Village Wise Drought Mitigation Measures -A Case Study Using Remote Sensing and GIS in Sivaganga Taluk

S. Manikandan, P. Indiramma, T. Rajesh

Abstract*: Drought is a recurring phenomenon in many parts of the world, bringing significant water shortages, economic losses and adverse social consequences. Hence knowledge of the drought risk area, their occurrence and their course is an essential aspect for planning. In southern state Ramand district is well known for its frequent monsoon failure, drinking water scarcity and worst drought condition, Remotely sensed data and GIS is widely accepted as a tool for the establishment of integrated information. Drought risk area, by nature, is a result of interrelated parameters concerned. The study area taken in to consideration is Sivagangai taluk , part of old Ramanad district historically a drought prone area. Using geomatic tools detailed analysis has been made with respect to rainfall, water level, subsurface formation, and the geomorphology derived out of remotely sensed data products. The collateral data collected from the field have been converted in to spatial themes and overlay analysis helped to derive the pattern of water level variation, ground water quality deterioration and ground water potential changes. Estimation of ground and surface water potential for a considerable period helped to identify the water stress condition and the same has been correlated with respect to individual villages of Sivagangai taluk. The village wise stress condition helped to plan for effective water resources management by providing recharge and remedial measures to combat the drought condition.

IndexTerms—hydrological drought, metereological drought,.

I. INTRODUCTION

Drought is a climatic anomaly, characterized by deficient supply of moisture resulting either from sub-normal rainfall, erratic rainfall distribution, higher water need or a combination of all the factors Droughts are the resultant of acute water shortage due to lack of rains over extended periods of time affecting various human activities and lead to problems like widespread crop failure, replenished ground water resources, depletion in lakes/ reservoirs, shortage of drinking water and, reduced fodder availability etc. Often a region adopts itself to a certain level of water shortage based on the long-term climatic conditions experienced by it. Any negative departure from these levels creates conditions of drought, depending on the intensity and duration of this deficit. Thus drought conditions differ from region to region.

Manuscript received December 15, 2013.

S.Manikandan, Civil Engineering, Veltech Engineering College, Chennai, India ,

P.Indiramma, Civil Engineering, Veltech Engineering College, Chennai, India,

T.Rajesh, Civil Engineering, Veltech Engineering College, Chennai,India.

II. OBJECTIVE

The main objectives of this project are,

1. To identify the Drought Prone Areas in Sivagangai Taluk and To study the Probability of drought prone zones
2. To identify the surface / Ground water potential
3. To study the Rainfall condition

III. STUDY AREA

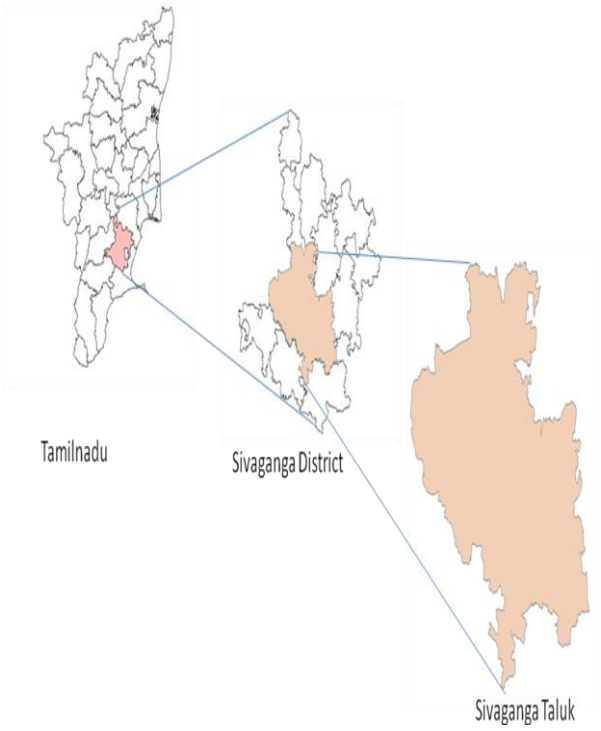

Fig 1. Study Area of sivaganga Taluk

Sivaganga Taluk of Tamil Nadu spreads over 1196 km². The geographical position of Sivaganga district is between 9º 43' and 10º 2' North Latitude and between 77º 47' and 78º 49' EastLongitude. It is bounded on the north and northeast byPudukkottai District, on the southeast and south by Ramanathapuram District, on the southwest by Virudhunagar District, and on the west by Madurai District, and on the northwest by Tiruchirappalli District

