International Journal of Research, Science, Technology & Management
ISSN Online: 2455-2240, Vol 6 Issue I, January 2017

AN INTEGRATED APPROACH FOR WATER RESOURCES ASSESSMENT AND MANAGEMENT

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ABSTRACT: ***There are 34 river basins in Tamil Nadu. For hydrological studies they are grouped into 17 river basins. The Nambiyar basin is one of them. This paper deals with assessment of Water Resources (Surface water & Groundwater) scientifically using the latest technology available and computing the sectoral demands for various sectors like, domestic, agriculture, industries, livestock, power generation for the present and future planning of Nambiyar river basin for the benefit of the society in an integrated manner. MRS (Monthly Runoff Simulation) model was used to assess Surface water potential. Based on the Ground water Estimation Committee Norms groundwater potential was assessed. Total water potential of the basin was thus arrived. The water demand for various sector also assessed scientifically. By using the results of the total water potential (Surface water & Groundwater) and demand, the water balancing was arrived. by deploying the River Basin Simulation Model for Tamil Nadu (RBASIMTN Model). Environmental issues and socio economic problems in the basin are also analysed. Water potential, demand, deficit and management aspects are discussed in this paper.***

1. INTRODUCTION

The earth is known as "Blue Planet" or "Water planet". The presence of water makes it unique and is the sole reason for the sustenance of life on the earth about 70.7% of the earth is covered by water and the remaining is land. However, out of this vast coverage of water only 1% is available for human consumption. The remaining 97% of water is in the ocean and 2% in the Polar regions in the form of glaciers. The 1% consumable quality of water is available on the surface of the earth as well as underground. In Tamil Nadu nearly 98% of the surface water resources and 73% of ground water resources have been exhausted. Unless we have better planning to harness, to conserve, manage and utilize the water resources, we have face a day of severe crisis for water. This has necessitated the micro level planning of the water resource river basin wise. There are 34 river basins in Tamil Nadu. For hydrological studies they are grouped into 17 river basins. The Nambiyar River basin is one among them. This paper deals with the Water Resources Assessment and Management of Nambiyar River Basin in an integrated manner.

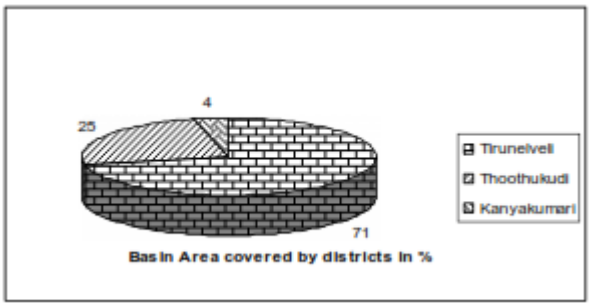
2. OBJECTIVES

The main objective of this paper is to assess the Water Potential (Surface water & Groundwater) scientifically using the latest technology available related to water resources, computing the sectorial demands for various sectors like, domestic, agriculture, industries, livestock, power generation, etc; and find out the water balance for the Nambiyar basin. This enables to identify the future problems the basin has to face and probable solutions for the same.

3. STUDY AREA

The study area chosen here is Nambiyar river basin. Nambiyar river basin covers an area of about 2018.4 sq.km in part of Kanyakumari,

Tirunelveli and Thoothukudi districts of Tamil Nadu. The total extent of the area falls within the administrative boundaries of 6 taluks and 10 blocks of which 3 blocks are full and the remaining 7 blocks are part.



