Trans. Inst. Indian Geographers
Vol. 5, No. 1, January 1983

EVALUATION OF LAND AND WATER RESOURCES OF CUMBUM VALLEY IN MADURAI DISTRICT, TAMIL NADU

M. SAMBASIVA RAO and K. NAGESWARI, Madurai

ABSTRACT : The Cumbum Valley covering an area of about 1500 Km^2 in Madurai District has been studied to evaluate land resources, surface and subsurface water resources with the help of LANDSATS, FCC's Survey of India Topographic sheets, detailed field studies, rainfall date from 9 raingauge stations over a period of 30 years, ground water level data from 25 controlled welles over a period of seven years from 1973–1980. The analysis of the data reveals the landforms, soils, landuse, hydrogeomorphic units, intensity of erosion, seasonal and annual rainfall distribution, variability, runoff, ground water level variations, change in water level, and average saturated hiekness.

Six classes of land have been evaluated. The total annual surface water potential is about 1,628,432,333 M^3 and subsurface is about 171,137,126.66 M^3. Annual water lost in the form of evaporation, potentio evapotranspiration, seepage etc. is about 622,345,206,34 M^3 (38.22per cent of the total surface and subsurface water potential) and recharge in the form ground water is 10.50 per cent of the total surface potential. The ground water potential of each land unit in the valley has been evaluated through rainfall recharge method and specific yield method. Based on the evaluation of land and water resources a sound land use has been called for with a few limitations.

Introduction

Study of Resources Potential for economic development has been recognized as an essential component of development planning. It has assumed much greater importance in India now with acceptance of multilevel regional planning. Drainage Basins or Watersheds form the most convenient, as well as most appropriate spatial units for the study of natural resources particularly the basic resources like land and water. Appraisal of resources and diagnosis of problems involved in management of these resources availability is particularly important in areas of scarce resources. The present study is selected with this point in view.

Land embraces the atmosphere, the soil, underlying geology, the hydrology and the plants on, above and below a specific area of the earth surface. It also includes the results of past and present human activities as well as animals within this area, in so far as they exert a significant influence on the present and future uses by man. The planning of development land and readjustment is usually carried in a number of successive phases, namely land evaluation, socio-economic analysis, classification and programme effectuation. Land evaluation includes both qualitative and quantitative classification. In developing countries like India where agriculture is the main economic activity Land and Water Resources have to be properly augmented for better planning and development.

The Cumbum Valley covering an area of about 1500 Km^2 falls in the talukas of Periyakulam and Uthamapalayam of Madurai District. The Cumbum watershed is drained by Varaha river, Theni river, Suruli Ar river and Vaigai river covers an area about 2200 Km^2. Perusal of Topographic sheets covering the district of Madurai (58 G, H, I & J) bring to light a few folded structures within the district showing both the synclines and anticlines of which the Cumbum Valley is a synclinical valley bordered by Palani hills on northwestern direction, Cardomum hills on the western side, Varushanad hills on south eastern side and Andipatti hills on the northestern side. The valley is located in between 9°.30' to 10°12' N and 77°7' to 77°45' E. Geologically this valley is composed of mainly unclassified granitic gneisses and charnockites of Archean age. Till to-day no serious attempt has been made to evaluate the basic resources of the valley except that of a reconnaissance morphological studies reported by Govindarajan et.al, (1980) using Remote Sensing Techniques. Based on the geophysical studies made by the State Ground water department Govt. of Tamil Nadu, he has concluded that the thickness of valley fills range from 20–50 metres on south western side of the valley and decrease towards the northeastern margin.

Objectives

The main objectives of this paper area :

1. To evaluate land resources based on studies from LANDSATS, FCC's, Topographic sheets and detailed field surveys.

2. To evaluate the surface water resources of the Cumbum watershed based on precipitation data over a period of thirty years collected from rainfall stations and discharge of water from Periyar lake into the Suruli Ar.

3. To evaluate the ground water resources of the valley based on ground water level monthly data collected from the 25 controlled wells of various morphological units and to evaluate the ground water potential applying Rainfall recharge method and specific yield method.

