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RESEARCH ARTICLE

Evaluation and management of water resources in Kongu Uplands, Tamil Nadu, India

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Abstract

Water is one of the important resources especially in semi-arid tracts and identifying suitable management strategies are highly tactical. The present study is an attempt to suggest suitable management techniques for the study area viz., the Kongu Uplands. The Uplands is an extension of Deccan Plateau in Tamil Nadu which consists of 81 blocks and distributed over 8 districts in which it covers 25,000 sq km of geographical area. Overlay method with the help of Geographical Information System (GIS) has been adopted in the study. The eight parameters such as are land use/ land cover, cropping intensity, population density, water level fluctuation, groundwater potential and rainfall have been adopted and analysed. The overall result in general reveals that most parts of the Upland areas need to adopt moderate level of management strategies.

Keywords: Management; GIS; Overlay Method; Water Level Fluctuation; Groundwater Level; Cropping Intensity

Introduction

Water is an inevitable resource due to its relative importance at all points of time. The properand scientific knowledge is essential for evolving suitable management measures for sustainable usage of these resources in various regions of interest. The management of water resources involves the evaluation of usage levels and quality aspects for adopting the best management practices that can be developed in course of time. An inventory of the sources of water pollution, the intensity of the usage of chemical fertilisers in agricultural fields which harmfully affect water resources and the adoption of scientific check to water pollution are the prime concerns in dealing with the formulation of policies in water resources management. Since Kongu Uplands relies on agriculture and industrial activities, the water usage and exploitation are currently higher and will result in adverse form in the future. These concerns in the Uplands necessitate to emphasis proper and appropriate water resource management strategies. Community managed indigenous system of water management existed in the Uplands for many centuries to meet the irrigation, drinking and domestic water demands of the community.

Study Area

Kongu Uplands has the latitudinal and longitudinal extension of 10°10' N - 12°10' N and 76°40' E - 78°25' E. It covers a total area of 26,000 km^2 approximately, which is nearly one fifth of the total geographical area of Tamil Nadu State. It shares its geographical boundaries with the Kolli Hills in the east, the Western Ghats towards the west, the Nilgiris hills on the northwest and Anaimalai and Palani hills in the south. It is a part of the Deccan Plateau which is highly characterised by hard rock complex. It has an average elevation gradually decreasing from west to east. The area possesses structural, fluvial and denudational origin of land forms. The region experiences a pleasant climate as compared to other regions of the state. Cauvery with its tributaries such as Bhavani, Noyyal and Amaravathi are the major drainage systems of the Uplands. It is one of the densely populated regions with high agricultural and Industrial activities.

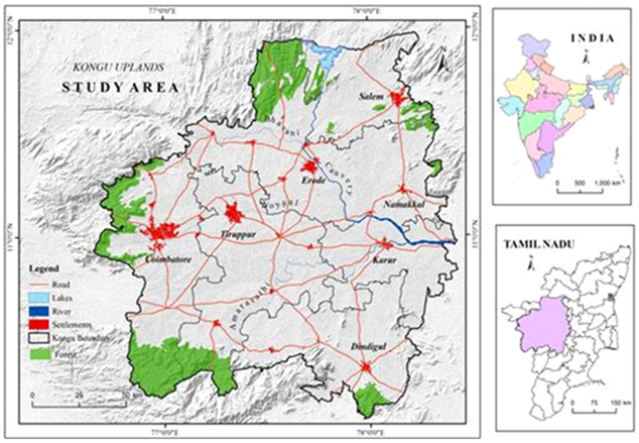

Fig. 1. Kongu Uplands (Aster DEM 30 m Resolution)

Materials and Methods

The study utilised the data from various sources. The natural boundary of Kongu Uplands has been demarcated with the help of 1:2, 50, 000 Toposheet and Aster DEM image with 30 m resolution. The cropping intensity has been calculated from the G- return data for the year 2015-2016 has been collected from the District Economics and Statistical Departments of respective Districts. Water level data and Rainfall data have been collected from State Ground and Surface Water Resources Data Centre , Tharamani, Chennai for the period of 1985-2015.Landuse/ land cover has been obtained from LISS IVimage. Groundwater potential has been delineated from various layers .Population density has been obtained from District Census Handbook 2011 for each District. All these resultant outcomes have been overlaid using weighted overlay method with the help of Arc GIS 10.1. Inorder to understand the spatial distribution all the resultant outcomes have been represented in the maps.

