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Sustainable Water Resources in sps Nellore District: A Geographical Analysis

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Abstract

Water is precious natural resource for sustaining life and environment. Effective and sustainable management of water resources is vital for ensuring sustainable development. In view of the vital importance of water for human and animal life, for maintaining ecological balance and for economic and developmental activities of all kinds, and considering its increasing scarcity, the planning and management of water resource and its optimal, economical and equitable use has become a matter of the utmost urgency. Sustainable water resources in India is of paramount importance to sustain one billion plus population. The water resources management practices should be based on increasing the water supply and managing the water demand under the stressed water availability conditions. For maintaining the quality of freshwater, water quality management strategies are required to be evolved and implemented. Decision support systems are required to be developed for sustainable water development in Nellore District. There is interplay of various factors that govern access and utilization of water resources and in light of the increasing demand for water it becomes important to look for holistic and people-centered approaches for water management. Safe drinking water can be assured, provided we set our mind to address it. The present article deals with the review of various options for sustainable water resource management in Nellore. Nellore district is one of the 9 coastal districts and it is situated in the south eastern part of Andhra Pradesh. Agriculturally it is an important district. The district has a coastline of 169 km. It is endowed by good rainfall and surface water.

Keywords: Sustainable; Water resources; Disaster prone area; Climate conditions and drainage system

Introduction

Sustainable water resources in India is of paramount importance to sustain one region population. The water resources management practices should be based on increasing the water supply and managing the water demand under the stressed water availability conditions. For maintaining the quality of freshwater, water quality management strategies are required to be evolved and implemented. Water is natural resource and abundant available as surface and ground water. Oceans cover about $\frac{3}{4}$ of earth's surface as per United Nations estimation the availability of water on earth is about 1400 million cubic k.m.

Surface water resources consists of frozen water in polar regions, oceans, seas, lakes, rivers, canals reservoirs, tanks and ponds derelict water and brackish water etc. The water resources are exploited for irrigation, hydro power, drinking purpose navigation water ways, industrial water supply.

Water is essential for human life, development and environment, but it is a finite and vulnerable resource which has quantitative limitations and qualitative vulnerability. As People Action International (PAI, 1997) states, water is the source of life and development on earth. Life is tied to water, air and food, while food is tied to water. Water is a regional resource, but water shortage is becoming a global issue due to increasing population, economic growth and climate change.

Development of new sources of water beside its efficient use, together with conservation measures, should be an important component of any country's national water plan. The Nellore district is divided into five revenue divisions viz., Nellore, Gudur, Atmakur, Nayudupeta and Kavali. Further these revenue divisions are divided into 46 revenue mandals.

This district has a road length of 8284 Km, out of which roads with a length of 361 Kms are formed with Cement concrete whereas roads with a distance of 4498 Kms and 642 Kms are blacktop and metalled leaving a remaining length of 2783 Kms as unmetalled. The National Highway i.e., Chennai to Kolkatta passes through the district more or less parallel to the broad guage Railway line from Chennai to Howrah.

Identification and analysis of resources is dire need of the hour. Because, identification, analysation and representation of resources helps in development of decision support system during emergency, rescue operations and developmental activities. As far as water resources are concerned, we should analyze, identify and develop sustainable management activities. SPS Nellore district is known for varied terrain as well as weather/climatic phenomena. Hence, analysis of water resources place a dominant roe in managing water resources for sustainable development. There are good number of studies on water resources. But, the study area lacks in such studies. Hence, an attempt is made in the present paper.

Importance of the study

The quality of water is as important as quantity. Water from shallow as well as deeper aquifers of consolidated formations of the district is generally good. In general water is suitable for domestic, industrial and irrigation purposes, except in Kondapuram and Kaluvoya areas, where EC values are more than permissible limit exist. Coastal salinity is the major problems in the deltaic area of the district. In the deltaic area the fresh to brackish/ saline water occur in hydraulic contact with fresh ground water. The quality of water varies widely from place to place even within short distances and the deeper aquifers are invariably saline. The salinity of water is caused mainly due to depositional environment and other factors like geomorphic landform, excess use of fertilizers and unregulated growth of aquaculture in the coastal area which also play an important role.