4. And finally to study the development of both land and water resources of the valley.

Methodology

The land resources of the valley have been evaluated with the help of data on relief, slope, landforms, soils, land use (1973), hydrogeomorphology, and intesity of erosion based on the studies from LANDSATS (1.250,000), False colour Composites (1.250,000), topographic sheets (1·63,360) and detailed field studies. A few traverses have been carried out in east-west direction from Bodinayakkanur to Andipatti in northern part of the valley, Thevaram to Royappanpatti in central and Cumbum to Surulipatti in the southern parts of the valley. Data on rainfall from 9 rainfall stations have been collected over a period of 30 years in the valley and seasonal, annual, variability and precipitation ratio of the valley were worked out to bring out the variations in the distribution of rainfall in the valley. The runoff of the valley has been evaluated in relation to rainfall distribution, slope, lithology and vegetation. The monthly ground water level data for the period from 1973 to 1980 has been collected from 25 controlled wells selected by the Ground Water Division, Govt. of Tamil Nadu to work out the seasonal and annual fluctuations in ground water, to study the change in water level over a period of 7 years to asses the thickness of saturated zone and to finally calculate the ground water potential of the valley. The various maps depicted in the Figs. 1, 2 have been prepared on 1:250,000 and reduced using aerosketch master to give a composite view as represented in the maps.

Evaluation of Land Resources

The land resources of the Cumbum valley have been evaluated based on the studies from relif, slope, landforms, soils, land use, intensity of erosion and hydrogemorphic units.

Relief

The studies from the topographic sheets of 58 G & H reveal that the major part of the valley falls in between 300 and 600 metres altitude above mean sea level. Profiles taken accross the valley in east west direction at 5' interval throw light on existence of one planation surface at an altitude between 300–600 metres. The Varushanad valley which falls within the Cumbum watershed also range in altitude between 300 to 600 metres. These two valleys and surrounding plains near to the hilly terrain namely the Dindigul Plains clearly envisages the possible existence of one distinct planation surface. However the super imposed profiles did not clearly depict the existence of other planation surface at higher altitudes.

Slope

The slope of the valley and the surrounding hilly terrain has been worked out applying Wentworth slope method on scale 1 : 1 mile with $\frac{1}{2}$" grid. Using relief, drainage and landform maps, the slope map of the Cumbum watershed along with the calculated values obtained using Wentworth method has been interploted. By and large the vally ranges in slope from 0 to 2 per cent indicating a gentle slope which is useful for augmentation of land and water resources with a few residual hills ranging in slope of about 5 to 10 per cent. The undulating terrain covering the parts of creep built plains and piedmont colluvial plains range in slope from 2 to 5 per cent. The debris plains and the colluvial fans deposited near the foot slopes of the hilly terrain range in slope from 5 to 10 per cent. The slope has increased from 10 to 20 per cent in the free-faces of the hilly terrain. In a few parts of the Cardomum hills and Palani Hills the slope exceeds 20 per cent. The western part of the region bordered by Cardomum hills show steep slope exceeding 20 per cent.

Landforms

The landforms of the valley have been identified from tonal variation, texture, process of their formations and alignment parallel to the hilly terrain and rivers. The bordered hilly terrains show ridge and valley topography with a few escarpments particularly on the western part of the valley in the Cardomum hills. Apart from these a few wind gaps. (Andipatti gap), waterfalls (Suruli Falls), watergaps, faulted valleys have been identified and are not depicted in the figure due to its small scale. The bordering plains of the hilly terrain are the piedmont colluvial plains with exposure of barren rocks (pediments) near to Andipatti hills on the northeastern part of the valley. Geophysical studies reveal that the thickness of sediments on the southwestern part of the valley range from 20–30 metres and these plains are formed by back weathering, gravity, lateral planation and rain wash. The creep built plains bordering the piedmont colluvial plains renge in thickness of sediments from 30 to 50 metres on the western side of the valley and decrease towards east. In a few pockets particularly near to Thevaram the fill up of the valley sediments is more. These plains cover an area of about 643.75 Km^2 approximately nearing to the half of the area of the valley fill sediments. In between Thevaram and Bodinayakkanur at a very few pockets, aeolian deposits have been deposited on the creep built plains.

The wash plains lying between the creep built plains and the fluvial plains, cover an area of about 126 25 Km^2. These plains are composed of mixed soils namely the sandy loams and are formed by rainwash from the bordering creep built plains.

The fluvial plains bordering the Suruli Ar river are formed by the materials deposited by the river Suruli Ar, on either side of the banks during the peak flood periods. These are composed of rich alluvial soils and cover an area of about 336·5 Km².

In a few pockets along the hilly terrain particularly near to Bodinayakkanur a few colluvial fans have been deposited by the action of streams. Detailed field studies on these fans reveal that they are composed of colluvium and at a few pockets near to Bodinayakkanur, alluvium is noticeable. This is possibly due to deposition of suspendend meterials deposited by the Theni river passing through these fans during peak flood periods.

Soils

The hilly terrain bordering the valley is composed of skeletal soils or hilly soils derived from the parent rock materials namely unclassified gneisses and charnockites. The piedmont zone and creep built plains are composed of coarse to medium textured red sandy soils. The wash plains constitute medium to fine textured sandy loams. The fluvial plains bordering the Surli Ar river are composed of fine textured clayey soils.