Results and Discussion

Table 1. Rankings and Weightage for Water Resource Utilisation

Sl. No	Influencing Factors	Category	Ranking	Weightage
1	Land use / Land cover	Barren Rocky or Stony waste,	4	4
		Built up (Urban)	4	
		Crop Land	4	
		Fallow Land	4	
		Built up (Rural)	3	
		Plantation	3	
		Scrubland	3	
		Clad Area	2	
		Gullied / Ravinous Land	2	
		Sandy Area	2	
		Waterbodies	1	
		Forest	1	
		Scrub Forest	1	
2	Population Density (No. of Persons / sq.km)	6,000-8,000	4	6
		4,000-6,000	3	
		2,000-4,000	2	
		>2,000	1	
3	Rainfall (in mm)	>500	4	1
		500-650	3	
		650-800	2	
		<800	1	
4	Groundwater Potential Zones	Low	4	2
		Moderate	3	
		Good	2	
		Very Good	1	
5	Water Level Fluctuation(m)	<25	4	3
		20-25	4	
		15-20	3	
		10-15	2	
		5-10	2	
		>5	1	
6	Cropping Intensity (in %)	<130	4	5
		120-130	3	
		110-120	2	
		>110	1	

In order to reach the aim of categorisation of water utilisation, the parameters that have direct and indirect relationships with the water utilisation in the study area

has been examined in detail using the indicators referred above like landuse/ land cover, cropping intensity, population density, water level fluctuation, groundwater potential and rainfall. In general, the area with high population density and high cropping intensity results in overdraft of groundwater. Similarly, area that receives a fair amount of rainfall and potential zones for groundwater occurrence are considered as sites for recharge of groundwater.

Landuse / Land Cover

To achieve an accurate result for water utilisation rate based on landuse/ land cover, LISS IV image was classified according to level I classification. Based on this, the built-up area (urban), barren rocky /stony waste, crop land and fallow land have been classified. Adoption of higher level of precision water management strategies are needed for these areas. The western portion of Kongu Uplands is covered by forests. This is followed by built-up (rural), scrubland and salt affected lands that have moderate water utilisation level and gullies (ravenous land, sandy area) are categorised as low water utilisation areas.

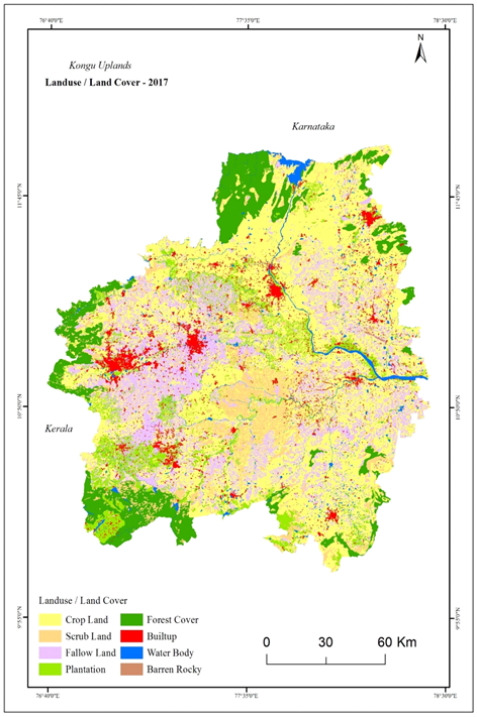

Fig. 2. Landuse/ Land Cover

Therefore, these areas have relatively low priority for adopting soil related water management practices. The built-up area exploits maximum amount of water than any other landuse and hence, there should be a high apprehension on the water resources in these areas. The crop land distributed in Central Tamil Nadu needs to adopt intensive water management practices.