In the northeastern part of the district seasonal water logging conditions exist. In the northwestern part of the district concentration of fluoride higher than permissible is also a considerable problem. Localized Nitrate pollution is another problem in the district, which is due to excess use of fertilizers, urban sewerage disposal and improper drainage system.

Study Area

The district lies between North latitude of 13° 30' and 15° 05' and East longitudes of 79° 05' and 80° 15' with an aerial extent of 13,076 km. It is bounded by the Bay of Bengal with a coastal length of 163 km on the East, Kadapa district on the West, Prakasam district on the North, Chittoor district on the southwest and Chengalpat district of Tamil Nadu state on the southeast. Chennai - Howrah broad gauge railway line and NH-5 runs across the district almost parallel to the coastline. India's prestigious and only satellite launch center known as SHAR is stationed at Sriharikota Island.

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Nellore town is the district's headquarters. The district is divided into five revenue divisions viz., Nellore, Gudur, Atmakur, Nayudupetaand Kavali. Further these revenue divisions are divided into 46 revenue mandals. There are 5 towns 1201 villages in the district.The district has one major (Pennar River Canal System) and five medium (Telugu ganga, Somasila, Kanpur canal, Gandipalem project and Swarnamukhi Barrage) irrigation projects.

To assess water resources in a region, two concepts based on water exchange characteristics are often used in hydrology and water management: a resource is defined as having static storage and renewable components. Static storage includes freshwater with a period of complete renewal taking place over several years or decades such as large lakes, groundwater, or glaciers. Intensive use of this resource inevitably results in depleting the storage components and has adverse consequences. It also disturbs the natural equilibrium established over centuries. Its restoration may require tens or hundreds of years. The renewable component replenishes annually which includes runoff from rivers within a specific region or from external sources, including groundwater inflow to a river network. In practice, the value of river runoff is used to estimate water availability and/or deficit in water resources for our region.

Methodology

The present research paper is based on analysis method. The analysis is purely based on the secondary sources that are available from the Government departmental manuals, data and brochures, reference books, journals article and online

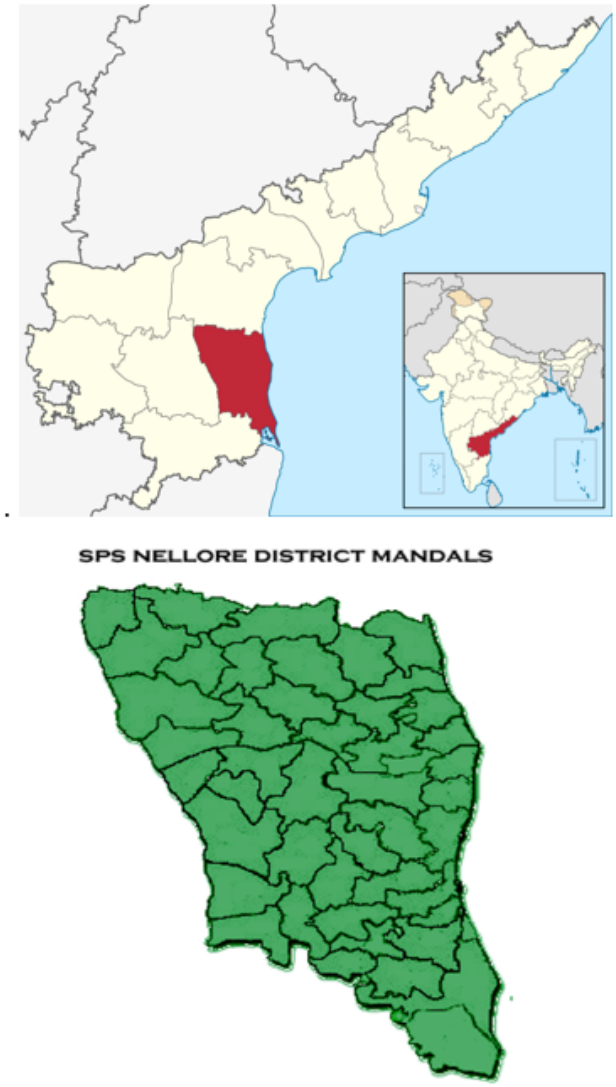

Fig. 1. Nellore District – Location map

resources and presented for five years i.e, from 2011-12 to 2015-16. Analyze have been tabulated and converted into diagrams and maps. GIS techniques for visualizations any suitable statistical techniques were used.