Land use

The land use on various land units have been studied with LANDSATS and FCC's aided with ground truth surveys. The study is as on date of LANDSAT (1973) shows the cultivable land along Suruli Ar river partially fallow land on wash plains, current fallow land on the creep plains, cultivable waste land on the piedmont plain sand barren land on the residual hills. The bordering hilly terrain is covered by moderate forests. Apart from this, the secondary data are collected at block level on different crops cultivated during 1976-1977. The food crops namely, paddy, cholam, cumbu, ragi, maize and pulses are brought up on fluvial plains, wash plains and in a few pockets on creep built plains. In between The varam and Bodinayakkanur cotton is the dominent crop. Majority of the creep built plains on the southern side of the valley are utilized to cultivate banana plantations and groundnut. The piedmont colluvial plains near to Andipatti are still left as barren lands. Recent field surveys reveal that in a few pockets on the creep built plains grape cultivation is being practised. Vegetables namely beetroot, cabbage, brinjal and tomatto are also being brought up on the piedmont colluvial plains and creep built plains. During the recent decade between 1970-1980 coconut plantations have grown enormously near Thevaram, Royappanpatti Surulipatti etc, particularly on the south-western side of the valley. Usually high yielding variety of paddy is being brought up with an average yield of about 30 to 40 bags/acre, on the fluvial plains along the Suruli Ar river. It is interesting to note that the thickness of sediments ranging from 20 to 50 mts. deposited on southern side of the valley on piedmont plains and creep built plais has enabled to develop intensive cultivation of cash crops on this part of the valley, possibly due to availability of more ground water resources.

Hydrogemorphic Units

The morphological development of the soil profile is known to be influenced by colour, texture, compactness, parent material, cementation, vegetation and actual moisture conditions, including the ground water (Pons and Zonneveld, 1965). Based on this concept studies carried out from the LANDSAT and FCC's reveal that the piedmont colluvial plans with less thickness in general and exposure of barren rocks in few pockets particularly on the eastern side of the valley show poor yield of ground water except along faulted zones or weathered rocks. The creep built plains on the southern side of the valley with more thickness of valley deposits show fair chances of ground water. The wash plains bordering the fluvial plains show possible existence of good ground water. The fluvial plains recharged through the seepage of water from the Suruli Ar river yield high ground water.

Intensity of Erosion

Based on the rainfall distribution, soils, land use, slope, deforestation and nature of drainage, the intensity of erosion in the Cumbum watershed has been evaluated. In the northwestern part of valley in the Palani hills near to Bodinayakkanur the severly eroded zone has been traced based on nature of gullying and slope. The slope at this region exceeds 20 per cent. This part of the area is being eroded severly because of recent deforestation and gullies formed due to steep slope. The hilly terrain surrounding the valley with more than 20 per cent slope and 5 per cent runoff of precipitation lacks thick forest cover due to semi arid climatic conditions and erosion in this region is severe at few pockets. The piedmont colluvial plains are left barren near Andipatti on the eastern side of the valley and erosion on these plains is moderate to high. The creep built plains and wash plains in the valley consisting of red sandy soils and sandy loams are being intensively cultivated by cash crops and plantations. The erosion on these plains seems to be moderate to low. The fluvial plains lying parallel to the Suruli Ar river covered with paddy fields show mill erosion. On the basis of interpretation it is concluded that the materials eroded from various units are slowly or grading in the reservoir of the Vaigai dam which is located 7 Kms. northwest of Andipatti resulting into siltation of reservoir. In other words the reservoir capacity which is about 6878 mcft. is being reduced. Therefore measurements have to be taken to control and retard the severely eroded zones particularly near to Bodinayakkanur by contour bunding and afforesation. The nature of accelerated erosion((active erosion) is by gullying, stripping, sheetwash and dissection in hilly terrain and normal erosion is by slope retreat, vertical incision, sheetwash, lateral erosion and dissection in valley fills.

Land Capability

Based on relief, slope, landforms, soils, land use, hydrogeomorphic units and intensity of erosion the land suitability of the Cumbum watershed has been evaluated. The various land units classified and ranked according to their hierarchy of classes are I Fluvial plains, II Wash plains, III Creep built Plains, IV Piedmont colluvial plains, V Hilly terrain, and VI Residual hills. Fig (1) and Table I give data on land evaluation of Cumbm Watersheed.