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

IV. METHODOLOGY

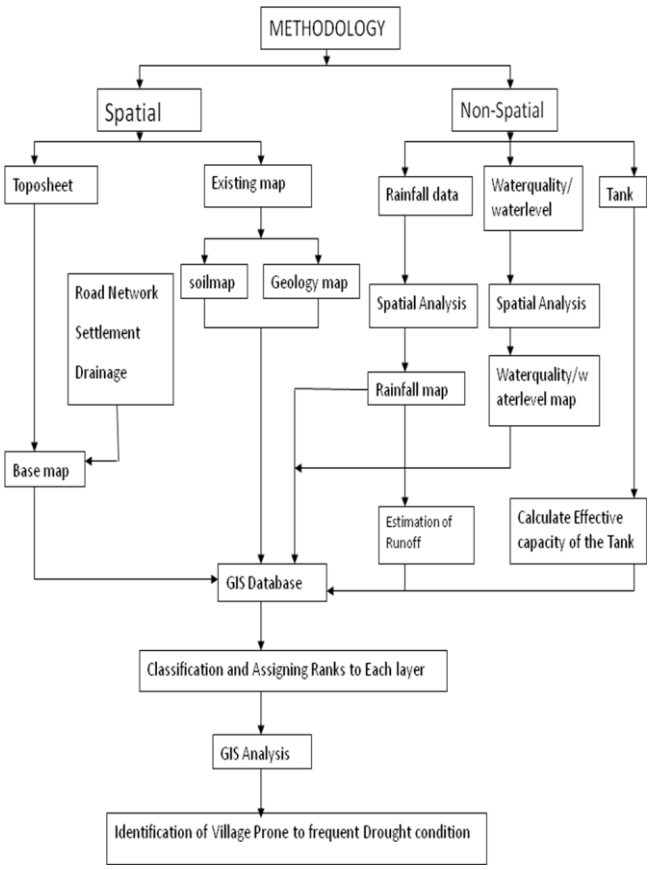

Fig 2. Methodology

V. RESULT AND DISCUSSION

A. Meteorological Drought

Most hydrologic problems require knowledge of the average depth of rainfall over a significant area. Some procedure must be used to connect the rainfall measured at rain gauges to areal averages. The average depth of rainfall also termed, as equivalent uniform depth of rainfall. it is never possible to determine exactly the average depth of rain fall over a given area. There are three methods of treating the rain gauge records to arrive at an approximate answer and in general the three methods give three different approximations. They are arithmetic mean, Thiessan weighted mean and isohyetal method. The first two methods are purely mechanical processes requiring no special skill or judgment on the other hand results obtained by the third method which perhaps should be most accurate, depend for their accuracy upon the good judgment of the person making the computation. There are 14 rain gauge stations functioning in this Taluk. There are Sivaganga, Thirupuvanam, Manamadurai, Ilayangudi, Thirupathur, Karaikudi, Karaikudi(S.RLY), Devakottai(Agri), Devakottai(PWD), Singampunari, Kalayarkovil Baganeri, Thiruvengampattu and Parthibanur. The average rainfall worked out for the taluk is based on the arithmetic mean of the said stations...10 years normal rainfall for the Taluk worked out to 804 mm in the present study the rainfall as published by IMD and given in the government website for sivagangai Taluk has been taken up for analysis.

The record from 1996 onwards shows normal rainfall (ie +/- 20% rainfall from the 10 years normal).the frequency of higher rainfall observed during 1996-2005 shows the following variation pattern. Above normal rainfall was observed continuously during 1997-1998and 2004-2005 during highest rainfall of 1300 mm was recorded during the year2005 and 675 mm was observed during the year 2005 northeast monsoon alone which is 142% excess of the normal rainfall. Over 1000 mm rainfall experienced for at least 4 years and 900-1000mm for 6 years from 1996-2005..above 801mm rainfall recorded at least for 2 years during this period. For at least 2 terms the above normal was recorded .continuously for 7 years and hence the water level and the potential would have been on higher side .the period between 1990- 2004 found to be of lesser rainfall and lower rainfall of 390mm recorded in the year 2004.