Objectives

The main objectives of present study area is sustainable water resources in Nellore District. In this study go through the overall water sources available for maintain sustainable water resources in Nellore District.

- To identify water resources in Nellore district.
- To study the drainage system of the study area.
- To analyze the rainfall and climate variations.
- To assess the sustainable water resources of the study area.

Hypothesis

- Study of water resources and drainage system will enhance the scope for sustainable development.
- An increase analysis of climate and rainfall focus on further decision support system for sustainable development in water resources.

Analysis

Studying the above objectives of the water resources available for maintain sustainable water resources in Nellore District. These are the results.

Drainage System

The manner in which the water of an area pass or flow off by ”surface streams or subsurface conduits” or a ’kollective term for the streams, lakes and other bodies of surface” water by which a region drained is called drainage. Drainage acts as a resource by providing water to the agricultural, industrial and other domestic purposes. Thus the study of drainage as a resource is essential. The topography of the district is hilly and undulating on the western side and plain on the eastern side, Surface water resources like canals are less towards the western side due to hilly region and are more in the plains on the eastern side. The western hilly ranges of the district are the main sources for the formulating sf numerous streams and rivulets. A number of rivers originate in the semi-arid zone of wester11 ghats remain dry during the major part of the year. They flow during heavy rains for a few days and remain dry for further out lashing of rains. Most of these rivers are non-perennial.

The Pennar is the major river which drain in the middle of the district. The other important rivers flowing in the district are Swarnamukhi, Manneru and Upputeru. All the rivers are non-perennial, flowing in the eastern directionand joins the Bay of Bengal. The general pattern is dendritic to sub-dendritic.

The drainage density varies from less than 1 to 3 km/km^2. Pulicatlake is located in the south eastern part of the district. Pulicat Lake is the second largest lagoon of India and boasts of a rich biodiversity. Therefore, the lagoon has been preserved as a Wildlife Sanctuary. It straddles the border of Tamil Nadu and Andhra Pradesh states. The lake is separated from the Bay of Bengal, by an inland spit called the Sriharikota Island. The lake has a length of 60 km and a breadth of 0.2 to 17.5 km. It has a high water spread of 460 sq. km and low water spread area of 250 sq. km with an average depth of one meter. The lake is drained by three larger inflows (Swarnamukhi, Arani and Kalangi) and many minor inflows. It is connected with

an estuary mouth with a width of 200 meters. Owing to its proximity to the sea, it has turned into a salt-water lagoon.

Rainfall & Climate

District lies in an area of precarious and uncertain rainfall. As such the climate of the district is generally dry and salubrious. Generally April, May and June are the hottest months with highest maximum temperature recorded was 39.70C in May whereas the temperature is low in the months of January and February and the minimum temperature recorded was 21.40C in January during 2015-2016.The normal rainfall of the district is 1080.4 m.m. During the reference year 2015-16, the actual quantum of rainfall received was 1358.0 m.m. The major portion of the rainfall is received during the North East Monsoon period to an extent of 952.2 mm.

The climate of the district is moderate and characterized by sub-tropical climate. The period from December to middle of February is generally the season of fine weather. The summer season is from March to May. This is followed by monsoon period from June to September, the post monsoon from October to December and the winter season from January to February. The maximum temperature is 36-46c during summer and the minimum temperature is 23-25c during winter. The rainfall ranges from 700–1000 mm through South West and North East Monsoons. Nellore is subjected to both droughts and floods based on the seasons. The annual normal rainfall of the district is 1084 mm.

