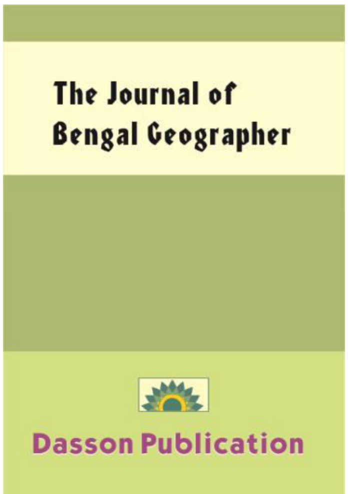
The Journal of Bengal Geographer



Dasson Publication
www.dassonpublication.com

Estimation of climatic balance and ground water potential in Sriniketan-Santiniketan planning area

Subhra Ghosh
Research scholar, Department of Geography
Visva-bharati, Santiniketan
&
Dr. Debashis Das
Professor, Department of Geography
Visva-bharati, Santiniketan

Abstract

In order to meet the water shortages, search for new sources of fresh water especially ground water has been emphasized. For this purpose both qualitative and quantitative approaches have been applied. The former are largely based on water table profiles and contours whereas the later are based on change in ground water shortage and factors causing them. Some of the villages of the study area record over utilization and remaining record under utilization of ground water. Water balance for the area as a whole has been studied for each of the heavy, normal and low rainfall years. Water is surplus in the months of August and September in heavy rainfall years, and in July and August in normal rainfall year. Naturally, there is no surplus in less rainfall years. A suitable plan for its development has been emphasized here by taking into account conjunctive use of water resources.

Key words: *1.Water balance, 2.Aquifers, 3.Ground water potential, 4.Geohydrological structure.*

Introduction:

Often confident of an undiminishing supply of water from surface and sub-surface sources, man has been wasting and polluting water. In fact, the fast growing population and rapid advancement in science and technology are exerting ever-increasing pressure on world's highly limited fresh water resources. There is high demand of ground water in the rural areas due to agricultural activity and hence the water table in the agriculture based areas is also depleting slowly. Thus, in the midst of plenty of water, a serious worldwide shortage of fresh water is being felt. Almost a 1000 million people in the world lack even the simplest dependable supplies of potable water for personal, domestic and agricultural use. In order to meet the challenges of water shortages, search for new sources of fresh water, especially ground water has now been intensified the world over, keeping the above in view, the present work attempts on estimation of climatic water balance and ground water potential in Sriniketan-Santiniketan Planning area in context of agricultural, rural and urban development of the area. Economy of the area is predominantly agricultural and almost all the large scale water in the area has been aimed at meeting the crop-water requirements of the area.

Location and extent of the study area:

Sriniketan Santiniketan Planning Area (SSPA) has multiple urban and rural local bodies within it. Sriniketan Santiniketan Planning Area as notified under provisions of West

Bengal town and country planning and development act 1979, vide gazette notification under no. 4069-Tanal CP/IS-25/87 dated 27th December 1997 is estimated to be about 108.08 sq. Km. Compromising 44 mouzas under Bolpur Police station, Birbhum district West Bengal.

Out of 44 mouzas 40 fall under Sian Muluk, Raipur-Supur, Ruppur and Kankalitala gram panchayets.

Sriniketan Santiniketan Development Authority (SSDA) was formed on December 14, 1989.

At southern part of Birbhum District in between latitude $23^0$37' N to $23^0$43' N and longitude $87^0$37'E to 87^0 47'E.This planning area is located under Rarh natural region. It possesses 108.08 sq.km area and population of SSPA is 85 thousand which includes 10 villages, other 34 villages have total population 59 thousand. Bolpur Municipality area has total population of 1Lakh 10 thousand. So the total population of SSPA is 2Lakh 54 thousand. This planning area is surrounded on the north by Nanoor on the south by Ajoy River and on the west by Illambazar block .The Kopai River marks the northern boundary and the Ajoy River indicates the southern boundary of this region. The entire region has come close to the base level of erosion. Agriculture and its allied activities are the primary occupation of the people.