Evaluation of Surface Water Resources

The surface water resources of the Cumbum watershed have been evaluated from rainfall distribution for a period of about 30 years from 9 rainfall stations and from the discharge data collected by the ground water division from Periyar lake to Suruli Ar river. Distribution of rainfall over a region depends on the latitudinal location, nature of topography and distance from the sea. The data collected from various rainfall stations has been analysed to work out characteristics of rainfall distribution like variability, precipitation ratio, and runoff. Unfortunately the Cumbum valley has fallen on the leeward side of the Cardomum hills. Perhaps this may be the major reason for the report of average rainfall of about 670 mm. per annum in the Cumbum valley which is less than the average annual rainfall(850 mm.)of Madurai District. Perusal of rainfall distribution map indicates that the precipation has receeded from the neighbouring hilly terrain to the centre of the valley. The maps also depict that higher altitudes located in the Palani hills, Cardomam hills, and Varushanad hills receive average rainfall of about more than 1,200 mm. per annum. The valley receives major part of the rainfall in the northeast monsoon.

Precipitation ratio denotes the abnormality in the occurrence of rainfall at any location. Higher values of the ratio indicate higher abnormalities and lower values denote greater stability of rainfall. Studies on the precipitation ratio of the Cumbum watershed indicate that there is greater stability in the distribution of the rainfall in the valley. The

Table I

Land Suitability Classification For Cumbum Watershed

Class	Land Units	Soil	Land Utilization (1982)	Cropping Pattern (1982)	Hydrogeomorphic Units	Erosion Appraisal
I	Fluvial Plains	Clayey	Cultivable	Paddy & Sugarcane	High	No erosion
II	Wash Plains	Sandy loams	Cultivable	Paddy.	Good	mild erosion
III	Creep buil Plains	Red Sandy	Partly cultivable & fallow.	Cotton, Banana, Coconut, Groundnut, Grape gardens, Vegetables etc.	Fair	Low-moderate.
IV	Piedmont Colluvial Plains.	Red Sandy	Partly cultivabie, Fallow & culliva-ble waste	Groundnut, Banana, Coco-nut, Cotton etc.	Poor	Moderate.
V	Hilly Terrain	Skeletal / Hilly	Low to moderate Forest eover.	Low to moderate Forest cover	Unproductive Zone.	Severe.
VI	Residual Hills	Barren	Barren	Barren	— do —	—

Thekkady rainfall station near to the Periyar lake has the highest precipitation ratio of 233 per cent which has recorded highest amount of rainfall of 1720 mm. per annum. The coefficient of variability of rainfall computed on yearly basis reveals that the hilly terrain has high degree of variability where as the valley proper shows relatively low variability. This again denotes that the valley has greater degree of rainfall stability than the hilly terrain. The runoff in percentage has been evaluated from slope, landforms, permiability of the soils, land use and rainfall distribution. The percentage of runoff on the fluvial plains, wash plains and creep built plains vary from 10 to 20 because of low relief, gentle slopes, intesive cultivation and moderate to high permiability of the soils. In the piedmont colluvial plains and parts of creep built plains where the slope ranges from 2-5 per cent with moderate vegetal cover, the runoff varies 20 to 40 per cent. The runoff percentage on foot slopes and debris slope regions of the hilly terrain with 5 to 10 per cent slope and sparse vegetation vary from 40 to 60 the runoff exceeds 60 per cent on the hilly terrain with more than 20 per cent slope. The surface water resources of the Cumbum watershed have been evaluated from the average annual rainfall distribution and area of the watershed. An annual discharge of about 50,432, 333 M^3 of water is disch rged into the Suruli Ar river from the Periyar lake. Therefore the total surface water resources of the Cumbum watershed are :

Through discharge from Periyar lake to Suruli Ar river (Average annual discharge (1963-1980)	50,432,333M^3.
Through preciptaition	1,578,000, 000M^3,
Total surface water resources	1,628,432,333 M^3,

Evaluation of Ground Water Resources

The ground water resources of the valley have been evaluated from the studies of ground water level data from Ground water Department Govt. of Tamil Nadu collected from 25 controlled wells- It is here accepted that the number of controlled wells taken by the Ground water Department, is megre to come to to firm conclusion in the regional distribution, fluctuations, change in water level of the valley. However, because of lack of any other data on the ground water the authors have to restrict themselves to data collected by the Ground water Division over a period of 7 years from 1973 to 1980 from the 25 controlled wells. The ground water level data have been recorded monthly by the officers of Ground water Department, with the help of this data the authoritiess have made an attempt to study the seasonal and annual fluctuations in ground water, change in water level over a period of 7 years, ground water contour map and the average saturated thickness of the valley. In this connection it may be pointed out that good work on optimum use of water resources isbeing carrie dout in the International Institute for Land Reclamation and Improvement by Brinkman and Symthu (1973), De Ridder and Erez, (1977), and Beek. (1978).