This basin is sandwitched between Tamiraparani basin on the north and Kodayar basin on the west. Physiograpically, Nambiyar basin is divided into western hilly region and eastern plain undulating topography. Western hilly region extents from Agsthayarmalai in the north and Kanyakumari town in the south and it acts as the western boundary of the basin. All the rivers flowing from the eastern slope of Western Ghats at various altitudes. A Stream from the east of Kalakkadu village joins with the Manimuthar Main canal and surplus from Vijayanarayanam tank forms the Karamaniyar river. Numerous streams in the downstream joins the river Karamaniyar. Its width is increasing from Sathankulam till its end. The river, Nambiyar originates in the eastern slopes of the Western Ghats near Nalikkal Mottai about 9.6km west of Thirukkarangudi village at an altitude of about 1646 m above MSL. Kalankal odai is a tributary of Nambiyar river which originates near Kannanallur area, after traversing 6.5km and finally it joins Nambiyar at 37th km near Kovankulam. Hanumanadhi originates in the eastern slopes of the western ghats at an altitude of 1100m above MSL in the Mahendragiri hill region. Uppar river originates in the eastern slopes of the western ghats near Takkumalai east forest at an altitude of about 808m above MSL. The entire basin is divided into 3 sub basins.

Name of the Sub basins and the geographical area

Sl.No	Name of the sub basin	Area (Sq.km)
1	Hanumanadhi	510.179
2	Nambiyar	604.324
3	Karamaniyar	903.937

3.1 GEOLOGY AND STRUCTURE

In Nambiyar river basin, rocks of khondalite and charnockite groups of Archaean age are found in major part of the basin area. Migmatite gneiss of Archaean age also occur in the plains. The coastal plains host rocks of Misocene, Quaternary and Recent age. In the eastern part of the basin, a few outcrops of hard marine sand stone and shell limestone with intercalations of pebble beds of miocene age are found. Teri sands occur north of

Tisaiyanvilai (Ittamali Teri) and Northeast of Sattankulam (Kudiramoli Teri) with a considerable thickness ranging from 20 to 35 m. These are reddish in colour and medium to coarse grained.

3.2 SOILS

The predominant soil types found in this river basin are Inceptisols, Alfisol, and Entisol. Northwestern part of Namibyar sub basin rock outcrops and fine loamy soil are found. Most of the basin area consists of sandy and fne loamy soil. In southern part of the Nambiyar sub basin salt affected lands are found.

4. METHODOLOGY

The complex problem of planning the Water Resource can only be solved if it is broken down into independent problems, which can be dealt with effectively. In that respect, river basins are suitable units of planning as they form cohesive entities in terms of water resources. In the similar manner Nambiyar basin area is grouped into 3 sub basins. Water Resources planning is people oriented and resources based. Data relating to geomorphology, hydrogeology, hydrology, Climatology, water quality, environment, socio economic, agricultural, population, livestock, industries, etc. are collected for analysis. For the sake of consistency, all other types of data are treated in the same way. Socio economic, agricultural and live stock statistics which are available in administrative units are converted into river basin units, in proportion to the area contained in the respective river basin. Water Resources planning follows a resource based approach to development especially for attaining self-sufficiency in food production. Based on the above principle, assessment of water resources, water demand and water balance of the basin are prepared. This water balance indicates the level of utilization of water resources for various sectoral demands and finally shows if the basin is a surplus or deficit basin.

4.1 CLIMATE

The details of average climatic data for the stations are tabulated below:

Climatological Parameters

Sl. No.	Climatological Factors	Aralvaimozhi
1.	Average monthly temperature in Celsius a). Max. b). Min.	 33.16 25.65
2.	Average mean temperature in Celsius	29.25
3.	Average Relative Humidity in %	68.56
4.	Average Wind Speed in Kmph	9.32

4.2 RAINFALL

There are 16 non-recording raingauge stations in and around the basin. Considering the distribution of raingauge stations and the availability of data, only 9 raingauge stations having long term records in and around the basin are considered for the detailed analysis.