Methodology:

Both qualitative and quantitative approaches have been used in details. The former are largely based on water table profile and contours whereas the later are based on change in ground water storage and factors causing them. The study takes into account the influence of both physical and cultural factors prevailing in the area, namely, climate, physiography, geology, drainage, water balance and hydrological properties of water bearing materials, recharge and shortage of ground water. For the purpose of the study out of the total 42 villages of Sriniketan-Santiniketan Planning Area, 10 villages have been selected.

Relief and drainage:

The south-western part of this area has comparative high relief. The elevation of this part is more than 50 metres but less than 100 metres from the mean sea level. To the east of this, relief is moderate and in terms of height it is less than 50 metres from the MSL. This elevation prevails in most part of this area. This portion is a low-lying area. The study area is actually the eastern most flank of the Chhotanagpur Plateau and a part of the Rarh Bengal. The term 'Rarh' comes from the Santhali word 'Rahro' meaning rocky land. The south-western part is characterised by undulations and a small patch of laterite is seen in the north of the study area also. Gradually, the relief from west to east becomes gentle (O'Malley, 1911).

The entire study area is a monotonous plain as the slope of the area is less than 10 metres per kilometre. This reveals that the whole area is a low lying tract subjected to flood and water logging during rainy season.

The entire area is drained by Ajoy and Kopai, Rivers. The southern boundary of the study area as well as Birbhum District is demarcated by the Ajoy river which flows from west to east of the study area. The Ajoy River flows over 3 C.D. blocks namely, Bolpur-Sriniketan, Illambazar and Nanoor. North of Ajoy River, almost in the middle of the study area the Kopai River flows from west to east and meets the Kula River which flows to the east over Labpur C.D.Block. A number of drainage channels, locally known as kandor flows over the entire area. Moreover, the entire area is full of small tanks, locally known as pukur, doba, dighi, and bill. (O'malley, L.S.S., 1911)