Cropping Intensity

Cropping intensity depicts the feasibility of land for cultivation more than once in a year.The blocks which have high cropping intensity are areas that depend on multiple sources of irrigation methods such as wells, canals, tanks etc. Hence, the water quality assessment and its management are very essential in those areas of exploitations. The blocks of Perundurai, Periyanaickanpalayam, Sulthanpet, Thanthoni, Pollachi North, Pongalur, Puduchatram and Taramangalam have high cropping intensity in the study area. Majority of the blocks in the Upland region have low cropping intensity where the utilisation of water is less. Hence, crops with minimum water requirement are recommended to be cultivated in these regions.

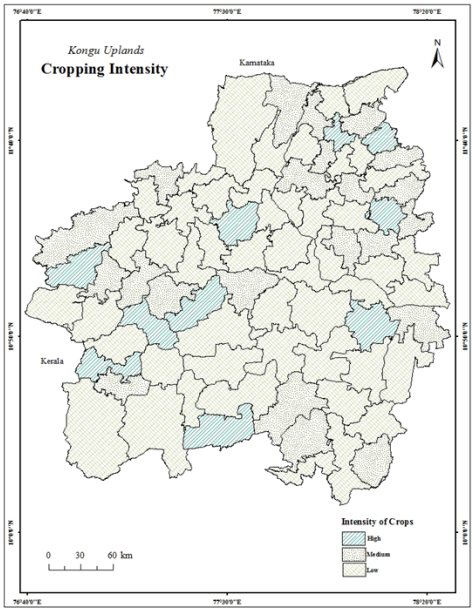

Fig. 3. Cropping Intensity

Population Density

As the population increases the need of water demand also increases and thereby it affects the overall quality and quantity of water resources. The water may be used for several purposes like domestic, agricultural and industrial and thereby increases the pressure on water resources. The density of population is very high in the blocks of Omalur, Salem, Tiruppur and Erode which needs very high management of water due to its high consumption.

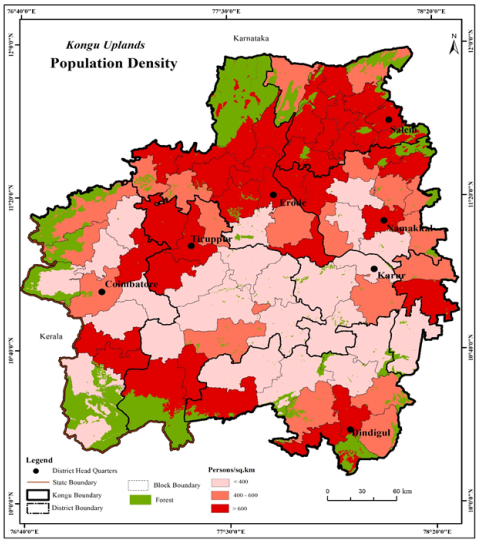

Fig. 4. Population Density

Rainfall

Rainfall is one of the most important factors which determine the water availability of a region. In general, rainfall deficient areas have direct relation with groundwater level. Hence areas with low rainfall should be given higher priority for suitable management strategies. Generally, central and southern portion Kongu Uplands receives less amount of rainfall.