The peculiarity of this district is that contribution of SW monsoon is far less than the contribution of NE monsoon rainfall. About 70% of the annual rainfall is contributed by the NE monsoon. In general the amount of rainfall is increases from west to east about 900 to 1300 mm in the district. The mean daily maximum temperature in the district is about 38°C in May and the mean daily minimum temperature is about 20°C in December/ January. Temperature in the district begins to rise from the middle of February till May. With the onset of southwest monsoon in June, the temperature decreases to about 20°C and is more or less uniform during the monsoon period. The relative humidity ranges from 60 to 80% in the mornings, whereas in the evenings it varies from about 45 to more than 70%. The annual rainfall during 2016 is 889 mm.

Water Resources

Water resources development around the world has taken different forms and directions since the dawn of civilization. Humans have long sought ways of reducing their vulnerability to irregular river flows and variable rainfall by moving, storing and redirecting natural waters. Early civilizations expanded in regions where rainfall and runoff could be easily and reliably tapped. He adds that the growth of cities required advances in civil engineering and hydrology as water supplies had to be brought from distant sources. In general, there are two classes of method for developing new sources of water supply:

1. The traditional approach to construct wells, dams, reservoirs, canals and pumps over the years to collect, control and contain excess flows and to distribute water on demand during different periods. They help to change the world's varying water resources into reliable and controlled supplies. As a result, most water users take for granted that unrestricted quantities of freshwater are instantaneously available to them on demand.

2. Un-conventional and exotic methods. Limited water availability and public resistance to the high financial and environmental costs of the traditional approaches have forced suppliers to consider alternative approaches such as recycling wastewater and desalination together with more exotic schemes such as cloud seeding, fog collection and towing icebergs.

Table 1. SPS Nellore District - Annual Rainfall Division Wise

Division name	Nor-mal	2011-12	2012 - 13	2013 - 14	2014-15	2015-16
Kavali division	1075	1094	717.6	684.8	514.5	1203
Nellore division	1106	1130	755.7	886.7	548.9	1482
Gudur division	1106	1072	1026	771.4	721.8	1547
Athmakur division	949.4	897.2	726.6	591.9	585.8	1104
Naidupet division	1219	1189	1163	873.7	826.4	1483
Total	1080	1066	848.1	758.9	620.2	1358

Source: Chief Planning Officer, Nellore

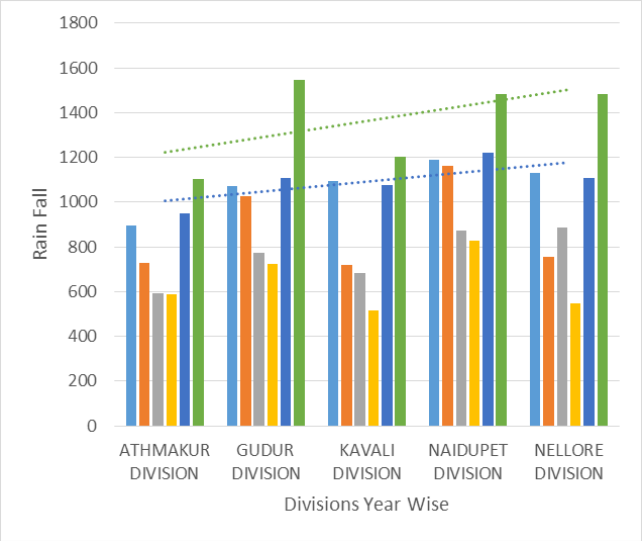

Fig. 2. Nellore District - Annual Rainfall Division wise

The Principal Rivers are Pennar and Swarnamukhi. The other streams are Kandaleru and Boggeru which are occasionally torrential in Character during rainy season. The rivers and rivulets remain dry for major part of the year and carry floods during rainy season. Pennar river is the most important one and flows for about 112 Kms in the district which serve as a boon to the eastern half of the Taluks of Nellore and Kovur. Two anicuts are situated one at Sangam and the other at Nellore.

During the agricultural year 2015-16, the Net irrigated area in the district is 3.08 lakh hectares out of Net Cropped area of 4.38 lakh hectares. The Net area irrigated in the district by canals, tanks and tube wells & filter points is 1.44, 0.81 and 1.02 lakh hectares respectively. An extent of 0.07 lakh hectares is irrigated under other wells apart from 0.03 lakh hectares under lift irrigation and other sources put together. The gross area irrigated is 3.40 lakh hectares which is inclusive of 0.32 lakh hectares under area irrigated more than once.