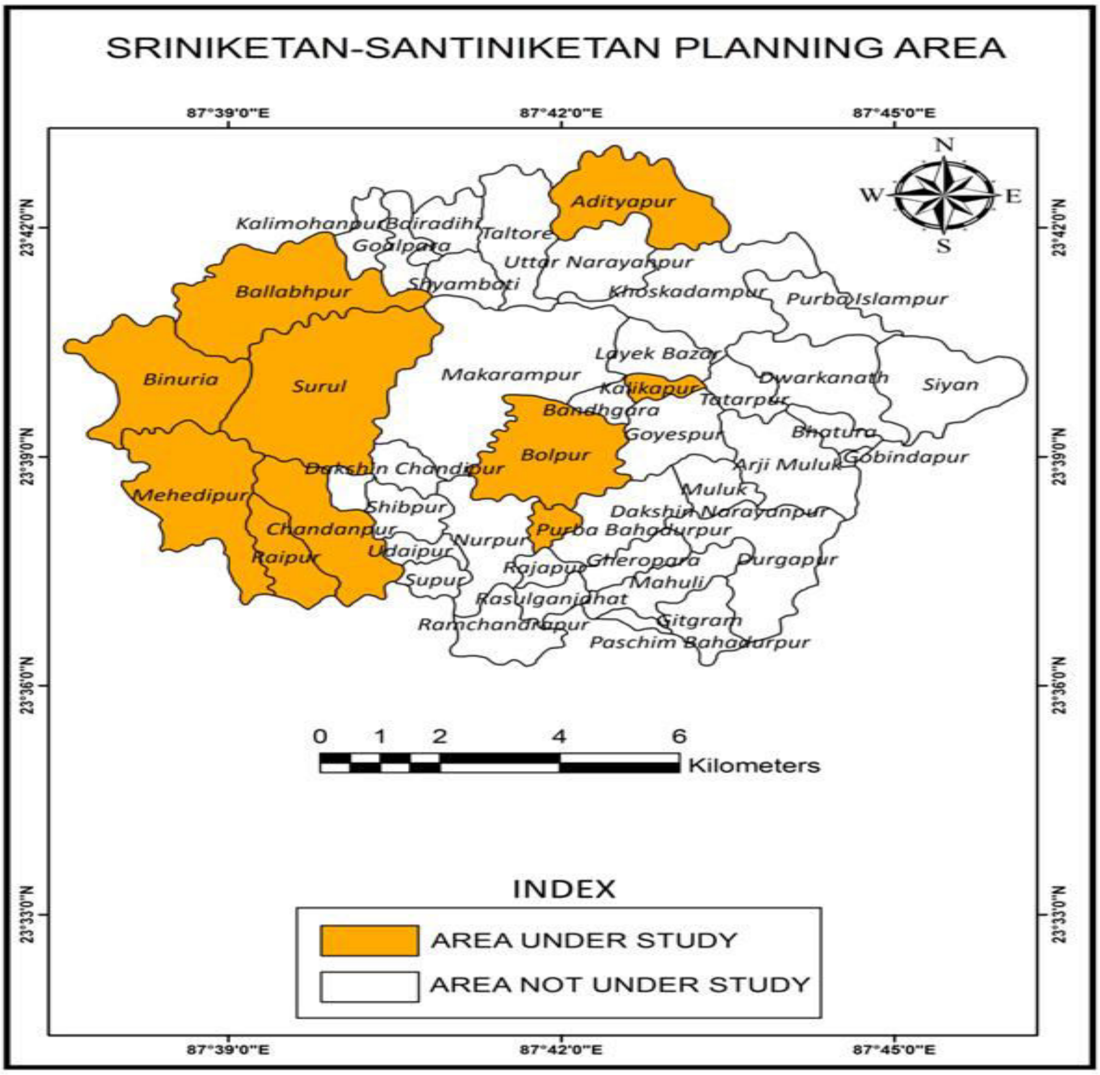


Figure 1

Climate:

The area under study enjoys monsoon type of climate reflecting a seasonal rhythm of weather. Thus, precipitation, temperature, pressure, wind, relative humidity etc. exhibit well marked seasonal variations. Availability of water is evidently the most significant factor controlling agriculture in the area on account of uneven temporal distribution of precipitation and also uncertainty of its occurrences. This has necessitated schemes for large scale development.

(a) **The cold weather season:** It is the coldest part of the year with an average temperature of 20°C average maximum 27.3 °C, average minimum 12 °C (table- 1). The cold weather cyclones also known as western disturbances are the main source of precipitation during this season. The rainfall although small in amount (10% of average annual rainfall of 100.7 cm.) is beneficial for Rabi crops.

(b) **The hot weather season:** It is characterised by low pressure conditions, low relative humidity (38% in April) with strong and scorching hot-dust laden winds, locally known as 'loo', generally blowing at their full fury during May and most of June (table-1). It is the hottest part of the year with an average temperature of 28 °C (mean maximum 35.5 °C and mean minimum 19.5 °C). A rise in temperature commences from late February and continues up to mid- June. It is also the driest part of the year accounting for only 4% of the average annual rainfall.

(c) Rainy season: The wet summer or rainy season is characterised by high relative humidity coupled with fairly high temperature resulting in sultry condition. In conformity with the monsoonal characteristics, about 86% of the average annual rainfall is received during mid-June to mid-October and that too in only 46 rainy days. As s result of this heavy concentration, most of the rainfall is drained out of the area without being put to any beneficial use. (Singh, R.L., 1971)

Table 1: Mean monthly climatic conditions at station sriniketan- santiniketan planning area.