During the year 2005 the rainfall over this regime is excessive. The years 97-98,98-99 and 2004-2005 experienced above normal rainfall continuously for 2 years considered problem free years in respect of water resource potential. The impact of could have been experienced in successive years. The year 2002-2003 seems to be of very less rainfall period compared with other years. Monthly rainfall data for 1996-2005is shown .for finding out the effective dependable rainfall in this area, May, October and November experienced high rainfall compared with other months. the cumulative rainfall for the period indicates January and February are the lean months in which less than 20mm rainfall occurred for the for all 6 years. August, October, November and may are the months where more than 400 mm(cumulative)the rainfall occurred in these year. Individually 350 mm rainfall recorded during October 2005 and 251mm during November 2005. 223mm was recorded during may 2003.april and may experience considerable rainfall indicative of the revival of monsoon .altogether 26% of the total rainfall occurred in the month of October , which follows 17% in may and 15% in November. August and September experienced 11 and 10 % respectively and all other months contribute very less percentage. Highest contribution is derived in the month of October, which amounts to 32%.during the year 2000 more than 335mm rainfall was recorded

. Table 1. Average rainfall values in the RainGauge stations

Station name	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Sivaganga	917.4	1489	816	985.7	614.5	865.9	869.1	750	938.4	1288.8
Thirupuvanam	576.1	893.8	1137	764	709.6	480.8	880	615.1	1286.3	1624.6
Manamadurai	1058.2	1761.6	945.4	707.3	859.3	783.7	1121	708.5	914.5	952.6
Ilayangudi	668	731	875.4	578	643.6	774.6	539.6	603.4	816.2	1056.2
Thirupathur	1101.5	1030.2	1372.3	1120	769.8	822	584.9	505.6	1618.5	1996.6
Karaikudi	1193.7	1063.9	1160.4	1043	1132.2	998.6	953.6	749.2	960	1303.2
Karaikudi(S.RLY)	1159	1069.8	1068	881	1224	942.6	862.2	749.2	998	1425
Devakottai(Agri)	1242	1296.5	1474.5	681.4	1408	1363	1022.6	1067.8	1561.8	942.6
Devakottai(PWD)	860	969	1156	918.3	1081	912.5	830.8	661.5	1065.6	1118

Table 2, Spatial distribution of rainfall

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Drought condition	Area (km^2)
Severe	45.252
Moderate	228.09
Very mild	376.10
Mild	550.241

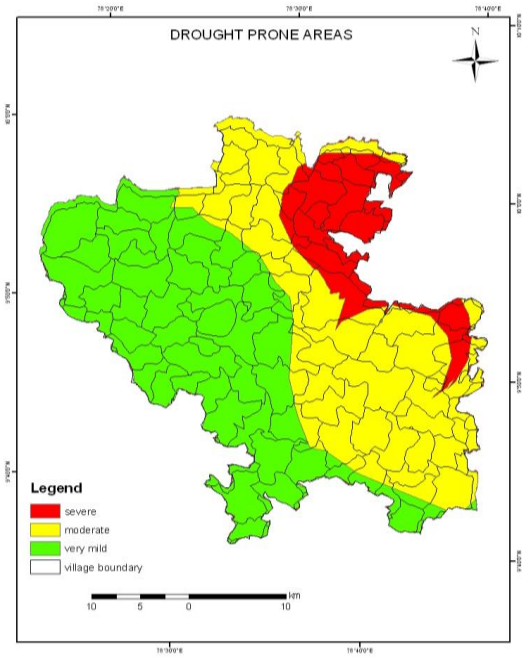

Fig 3. Topographic map of Drought Prone areas

The result shows severe drought mainly in the southern region covering 45.252 sq.km of the total area i.e., 1196 sq.km which is approximately 3.78%. The moderate drought mainly in the eastern region covering 228.09 sq km of the total area ie.,1196 sq km which is approximately 19.07%. The statistics of Meteorological drought shows that high drought class accounts 3.78% i.e., 45.252 sq.km of the total area, with mean average rainfall varying between 712.252mm-1300.844mm. The moderate and least drought areas are found extensively in the northern and eastern part of sivagangai Taluk.Paganeri,kadaneri,madagupatti,ammanpatti,nagaramp ati,panangudi,sembanur,nerpugapati are highly affected by the drought conditions with getting rainfall 0-381mm. The high drought occurs in kadaneri, paganeri,nerpugapatti, sembanur alone which covers an area12.54sq km,10.71sq km,0.456sq km and 0.36 sq km respectively. Very mild drought occurs in the western region of sivaganga taluk.
Increasing land use patterns, insufficient rainfall conditions and excessively drained conditions of the soils in these sivaganga Taluk are some of the reasons for the drought. If the above conditions prevail, there is a possibility of these high drought areas, converted to severe drought areas and further leading to desertification. Hence Action plan for drought management in these sivaganga Taluk is essential to mitigate the drought.