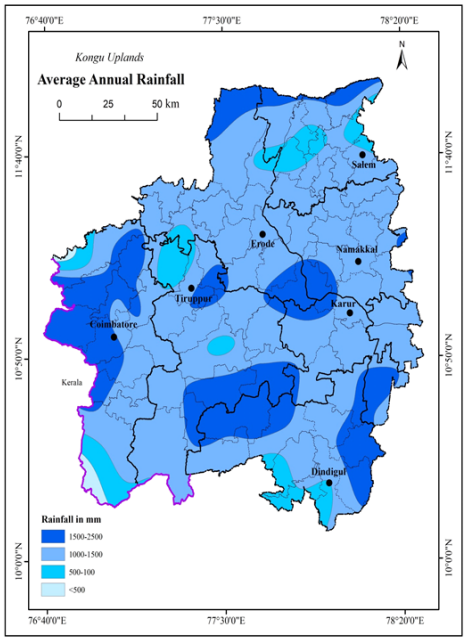

Fig. 5. Rainfall

The highest rainfall receiving area include Yercaud (1745.55 mm) followed by Avanashi and Topslip. The blocks with moderate rainfall are Ayodhyapattanam, Danispet, Dindigul, Erode, Gobichettipalayam, Mackinaykampatti and Negamam which records between 900mm and 1200mm. Krishnapuram in Karur district, Tholampalayam, and Pallipalayam in Erode have low rainfall. The adoption of dry land farming which is the cultivation of crops which require less amount of water are suggested for arid regions.

Groundwater Potential Zones

The delineation of groundwater potential zones gives an idea about the overall quantity of groundwater the Kongu Uplands. The low potential zones need adequate conservation of quality and quantity by bringing appropriate management measures such as construction of recharge pits, artificial recharge structures and rainwater harvesting measures. The following area needs immediate attention where low groundwater potential area found on central and southern portion of Kongu Uplands especially blocks such as Udumalapettai, Dindigul, Palani, Sanarpatti, Vadamadurai, Ottanachathiram, Thoppampatti, Guziliamparai, Dharapuram, Sulthanpet, Karamadai, Periyanickanpalayam, Elaichipalayam, Salem and Anthiyur.

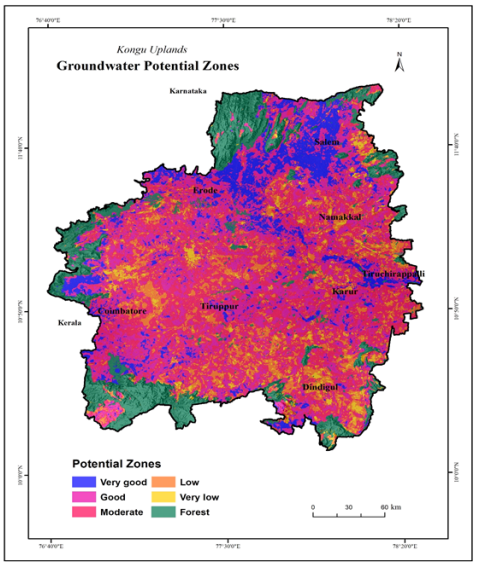

Fig. 6. Groundwater Potential Zones

Water Level Fluctuation

The water level is determined by the depth at which the water table is located. The depth of water table in terms of shallow or deep is determined by the underlying formation i.e. confined or unconfined aquifer. Besides geology, rainfall, topography, landuse and land cover, evapotranspiration rate also controls the ground water level in a particular region.

In general, Kongu Uplands have moderately deep water level of about 15 to 20 mbgl. Over utilisation of groundwater result in water level fluctuation or fall in level of water table. In addition to this, areas where there is over extraction of water have high possibility of salt water intrusion from the adjacent region. A fall in water level is observed in the controls wells located in the blocks like Pollachi, Dindigul, Coimbatore South, Aravakurichi, Sulur, Karur, Kadavur, Krishnarayapuram, Erode, Tiruchengode and Mettupalayam. This indicates water utilisation is high in these area hence more management measures to be implemented to maintain the quantity and quality of groundwater.