Perusal of figure 2 on seasonal variations in ground water level reveals that in winter the ground water depth is between Uthamapalayam and Bodinayakkanur. In the northern and eastern part of the valley and part of the valley near Thevaram the depth of water level varies from 9-12 metres. The south western part of the valley during winter shows the maximum depth ranging from 12-15 metres. Study of ground water level data in summer and southwest monsoon more or less indicate the same pattern of ground water level ranging from

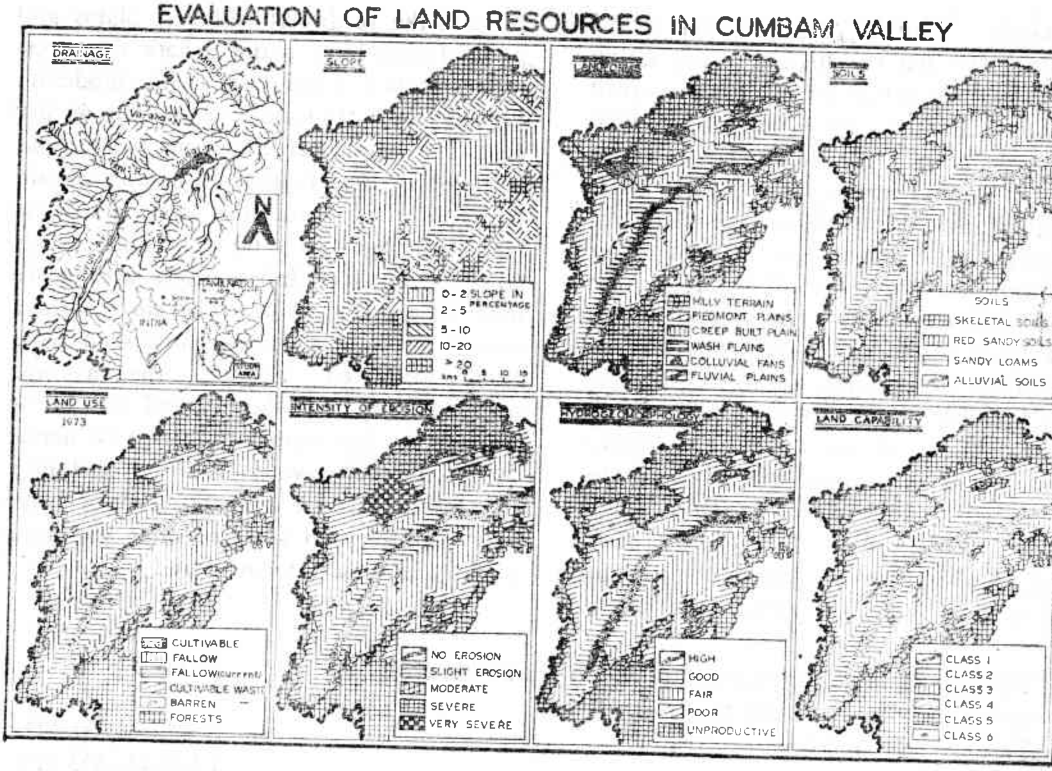
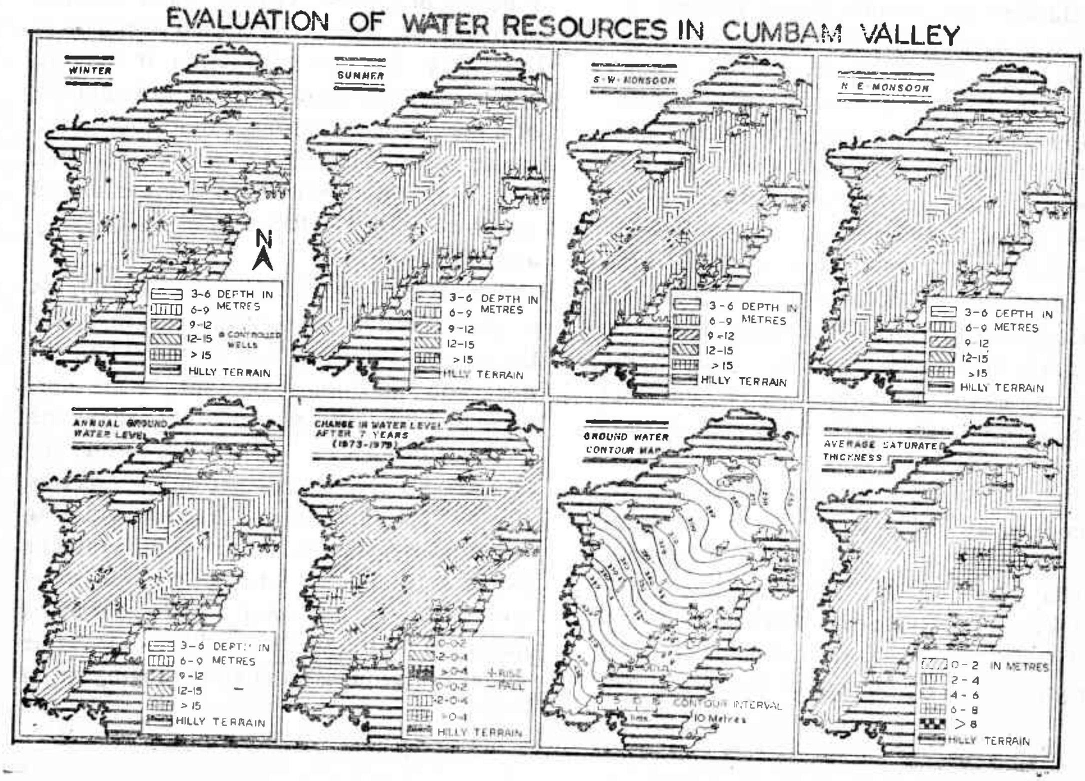