B. Hydrological Drought

31 observation wells have been identified for periodical water level monitoring (pre and post project intervention).its location with reference to geographical coordinates has been picked up using gps.31 open wells are identified. Based on the hydrogeological condition of the area a separate thematic map showing the spatial distribution of the observation wells has been prepared. The location of observation well and its details presented in important characteristics of the wells such us its depth ,size,shape,formation details, weathering thickness, intrusions observed and its thickness have been obtained to use it as a parameter while making further analysis. The bore well depth is ranging from 220m-280m and they have been drilled in different periods. Three of them located near the temple of which two bore wells have been abandoned. One bore well abandoned since it has failed to yield and the other one is not giving sustained yield. Hence the three bore well which is functioning now also unable to cope up with the present demand. Further the norm replenishment of deeper fractures on which the bore well depends makes the yield in adequate and non-sustainable during summer months. The open well-chosen are used for agriculture activities and most of them are power driven. The depth of wells ranging from 13.5m-22.7m bgl.some of the open wells found to be dry almost all the months before construction of the recharge shaft around the defund bore wells. The result shows severe drought mainly in the northern region covering 37.94 sq.km of the total area i.e., 1196 sq.km which is approximately 3.17%. The moderate drought mainly in the northern region covering 408.4 sqkm of the total area ie.,1196 sqkm which is approximately 34.15%. The statistics of hydrological drought shows that high drought class accounts 3.178% i.e., 37.94 sq.km of the total area, The moderate and least drought areas are found extensively in the southern part of sivagangai taluk. Perungudi ,Piravalur ,O.pudur ,Keelapoongudi, Nagarampati are highly affected by the drought conditions. The high drought occurs in piravalur alone which covers an area 14.91sqkm. Very mild drought occurs in the western region of sivaganga taluk

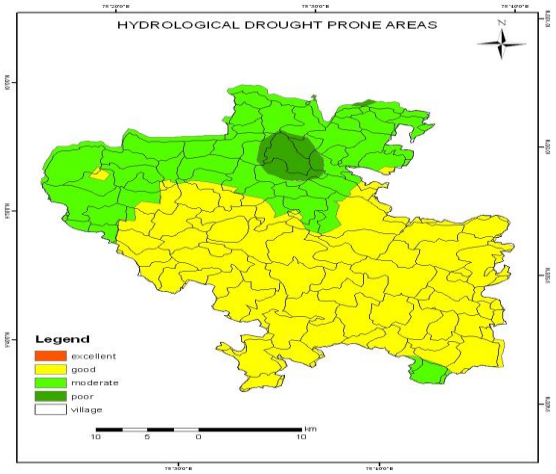

Fig 4. Topographic map of Hydrological drought prone areas.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Table 3, Spatial distribution of water level.

Water level	Area (km^2)
Excellent	0.089
Good	748.9
Moderate	408.48
Poor	37.94

C. Water quality map

The vulnerability of the surface water and ground water to degradation depends on a combination of nature landscape features , such us geology , topography and soil; climate and atmospheric contribution; and human activities related to different land uses and land management practices .more nitrogen and phosphorous can be used by crops and animals . all this growth puts great stress on the natural water resources , the ground water samples from the three drinking water sources and other observation wells have been tested for physical and chemical quality . The quality of the defunct sources found to be not potable during the pre-project period. TDS total hardness and calcium (ca)sulphate (so4)nitrate (no3) found to be excessive and makes the quality of the water not potable. Nitrate is found to be excessive in the defunct bore wells and in the public open well. These excess nutrients have the potential to degrade water quality if decorporated in to run off. The quality of the defunct bore well chosen for conversion as recharge bore well and existing drinking water source in use is found to be potable. The water quality data after the construction of the recharge shaft shows that a considerable improvement in the TDS and calcium in all the observation wells. Water sample analysis report reveals that TDS is excess in bore well 3 which is a defunct well taken for the executing the recharge shaft , and in all open wells except well no 13 .total hardness is excess in almost all wells, which shows excess TDS.