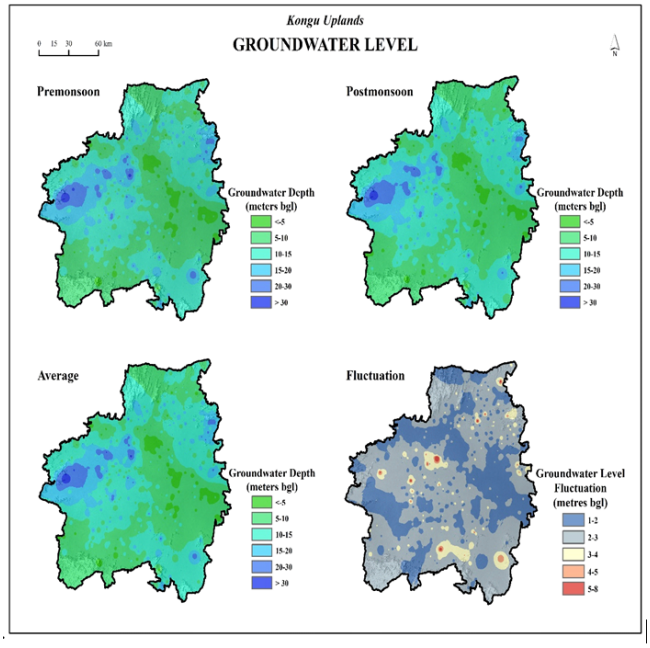

Fig. 7. Water level Fluctuation

Management of Water Resources

The above mentioned parameters have been assigned weight and rank through weighted overlay analysis and classified the Uplands into Priority Classes I, II, III, and IV based on the water utilisation. The output of the analysis shows the water utilisation pattern of whole Kongu Uplands. Areas with high utilisation of water need immediate attention to properly manage and conserve it for a long period.

Priority Class I

Around 2,492 sq.km of the Kongu Uplands is classified under priority class I, where the water utilisation is very high and further due to over exploitation it affects the water quality too. The geology under this area is marked with granite, pink migmatite and quartzite rocks. The areas which need high management isSultanpet Block in Coimbatore District which covers an area of 203.97 sq.km. This is followed by Sulur (185.74 sq.km), Pongalur (161.26 sq.km), Udumalapet (142.2 sq.km) and Periyanaickanpalayam (114.64 sq.km). Besides this Thanthoni, Pollachi North, Karamadai, Reddiarchattiram, Kodumudi, Palani, Salem, Krishnarayapuram, Sanarpatti, Perundurai, Vadamadurai, Senthamangalam, Tiruppur, Puduchatram, Pallipalayam and Namakkal needs more management as the water utilisation rate is very high. The dominant LU/LC is fallow land, crop land, built up area and barren lands. The fallow land covers an area of 4,980 sq.km. This area considered as fallow land need to be efficiently managed in terms of its quality otherwise which may expand to nearby regions. The crop land distribution of the Upland region covers an area of 11,335.8 sq.km. The crop land needs more water, so the water utilisation is high here and leads to deterioration of water quality. Built-up areas (urban) utilises more water as population is very high and most of the people depends on groundwater as the only source for drinking and other purposes. There is a close relationship between cropping intensity and water level. The area where cropping intensity is high consumes more water and hence there is a fall in water level. The study on Kongu Uplands also reveals that areas where rainfall is scarce and cropping intensity is high depends on other irrigation sources mainly underground water. This dependence on other irrigation sources increases the groundwater extraction further results in groundwater depletion and leads to unavailability of water. These areas require immediate attention and hence falls under Priority class I in terms of adoption of management practices to slow down the runoff rate and maintain the water level by construction of recharge structures like check dams, storage bunds etc.