EVALUATION OF LAND RESOURCES IN CUMBAM VALLEY
DRAINAGE
SLOPE
0-2 SLOPE IN PERCENTAGE
2-5
5-10
10-20
>20
HILLY TERRAIN
PIEDMONT PLAINS
CREEP BUILT PLAIN
WASH PLAINS
COLLUVIAL FANS
FLUVIAL PLAINS
SOILS
SOILS
SKELETAL SOILS
RED SANDY SOILS
SANDY LOAMS
ALLUVIAL SOILS
LAND USE
1973
CULTIVABLE
FALLOW
CULTIVABLE WASTE
BARREN
FORESTS
INTENSITY OF EROSION
NO EROSION
SLIGHT EROSION
MODERATE
SEVERE
VERY SEVERE
HIGH
GOOD
FAIR
POOR
UNPRODUCTIVE
LAND CAPABILITY
CLASS 1
CLASS 2
CLASS 3
CLASS 4
CLASS 5
CLASS 6

Fig. 1


EVALUATION OF WATER RESOURCES IN CUMBAM VALLEY
WINTER
3-6 DEPTH IN METRES
6-9
9-12
12-15
>15
HILLY TERRAIN
SUMMER
S-W MONSOON
N E MONSOON
ANNUAL GROUND WATER LEVEL
CHANGE IN WATER LEVEL AFTER 7 YEARS (1973-1979)
+ RISE
— FALL
GROUND WATER CONTOUR MAP
CONTOUR INTERVAL 10 Metres
AVERAGE SATURATED THICKNESS
0-2 IN METRES
2-4
4-6
6-8
>8

6–12 metres in general in the central and northern part of the valley, with a few changes in ground water level ranging from 3 to 6 metres on the northeastern part of the valley. However the ground water level on the southwestern part of the valley remains 12 to 15 metres. During northeast monsoon the valley receives more amount of rainfall of about 350 mm. The ground water level during this period on the eastern and north eastern part of the valley ranges from 6 to 9 metres. In the western part of the region between Thevaram and Bodinayakkanur there is decrease in water level ranging from 9 to 12 metres. In general the seasonal variation in ground water level depicts that during summer, south west monsoon and northeast monsoon there is low variability in the ground water levels. However the ground water level in winter season seems to be comparatively at a higher level than other seasons. This may be due to accumulation of recharged water during northeast monsoon period, less extraction and cool climatic conditions. During the four seasons the southwestern part of the valley shows similarities in depth of ground water ranging from 9 to 15 metres. About 20 Km. north east of Uthamapalayam near Uppanuthu the ground water depth throughout the seasons recorded is more than 15 metres. The annual ground water level more or less shows similar pattern of variation in ground water levels as depicted during summer and southwest monsoon periods. The change in ground water level after 7 years from 1973– 1980 indicate that there is rise in ground water level in between Uthamapalayam, Bodinayakkanur Theni and Andipatti in general to about 0.21 to 0.4 metres. The fall in water level is particularly noticed on the northern part of the valley around Periyakulam, Sankarapuram on the western side of the valley and in between Thevaram and Melangudadore on the southern and southwestern part of the valley range from 0.2 to 0.4 metres (Fig. 2 This may be due to intensive cultivation of the regions on the southwestern part of the valley and around Periyakulam where the main source of irrigation is by energidised wells. In other words the extraction of ground water in these regions seems to be more than in other parts of the valley. A glande at the water table contour map (Fig.2) shows a rather incresse in water table gradient in between Thevaram and Meenakshipuram on the western side of the valley. This may be due to protrusion of hills in of north west, soth east direction near to Thevaram,and accumulation of more sediments ranging from 20 to 60 metres from T. Meenakshipuram to Thevaram. In general in other parts of the valley the gradient is low. The average saturated thickness depicts that on the western part of the valley near Bodinayakkanur and south western part of the volley near Cumbum is below 2 metres. The central, northern and parts of the eastern part of the valley the saturated thickness varies from 2-4 metres. The maximum saturated thickness is noticed south of Andipatti on the creep built plains ranging from 6-8 metres. The ground water potential has been evaluated basing on Rainfall Recharge method and specific yield method.