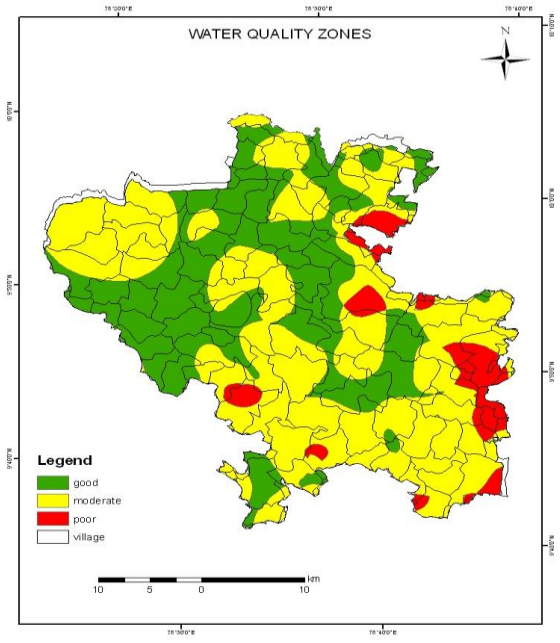

Fig 5. Map of water quality zones

Table 4. Spatial distribution of water quality

Water quality	Area (km^2)
Good	435.735
Moderate	658.566
Poor	76.64

VI. CONCLUSION

India being a tropical country with hot and humid climates and high temperature conditions. Delay in the monsoons as well as high evaporation rate of the surface water bodies is making some of the regions into drought areas. In particular sivaganga district is one of the drought prone district with reports of economic and human loss.

As the drought is dynamic in nature, which builds over a time, timely and reliable information is essential for effective drought monitoring and management. Satellite remote sensing provides multi-spectral, multi spatial and multi temporal data useful for drought monitoring, assessment and management.

The present study is a comprehensive evaluation and integrated analysis of drought, which has been carried out by using satellite based remote sensing and GIS techniques. The study area experiences semi - arid climatic conditions, with average annual rainfall of about 989.234mm. The maximum and minimum temperatures are 41.3°C and 13.4 C respectively.

The study was aimed at assessing the drought prone areas, based on the meteorological, hydrological parameters. Rainfall data, ground water data, water source area, soil and geomorphology data were used in assessing the various drought types as well as drought prone areas. The various drought prone areas were classified further into four different classes of drought.

According to the results, severe drought class accounts 3.78% i.e., 45.254 sq.km of the total area and out of which 24.06 sq.km was covered in kadaneri, paganeri, nerpugapatti, sembanur alone which covers an area12.54sqkm, 10.71sqkm, 0.456sqkm and 0.36 sqkm respectively.

Adverse climatic conditions may further convert these high drought prone areas to severe drought areas. Some action plans comprising of drought proofing works, employment generation programs and social security programs were discussed for managing the drought prone areas.

The present study of drought assessment and mitigation is an integrated approach of Meteorological drought, Hydrological drought. The study, though having some limitations, is an ideal approach for drought analysis, as the meteorological, hydrological parameters are interrelated for any prevailing conditions of drought conditions.

REFERENCES

1. Saenjan. P., Ganier. B.J., Maclean. P.A., 1990. Patterns of Wet Season Rainfall in Northeast Thailand In Proceedings of the Seminar on Remote Sensing and GIS for Soil and Water Management. Khon Kaen : Khon Kaen University, p 180-p 202. Siripon. K., and Mongkolsawat. C., 2000. Spatial and Temporal Analysis of Rainfall Pattern in Northeastern Thailand : Application of GIS. Journal of Remote Sensing and GIS Association of Thailand. Vol.1, No.1, p.1-p 18.

2. Wongvitavas.P., 1993. Rainfall Analysis in Northeastern Thailand. Bangkok Meteorological Dept, Technical Document No.551.577.3-01, 99p.
3. Palmer., 1965. Meteorological Drought, Office of climatology, Washington D.C., U.S. Weather Bureau, Research paper No 45, 58p.
4. Rig, D.J., 1985. The role of environment in limiting the adoption of new rice technology in Northeast Thailand. Transs. Inst. Br, Geog. N.S.10. p 481-494.

AUTHORS PROFILE

S. Manikandan was born in sivaganga Tamilnadu. He has completed M.Tech in Remote sensing under Anna university Trichy. Presently working as an Assistant Professor in Veltech Enginnering college, chennai since 2011. His research interest towards in the field of Remote sensing and GIS

P. Indiramma, has completed B.E and M.Tech in Geotechnical Engineering under S.V.university,Tirupati. She has around 6 years of teaching experience working as an Assitant Professor in Veltech engineering college ,Chennai.

T. Rajesh, was born in Madurai Tamilnadu. He has completed M.Tech in Remote sensing under Anna university Trichy. Presently working as an Assistant Professor in Veltech Enginnering college, chennai since 2010. His research interest towards in the field of Remote sensing and GIS