Sl.No.	Raingauge Station	Taluk	District
1.	Aralvaimozhi	Thovalai	Kanyakumari
2.	Nanguneri	Nanguneri	Tirunelveli
3.	Radhapuram	Radhapuram	Tirunelveli
4.	Nelaparai	Nanguneri	Tirunelveli
5.	Kalakkadu	Kalakkadu	Tirunelveli
6.	Sathankulam	Sathankulam	Thoothukudi
7.	Srivaikundam	Tiruchendur	Thoothukudi
8.	Tiruchendur	Tiruchendur	Thoothukudi
9.	Kulasekarapattinam	Tiruchendur	Thoothukudi

The rainfall for 30 years and above period for the above stations were taken and analysed, 75% dependable rainfall, monsoon wise have been found out using the formula M/(N+1) and tabulated below:

75% dependable rainfall for Nambiyar river basin

Nambiyar river basin 75% dependable Rainfall in mm	Southwest	Northeast	Winter	Summer	Annual
	56	286	2	66	553

The annual maximum rainfall varies from 1075 mm to 1599 mm and the minimum varies from 47mm to 392mm. The annual average rainfall varies from 618 mm to 776mm for the basin. The entire Nambiyar basin comes under Semiarid except 2 stations in Radhapuram and Srivaikundam which are coming under arid region.

4.3 RIVER SYSTEMS

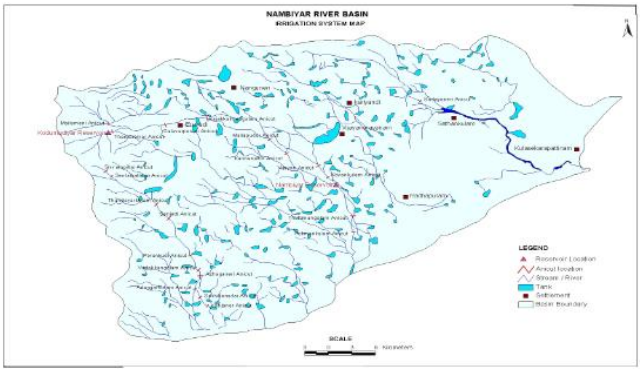
The basin is drained by the major river Nambiyar and other three separate minor rivers known as Karumeniar, Hanumanadhi and Uppar. There are two Reservoirs in this basin namely Kodumudiyar and Nambiyar. There are about 559 system tanks and 38 non- system tanks by which 33,615 ha are being irrigated. The approximate storage capacity of these tanks is 94.54 Mcm. Hence the approximate total storage capacity of tanks and reservoirs in this basin is 100.45 Mcum.

4.4 SURFACE WATER POTENTIAL

There is one gauging station maintained by PWD which is at Pulimankulam Anicut. The Surface Water Potential is assessed by using Monthly Runoff Simulation Model. The monthly weighted rainfall of each sub basin, evapotranspiration values and sub basin area are given as input of the model. From the measured flow at the nodal points the model is simulated to the basin by adjusting various factors like runoff coefficient, fraction of impervious area, evaporation adjustment factor etc. The potential is assessed sub basin wise and the total surface water potential is assessed.

Sl. No.	Name of Sub basin	75% Dependable Surface Water Potential in Mcum			
		SW	NE	NM	Annual
1.	Hanumanadhi	5.96	28.63	7.22	41.81
2.	Karamaniyar	6.05	61.11	18.92	86.07
3.	Nambiyar	7.22	43.61	24.42	75.26

Surface Water Potential of Nambiyar Basin is 203 Mcum.



4.5 GROUNDWATER OCCURRENCE

The appraisal of Ground water occurrence is based on the analysis of lithological log data of the 29 observation wells and other deep bore wells along with the water level fluctuation data of the shallow observation wells and of the deeper bore wells.

4.6 Groundwater Potential

4.6.1 Methodology of Groundwater Assessments

The methods of evaluation of groundwater potential are based mostly on water level fluctuations and specific yield approach. This methodology is also applied by the CGWB and the GWD to assess groundwater potential.

The Groundwater Estimation Committee constituted by the Government of India has also recommended norms and standards for specific yields of different types of geological formations in the zone of water level

fluctuation (2% to 4% for granites and 1 to 3% for weathered rocks), seepages and return flows from canals and irrigation, well abstraction, etc. The groundwater extraction is worked out based on the cropping pattern and the existing number of wells.