Rainfall Recharge Method

Geographical area x mean annual ranifall x recharge. (It is presumed that 20% of annual rainfall goes in the form of Recharge by the Ground water Division, P. W. D., Govt. of Tamil Nadu).

Specific Yield Method

Geographical area x water level fluctuation x Specific Yield,

The ground water potential has been calculated for each land unit namely for piedmont colluvial plains, creep built plains, wash plains, and fluvial plains using both the methods and presuming 30per cent of the total potential would be lost in the form of potential evapotranspiration, evaporation and seepage (Ground Water Division, Govt. of Tamil Nadu). Table II gives data on average water level depth in metres from

Table II

Data on Water Level From 25 Controlled Wells

S. No.	Winter	Summer	Northeast monsoon	Southwest monsoon	Annual	Average Saturated thickness in metree	Change in Water level (1973 – 79) in Metres.
	(average water depth in metres)						
1.	13.76	14.38	14.48	14.37	14.25	1.40	— 0.16
2.	6.78	7.59	7.58	6.52	7.12	4.14	— 0.11
3.	9.20	12.12	13.76	12.05	11 78	1.32	+ 0.22
4.	4.42	0.65	5.85	5.22	4.94	1.6	—
5.	9.65	19.17	10.26	10.06	10.04	4.58	— 0.22
6.	3.68	4.60	6.26	5.82	5.09	6.17	— 0.30
7.	8.77	10.71	12.20	11.75	10.86	2.67	+ 0.52
8.	17.10	18.01	18.01	17.80	17.73	1.59	— 0.93
9.	14.96	15.39	15.82	15.69	15.47	2.96	— 0.58
10.	19.97	20.46	19.68	20,84	20.24	3.03	+ 0.06
11.	3.13	3.91	4.41	3.62	3.77	2.70	+ 0.08
12.	6.12	7.29	9.50	7.61	7.63	6.90	+ 0.52
13.	4.31	4.22	6.10	5.91	5.14	4.76	— 0.24
14.	3.64	4.72	6.04	4.81	4.80	4.41	+ 0.12
15.	3.51	6.29	9.76	8.14	6.93	11.38	+ 0.50
16.	7.89	11.42	11.34	10.94	10.40	6.03	—
17.	6.13	7.68	9.45	6.77	7.51	6.46	— 0.09
18.	8.56	10.96	12.30	10.61	10.61	9.43	—
19.	3.27	4 48	5.01	3.80	4.14	4.49	+ 0.01
20.	14.19	13.30	16.20	14.55	14.56	5.33	—
21.	6.07	7.32	8.36	6.01	6.94	5.01	+ 0.24
22.	5.69	7.20	7.63	7.61	7.03	6.39	+ 0.22
23.	4.39	6.48	7.91	4.89	5.92	5.89	— 0.07
24.	4.48	4.86	5.48	4.96	4.95	2.45	— 0.06
25.	4.59	6.18	7.59	5.77	6.03	4.85	+ 0.27

the ground level, saturated thickness and change in water level (1973-1980) for the 25 controlled wells. Table III gives data on average water potential computed through rainfall recharge method and specific yield method for each land unit. Table IV gives data on amount of water that could be extracted through rainfall recharge method and specific yield method in gallons/hectare/day and average of the both. The ground water potential of the valley is 171, 131, 126.66 M^3. From the arrived data (Table III) on ground water potential in each land unit reveals that more resources of ground water are located in the creep built plains. This may be due to accumilation of vast valley fill sediments in the creep buil plains ranging from 20 – 50 metres particularly on the southwestern part of the valley and recharge of water precipitated from the surrounding hilly terrain, due to more permeability (52.11 gallons of water/square