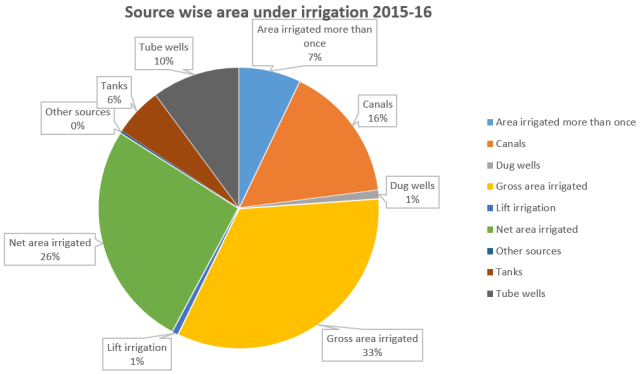

Fig. 3. Area irrigated under different sources (in hectares)

Table 2. Source of irrigations

S.No.	Source of irrigation	2011-12	2012-13	2013-14	2014-15	2015-16
1	Canals	133901	132154	99795	141617	143757
2	Tanks	80675	73220	64813	50127	81340
3	Tube wells	100660	100952	110535	90564	102464
4	Dug wells	14332	12692	12413	8294	6829
5	Lift irrigation	4061	5293	5465	5457	3109
6	Other sources	1676	2081	2448	2034	2963
7	Gross area irrigated	335305	326392	295469	298093	340462
8	Area irrigated more than once	70334	57435	37497	63670	32539
9	Net area irrigated	264971	268957	257972	234423	307923

Source: Chief Planning Office, Nellore

Recommendations& Suggestions

• Water should be judiciously exploited in the shallow fresh water aquifers of coastal area without disturbing the fresh/saline water interface.

• In the limited fresh water potential areas and in the critical and over-exploited areas, modern irrigation methods like drip and sprinkler irrigation should be adopted to increase the command area of the wells.

• The aqua culture development should be restricted to areas close to the coast line only. The practice of converting agricultural lands in the inland areas should be stopped to avoid the pollution of fresh water aquifers.

• Conjunctive use of surface and water needs to be planned in the command area, particularly in the deltaic region, to prevent the water logging conditions and to improve or to avoid further deterioration of quality of water.

• Artificial recharge measures should be adopted in the urban areas, in the deltaic area and in areas with considerable exploitation of water particularly in semi-critical, critical and over-exploited mandals for improving the water situation.

Conclusion

Based on this study decision support systems are required to be developed for sustainable water resources in Nellore District. There is interplay of various factors that govern access and utilization of water resources and in light of the increasing demand for water it becomes important to look for holistic and people-centered approaches for water management. Safe drinking water can be assured, provided we set our mind to address it. The present article deals with the review of various options for sustainable water resource management in Nellore.Based this article we can implement easily in water development programs like Neeru – Chettu, Vanam-Manam.

A multi-sectoral approach is needed to study the water development, augmentation and management perspective. Therefore, all the aspects related to water, involvement of NGOs and mass awareness campaigns will play an important role in conserving and developing the precious sustainable water resources.