Groundwater potential = Specific yield x {water level fluctuation x influencing area}

Based on the above method ground water potential of Nambiyar river basin is worked out as 163 MCM.

Stages of Groundwater in Nambiyar Basin (blocks wise)

Sl.No.	DISTRICT	BLOCK	LEVEL
1	Tirunelveli	Kalakkadu	Safe
2	Tirunelveli	Valliyur	Over Exploited
3	Tirunelveli	Radhapuram	Over Exploited
4	Tirunelveli	Nanguneri	Safe
5	Kanyakumari	Thovalai	Safe
6	Kanyakumari	Agastheeswaram	Safe
7	Tuticorin	Alwarthirunagar	Semi Critical
8	Tuticorin	Tiruchendur	Semi Critical
9	Tuticorin	Sattankulam	Over Exploited
10	Tuticorin	Udankudy	Over Exploited

4.7 TOTAL WATER POTENTIAL IN NAMBIYAR BASIN

The total surface water potential available 203 MCM. The total Groundwater potential available is 163 MCM.

Total water potential of Nambiyar River Basin 366 MCM

5. ASSESSMENT OF DEMANDS

5.1 IRRIGATION WATER DEMAND

The present gross irrigated area in the basin under different crop is 34707 Ha. Under irrigated conditions, Paddy (20421 ha) is the main crop irrigated in this basin, followed by Coconut (3739 ha), Banana (3492 ha), Vegetables (3119 ha), Groundnut(1745ha), Cotton (1143 ha) and chillies, Onion, Flowers, Pulses, Gingelly, and

Sugarcane are also grown. Rainfed area in this basin is about 12100 Ha. The average data on irrigated area for various seasons, for indicative planting dates, were collected from the Economics and Statistics Department, Joint Director of Agriculture in the basin area. The block wise crop area and the actual command area of the irrigation system were transformed to sub-basin areas by its block proposition to the sub-basin. The weighted rainfall of each sub basin is calculated and Reference Crop evapotranspiration is also found out. Kc (crop Co efficient) values for each crop is taken from Food and Agricutural Organisation (FAO) Irrigation Paper No.56.

Crop water requirement = Kc x Eto – Effective Rainfall

From the above, crop water requirement of each crop was found out. These crop water requirement when applied to the crop areas of the 3 sub basins of Nambiyar basin the Irrigation demand was arrived.

The gross irrigation requirements (GIR) is obtained by applying efficiency factor EF, as follows:

GIR=(TIR+RIR+LIR)/EF.

GIR = Gross irrgation demand

RIR = Regular Irrigation requirements

LIR = Leaching irrigation requirements

TIR = Technical Irrigation requirements

NET IRRIGATION WATER DEMAND OF NAMBIYAR BASIN FOR 75% DEPENDABILITY RAINFALL

Sl. No.	Sub Basin	Present Net irrigation demand (Mcum)
1	Hanumanadhi	68.90
2	Nambiyar	161.20
3	Karamaniyar	126.80
Total		356.90

Note: The above tabulation shows the net irrigation water demand at field level only.

5.2 DOMESTIC WATER DEMAND

The total population in the basin area is arrived from the 2001 census data and using exponential growth formula the future population is projected for 2004, 2020 & 2045.

$P_t = P_o (1+ X)^t$

Where P_t = Population after 't ' years

P_o = Population in the beginning years

X = Annual growth rate (Urban – 2 % Rural 1.3%)

t = Period in years

The technical subcommittee for urban, rural, domestic, livestock water supply & sanitation sector of the Water Resources Control and Review Council (WRCRC) has recommended the water demand norms to be used for water planning and the same is adopted for estimating the water demands. (ie 100 lpcd for urban and 70 lpcd for rural population)

5.3 LIVE STOCK WATER DEMAND

The district wise Livestock population census data for Nambiyar Basin has been collected from the department of Animal husbandry.The assumption of the Animal husbandry department that no growth in the animal population is expected in the future was adopted for forecasting.Based on the norms of the Indian council of agriculture and research the capita water requirement for each variety of live stock have been adopted in estimating the livestock water demand sub basin wise andgrouped the total live stock demand for Nambiyar basin as 16.363 MCM.