Table III

Landform	Mean Annual Rain fall in mm.	Permeability in gallons per M^3 / day	Recharge in mm (20% of annual rain fall)	Specific Yield in %	Average saturated Thickness in metres	Ground water potential in M^3 Metres
1. Piedmont Colluvial Plains	801.73	53.03	160.35	2.74	4.20	43,950,907
2. Creep built Plains	792.38	52.11	158.48	3.3	4.93	72,255,465 63
3. Wash Plains	620.74	16.2	124.15	3.66	4.06	32,104,993.90
4. Fluvial Plains	591.62	16.2	118.33	6.86	5.81	22,825,760.13

Table IV

S. No.	Landform	Water that could be extracted in gallon s/ hectare/ day		
		Through Rainfall Rechagre Method	Through Specific Yield Method	Average
1.	Piedmont Colluvial Plains	676.29	486.42	581.26
2.	Creep built Plains	667.84	687.66	677.75
3.	Wash Plains	524.13	628.09	549.38
4.	Fluvial Plains	498.76	1684.66	1091.71

metre). The fluvial plains and wash plains are recharged through the seepage of water from Suruli Ar river (110, 055 gallons of water per annum) and from the rainfall precipitated, posses the average ground water potential of about 54,930,754.03M^3, The piedmont colluvial plains possesing more permiability rate are recharged by the precipitation and the water runoff from the surrounding hilly terrain posses ground water potential of 43,950,907M^3. The data shows considerable accumilations of ground water in all the land units of the valley.

Water Balance

1.	Total average anuual surface water resources (through precipitation and discharge from Periyar lake).	... 1628,432,333 M^3
2.	Total average annual subsurface water resources.	... 171,137.126.66M^3
3.	Average annual inflow of water into Vaigai Reservoir (PWD Vaigai Project, Govt. of Tamilnadu).	... 834,950,000 M$_3$
4.	Water lost in the form of Evaporation, (potentio evapotransiparation, seepage etc.)	... 1,628,832,333 (—)
	Total average annual surface water resources (—) (average annual subsurfaces water resource (+)	... 1,006,087,126.66

Average annual inflow of water into Vaigai Reservoir : 622,354,206.34M^3 From this it is derived that 38.22 per cent of the total annual surface and subsurface water potential is lost in the form of evaporation, potential evaportansiparation, seepage etc. 10.50 per cent of the total annul surface potential is recharged in the form of ground water and 51.28 per cent is the inflow into the Vaigai Reservoir.

Land and Water Resources Development

From the studies on land and water resources the land suitability, and subsurface water availability in the vailey could be evaluated. Six classes of the land have been interpreted. The ground water potential of each unit has been evaluated. From the evalution of land water resources it is revealed that fuluvial plains bordering the Suruli Ar river seem to be the good zone for the development of land resources and excavation of under ground water resources particularly for cultivation of paddy and sugarcane. The wash plains and creep built plains also seem to posses high ground water potential and the red sandy soils and sand loams deposited can be developed well for the cash crops namely cotton, banana, coconut, grape gardens, vegetables, groundut etc. Though the piedmont colluvial plains are not rich in minerals, they have been well utilised for the cultivation of groundnut, banana, coconut and cotton on the southern and western part of the valley. Therefore it is suggested that the barren lands on the eastern part of the valley could be developed for cultivation of groundnut, banana, sunflower, vegetables etc. The foot slopes and debris plains ranging in slope from 5-10 per cent on eastern side of the valley can be utilized for the development of pasture lands. The zones where erosion is intensive can be retarded by contour bunding and afforestion.

Acknowledgements

We are thankful to the Ground Water Division, Govt. of Tamil Nadu for kindly providing necessary data pertaining to ground water and to Prof. S. Jayachandran Professor and Head, Depatment of Geography, Madurai Kamaraj University for providing facilities to complete this piece of work.

References

Beek K. J. (1978) : Land evaluation for Agricultural Development. International Institute for Land Reclamation and Improvement, Publication No. 23, P. 333

Brinkman R. and *Symhtu A. J.* (1973) : *Land Evaluation for Rural Purposes Ibid.* Publication No. 17, 116 P.

De Ridder N. A. and *Erez A.* (1977) : *Optimum use water Resources : Ibid*, Publication No. 17, P. 250

Thillai Govindarajan., S. Balasubramaniam T., and Radhakrishnan P. (1980) : Hydrological study - Kombai river Basin of Madurai District using Remotely sensed data, Symposium Water Resource of Southern States, *Department of Geography, Madurai Kamaraj Uuiversity*, Madurai.

Pnos, L. J., and I· S. Zonneveld (1965) : *Soil Ripening and Soil Classification* ILRI Publication No. 13 pp. 128

Address of the authors

Dr. M. Sambasiva Rao And K Nageswari, Dept. of Geography, Madurai Kamaraj University, Alagarko Road, Madurai - 625 002.