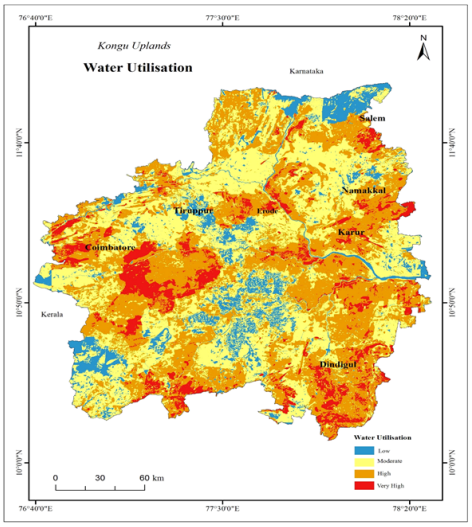

Fig. 8. Water Utilisation in Kongu Uplands

Priority Class II

Almost 10,792.83 sq.km i.e. 42 percentage of the geographical area of Kongu Uplands is classified under Priority class II. This area also needs management for the problems occurred in this region. The geology of the area is marked up with ultramafic, pyroxene granulite, gneiss, gabbro, laterite and dunite. Boulders and valley fill were also dominant in this region. The main LU/LC of this region is scrub, salt affected land, industrial and built-up area (rural) which utilises more water. In this category the areas needs more management is Anthiyur in Dindigul District which covers an area of 520.39 sq.km followed by Karur Paramathi (400 sq.km), Guziliamparai (332 sq.km), Palani (292 sq.km), Thanthoni (262 sq.km), Kinathukadavu (260 sq.km), Palladam (258 sq.km), Ottanachathiram (236sq.km), Krishnarayapuram (229sq.km), Reddiarchattiram (225sq.km), Sanarpatti (220 sq.km) andKaramadai (218 sq.km). Since water utilisation is high in these blocks, these area falls under Priority Class II.

Priority Class III

Thoppampatti (420 sq.km), Avinashi (306 sq.km), Karamadai (289 sq.km) and Udumalapet (279 sq.km)are the blocks that comes under this category. These areas are categorised as Priority Class III, since the water utilisation pattern is moderate in these blocks. The geology of this area is marked with charnockites and hornblende biotite gneiss. The major landuse type of this region is clad area and gullied/ravenous land. Small stretches of sandy area is also seen along the industrial areas.

Priority Class IV

This class generally covers the blocks of Kadayampatti (81 sq.km), Kolathur (176 sq.km), Thoockanaickenpalayam (96 sq.km), Aravakurichi (278 sq.km), Mulanur (227.78 sq.km), Dharapuram (196 sq.km) and Kundadam (272 sq.km), Anthiyur (452 sq.km), Thoppampatti (420 sq.km), Udumalapet (279 sq.km), Madukkarai (220 sq.km).Approximately, 2,650 sq.km falls under this category which 10% of the Kongu Uplands.

Table 2. Status of Water Resource Utilisation in Kongu Uplands

Class	Area (in sq.km)	Area (in%)
Priority Class I	2,429	9
Priority Class II	10,793	42
Priority Class III	10,026	39
Priority Class IV	2,650	10

Management Practices Recommended for Kongu Uplands

Since water is an over demanded resource, proper utilisation and appropriate management becomes compulsory to enhance the quality and quantityof groundwater resources in the Kongu Uplands. Irrigation is inevitable for the growth of agricultural sector and other allied activities that provides food to feed a large population which simultaneously facilitates and ensures a better economic growth. The water resources in the Kongu Uplands are found to be ranging from moderate to good conditions in most of the areas. But there are limitations of pH, EC, TH, TDS, Calcium, Magnesium, Fluoride, Chloride, Sulphate, Nitrate etc. Besides SAR, RSC, SSP for both considering irrigation and domestic as a whole.

The following practices can be adopted for the efficient management of water resources in Kongu Uplands.Construction of check dams, cultivation of salt tolerant crops, construction of artificial recharge sites, adoption of rainwater harvesting techniques and desiltation of wells are some techniques which can be adopted to manage the use of water resources. Implementation of proper irrigation methods, measures to improve cropping intensity like earlier maturing crops, mixed cropping, crop rotation, relay cropping, and cultivation of suitable plants should be adopted, conservation of water resources, emphasis on irrigational projects, rainwater harvesting„ soil and water conservation in the river catchments, replacement of old pump sets, minor irrigation schemes, improvement of judicial irrigation practices, drip irrigation, improve the quality of groundwater for irrigation, measures to reduce water acidity and alkalinity-likeneutralising filters (calcite), chlorine solution and soda ash, weak acid treatment/ion exchange unit and alum treatment should be adopted in the study area inorder to conserve the available water resources.

Conclusion

The groundwater potential varies throughout the Kongu Uplands. It is possible to rectify and improve the quality of groundwater in the Uplands by the adoption of proper management techniques. Population density of the study area is very high and hence water utilisation is also very high. So the judicial utilisation of the availableresources is very essential. Hence a sustainable management plan for proper utilisation of water resources in Kongu Uplands should be adopted.

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