5.4 INDUSTRIAL WATER DEMAND

In the Nambiyar Basin there are 15 numbers of Large and Medium Industries and 5413 numbers of Small Scale Industries. The Small Scale Industries are of food products, tobacco products, textiles, wood products, paper products, rubber & plastic products, and leather products, Basic metal Industries etc. Where as the large and medium industries are of sugar, mills, Spinning mills, automobiles, chemical, leather goods, tanneries etc. The norms for water requirement as per the recommendations of Industries department is 2500 m3 / day for large and medium Industries and 2.5 m3 / day for small scale Industries. Accordingly the yearly requirement of water for small scale industries during the year 2006 is calculated as 4.94 MCM and for the large and medium industries is calculated as 13.69 MCM. Hence the total annual water requirement for Industries in this basin is 18.63 MCM. For forecasting the water demand of Industries for future Years, a simple arithmetic increase of 8% per year over the present requirement has been adopted. The computed values for the years 2004, 2020 and 2045 have been tabulated.

ANNUAL WATER DEMAND FOR THREE MAJOR SECTORS "DOMESTIC, LIVE STOCK AND INDUSTRIES"

S.No.	Name of the Sub Basin	Domestic water Demand in MCM			Livestock water Demand in MCM			Industrial Water Demand in MCM		
		2006	2020	2045	2006	2020	2045	2006	2020	2045
1	Hanumanadhi	6.242	7.82	11.75	3.408	3.408	3.408	5.93	12.57	24.43
2	Nambiyar	6.19	7.83	11.97	5.298	5.298	5.298	6.71	14.23	30.11
3	Karumeniyar	9.28	11.57	17.27	7.657	7.657	7.657	14.20	30.11	58.51
Total		21.71	27.22	40.99	16.36	16.36	16.36	26.84	56.91	113.05

Town = 100 lpcd, Rural = 70 lpcd

Small Industries = 2.5 m^3/day / unit

Large and Medium Industries = 2500 m^3/day / unit

6. WATER BALANCE

The River BAsin Simulation Model for Tamil Nadu (RBASIMTN) is used for simulation of Nambiyar basin. The model presents the water resources operation and development activities at the sub basin level. It considers the water demand for various sectors, the availability of groundwater and surface water resources and evaluates the probable water balance, under different conditions. In this basin, the water is

required for domestic, irrigation, livestock and industries. The water sources are: river flows, reservoirs, tanks and groundwater.

Water Potential, Demand and Deficit

	2006	2020	2045
Total water potential in MCM	400	400	400
Total water demand in MCM	533	559	620
Total water deficit in MCM	133	159	220

7. CONCLUSIONS

The total water potential and total water demand were worked out for Nambiyar river basin for the years 2020 and 2045. From the above table, it is noticed that the total water potential is less than the total water demand. Hence Nambiyar river basin is a deficit basin.

8. ENVIRONMENTAL ISSUES

- Over exploitation of groundwater due to increased demand.
- Illegal sand Mining is predominantly noticed in many places along the river course.
- Salinity in coastal villages due to sea water intrusion and marinr aqua culture farms.
- Tank siltation reduced the storage capacity of the tanks.

9. SUGGESTIONS FOR FUTURE PLANNING

- Sustainable drinking water schemes are to be introduced to provide drinking water sufficiently.
- Rainwater harvesting and management to be done effectively to protect the ground water quality and to avoid sea water intrusion.
- Soil conservation programmes like construction of check dams, planting trees on the bunds and
- mountains are to be carried out to avoid excessive erosion and siltation.
- The storage capacity of the reservoirs and tanks can be improved by desilting them periodicallyChanging the cropping pattern, changing the irrigation methods, levying water charges and crop rotation may be introduced to reclaim the soil and to reduce the irrigation demands.
- Dry land farming policy has to be encouraged for raising production in semi arid and arid region to cut down the risk during drought.

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