Table 3. Annual Rainfall Mandal Wise last five years

S.No.	Mandal	Normal	Actual				
			2011-12	2012 - 13	2013 - 14	2014-15	2015-16
	Kavali division						
1	Varikuntapadu	884.6	805.6	562.6	280.6	551.3	785.2
2	Kondapuram	1008.4	1158.6	564.4	483.2	430.9	1103.5
3	Jaladanki	1233.2	1140.5	668.4	751.6	469.7	1168.1
4	Kavali	1192.5	1186.4	806.2	986.0	495.1	1104.8
5	Bogole	1123.4	1127.1	824.5	777.8	531.7	1303.1
6	Kaligiri	981.9	928.7	828.7	516.8	512.8	1180.1
7	Duttalur	1024.2	1083.8	643.0	722.6	376.9	939.8
8	Dagadarthi	1089.4	1134.1	792.0	719.4	637.5	1540.8
9	Allur	1133.7	1279.0	769.0	925.6	624.3	1697.8
	Sub-total	1074.6	1093.8	717.6	684.8	514.5	1202.6
	Nellore division						
10	Vidavalur	1140.5	1249.5	718.2	1087.0	501.5	1443.3
11	Kodavalur	1036.5	936.6	632.5	1106.6	338.7	1279.2
12	Buchireddipalem	1091.3	976.2	642.2	827.1	660.0	1372.2
13	Rapur	1074.9	893.8	1041.8	580.4	518.6	1478.5
14	Podalakur	1064.6	999.9	807.0	555.2	523.8	1434.1
15	Nellore	1140.9	1262.0	667.2	983.0	558.1	1484.9
16	Kovur	1094.7	1065.1	788.2	909.2	712.9	1521.0
17	Indukurpet	1143.1	1308.8	572.2	1004.0	504.9	1589.7
18	Thotapalligudur	1178.8	1247.6	611.4	1027.0	404.7	1288.1
19	Muthukur	1216.4	1363.6	720.0	948.8	585.5	1618.3
20	Venkatachalam	1071.9	1049.6	903.7	703.0	548.5	1576.9
21	Manubolu	1014.6	1094.4	964.0	909.6	729.5	1699.8
	Sub-total	1105.7	1130.3	755.7	886.7	548.9	1482.1
	Gudur division						
22	Gudur	995.7	1003.2	1128.4	916.7	646.1	1709.4
23	Sydapuram	1057.6	922.7	1056.0	783.9	591.8	1695.4
24	Dakkili	1034.2	847.4	939.9	439.8	653.9	1382.3
25	Venkatagiri	1213.0	1396.3	1160.8	489.6	692.0	1754.6
26	Balayapalle	1102.0	970.2	1173.2	739.2	619.6	1872.5
27	Chillakur	1015.4	916.6	1046.6	863.0	717.3	1427.5
28	Kota	1240.5	1172.1	1045.4	986.4	912.1	1603.2
29	Vakadu	1205.7	1278.4	877.2	939.6	1004.9	1360.5
30	Chittamur	1090.8	1137.6	804.4	784.0	658.6	1116.2
	Sub-total	1106.1	1071.6	1025.8	771.4	721.8	1546.9
	Athmakur division						
31	Seetharamapuram	953.2	971.8	759.0	613.4	509.2	640.4
32	Udayagiri	1033.7	860.8	751.0	720.0	401.8	805.4
33	Vinjamur	938.5	1150.8	875.0	732.8	673.6	1042.2
34	Marripadu	911.6	819.7	652.5	536.2	559.3	1041.9
35	Atmakur	918.7	903.8	710.2	702.6	1024.0	1358.0
36	Anumasamudrampeta	907.0	882.0	625.0	431.0	535.6	1118.4
37	Sangam	919.3	981.5	774.1	822.4	707.0	1457.8
38	Chejerla	934.8	753.0	722.4	391.8	410.1	1211.6
39	Ananthasagaram	902.8	736.9	607.2	450.8	548.1	1083.0
40	Kaluvoya	1073.9	911.8	790.0	518.0	489.6	1281.4
	Sub-total	949.4	897.2	726.6	591.9	585.8	1104.2
	Naidupet division						
41	Ojili	1088.3	1212.0	1017.2	862.3	727.8	1606.3
42	Naidupet	1064.2	1100.0	952.3	945.5	798.1	1518.4
43	Pellakur	1129.2	1158.4	1162.6	659.4	750.4	1361.2
44	Doravarisatram	1306.3	963.0	1206.4	946.0	724.8	1295.7

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Table 3 continued

45	Sullurpeta	1331.7	1322.0	1097.8	857.4	858.9	1446.4
46	Tada	1395.2	1381.0	1542.6	971.8	1098.3	1668.3
	Sub-total	1219.2	1189.4	1163.2	873.7	826.4	1482.8
	Total	1080.4	1066.2	848.1	758.9	620.2	1358.0

Annual Rainfall Mandal Wise last five years

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