cover in the watershed include kharif cropland, double crop, cropland mixed with plantations, plantations, closed and open forest, land with scrub etc. The major part of Upper Kovvadakalava sub-watershed is covered by dense forest. The kharif cropland, double crop and cropland mixed with plantation are the prominent landuse practices in the Lower Kovvadakalava sub- watershed. The irrigation requirements are mostly met by tapping ground water. Intensive irrigation particularly for the long duration crops and plantations like sugarcane, tobacco, banana and oil palm has resulted in the depletion of ground water in this area.

6.2 Watershed Treatment and Management

The soil erosion and moisture conservation measures are to be taken up on top priority in Polavaram, Buttayagudem and Gopalapuram mandals of the Upper Kovvadakalava sub-watershed and northern part of Lower Kovvadakalava sub-watershed on micro-watershed basis to arrest siltation of Kovvadakalava reservoir and tanks. The desiltation of reservoir is a very tough task and not possible. Deforestation and excess grazing are to be regulated immediately in the Upper Kovvadakalava sub-watershed. This will enhance the efficiency and life of these surface water irrigation systems. Desiltation and clearing the encroachments programme of tanks in the watershed is to be taken up on priority basis to improve the water holding capacity, reduction of floods and enhancement of the command area. This will also facilitate ground water recharge.

The ground water draft in this watershed is in the semi-critical stage. Conjunctive use of surface and ground water is to be planned in lower the Lower Kovvadakalava sub-watershed in such a way that the kharif crop is to be irrigated by surface water irrigation systems i.e. Lift irrigation of Tadipudi, Gutala, Vegeswarapuram and Kumaradevam and the rabi crop by tapping ground water. Efficient irrigation systems like drip irrigation for plantation and sprinkler systems for commercial crops particularly while using ground water. This will help in the optimization of ground water resources and judiciously planning sustainable cropping systems.

6.3 Watershed Prioritization and Implementation Strategy

The implementation of various land and water resources development, conservation and management measures in a region are to be taken up on priority basis depending on the severity of the problems. Considering various aspects related to financial, execution and social problems, it is not possible to implement various remedial measures at once in all the four watersheds of the study area. The soil and moisture conservation studies are to be taken up and the suitable remedial measures are to be implemented immediately. The remedial measures include construction of vegetative barriers, contour bunding with stone checks, furrow method of cultivation, conservation ditches, construction of brush wood / rubble dams, cordon wall, trenching, terracing, planting soil binding species etc. This watershed is subjecting to extreme to strong water erosion in which the medium irrigation projects are located is to be considered immediately to arrest premature siltation and enhancing the longevity of these systems. The deforestation and overgrazing in the hilly regions in the study area is to be arrested to reduce the soil erosion phenomena. These activities must precede any surface water resource development programmes. The desiltation of tanks is to be taken up on priority basis in the over-exploited ground water zones subjecting to intensive irrigation practices. The clearing of all the agricultural encroachments in the foreshore areas of tanks in all the four watersheds is to be taken up for increasing the water holding capacity of tanks.

The construction of check dams, percolation tanks and new minor irrigation tanks suggested in the present study is to be taken up only after successful implementation of desiltation programmes in each watershed. The connection of minor irrigation systems for effective harvesting of surface run-off is to be taken up only after desiltation of tanks and establishing excess run-off in the area. As the area enjoys good rainfall and numerous minor irrigation systems have been already constructed, it is preferred to rejuvenate the same and shift over to surface water irrigation at least for kharif crop in those areas. This facilitates the usage of ground water for rabi crop in those areas.

Though the watershed programmes include technical feasibility, economic viability and political aspects, no developmental programme can be implemented without the acceptance and participation of the people. So, people awareness programmes on geo-environmental problems such as soil erosion, optimal land use practices, surface and ground water utilization are to be conducted in the area. The information on impacts of overexploitation must percolate to all the sections of the society particularly farmers and farm workers. This helps in optimizing the available resources and sustainable agricultural activities.

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