Months	Temperature (^{O}C)			Relative humidity (%)	Rainfall	
	Max.	**Min.**	**Mean**		**MM**	**Amount (%)**
January	23.4	8.3	15.8	77.0	14.7	1.45
February	27.2	11.4	19.3	66.0	17.5	1.73
March	33.3	16.5	24.8	47.8	7.6	0.75
April	38.4	22.3	30.3	38.7	7.6	0.75
May	40.8	24.9	32.8	45.3	17.5	1.73
June	38.2	22.0	30.3	59.5	123.9	12.29
July	33.8	26.0	29.9	80.2	273.6	27.21
August	32.3	25.5	28.9	85.6	294.4	29.21
September	32.7	22.1	27.4	82.1	181.4	17.99
October	32.4	19.4	25.9	73.0	59.7	5.92
November	29.4	14.5	21.8	66.5	5.6	0.55
December	24.3	8.8	16.5	73.1	4.3	0.42
total	-	-	-	-	1007.8	100.00

Source: Srinikrtan-santiniketan planning area, 2010

Climatological water balance:

It is the balance between the incoming precipitated water and its outflow from the area. According to Thornthwaite and Mather (1957), the climatological water balance for any period may be expressed by the equation:

$P = (PE - D) + S \pm \Delta St$,

Where, P = Precipitation, PE= Potential Evapotranspiration, D = Water Deficit, S= Water Surplus, and Δ St = change in soil moisture storage

Water balance for the study area has been calculated for each of the heavy, normal and low rainfall years. Water surplus occurs in the months of August and September in heavy rainfall year and in July and August in normal rainfall year. There is no surplus recorded in any month during low rainfall year. The normal surplus amounts to 250 cm. and 6.3cm. in a heavy and normal rainfall year, respectively, whereas, water deficit amounts to 39.1, 53.1 and 89.5 cm. in heavy, normal and low rainfall years, respectively (table -2, fig. 2).

Table 2: climatological water balance for srinikrtan-santiniketan planning area

*Soil moisture storage at field capacity = 300 mm.

Items		Months												Annual
		J	F	M	A	M	J	J	A	S	O	N	D	
T (°C)		15.8	19.3	24.9	30.3	32.8	30.3	29.9	28.9	27.4	25.9	21.8	16.5	-
PE		20	43	114	175	207	202	190	165	147	116	68	25	1472
P	a	34	15	08	30	03	220	327	437	160	48	-	04	1286
	b	14	17	07	07	17	124	274	294	181	60	05	04	1004
	c	-	-	-	-	-	39	304	162	42	30	-	-	577
P-PE	a	14	-28	-106	-145	-204	+18	+137	+272	+13	-68	-68	-21	-186
	b	06	-26	-107	-168	-190	-78	+84	+129	+34	-56	-63	-21	-468
	c	20	-43	-114	-175	-107	-163	+114	-03	-105	-86	-68	-25	-795
St	a	150	136	89	49	22	51	220	300	250	192	146	134	-
	b	131	120	78	40	17	40	84	190	250	179	140	130	-
	c	33	28	17	08	04	02	120	125	76	52	40	36	-
∆St	a	+16	-14	-47	-40	-27	+29	+169	+80	-50	-58	-46	-12	-
	b	+01	-11	-42	-38	-23	+23	+44	+106	+60	-71	-39	-10	-
	c	-03	-05	-11	-09	-04	-02	+118	+05	-49	-24	-12	-04	-
AE	a	20	32	55	68	31	202	190	165	147	110	46	15	1081
	b	20	32	48	44	28	101	190	165	147	105	46	15	941
	c	03	05	11	09	04	38	190	160	92	49	12	04	577
WD	a	-	11	59	107	176	-	-	-	-	06	22	10	391
	b	-	11	66	131	179	101	-	-	-	11	22	10	531
	c	17	38	102	166	203	164	-	05	55	67	56	21	895
WS	a	-	-	-	-	-	-	-	192	13	-	-	-	205
	b	-	-	-	-	-	-	40	23	-	-	-	-	63
	c	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: Computations are based on thornthwaite and mather (1957).

N.B. a = a heavy rainfall year (2007), b = a normal year (2008) and c = a low rainfall year (2005)

Abbreviations: T = Temperature, PE = Potential Evapotranspiration, P = Precipitation,

St = Soil Moisture Storage, ∆St = Change In Soil Moisture Storage, AE = Actual Evapotranspiration, WD = Water Deficit and WS = Water Surplus

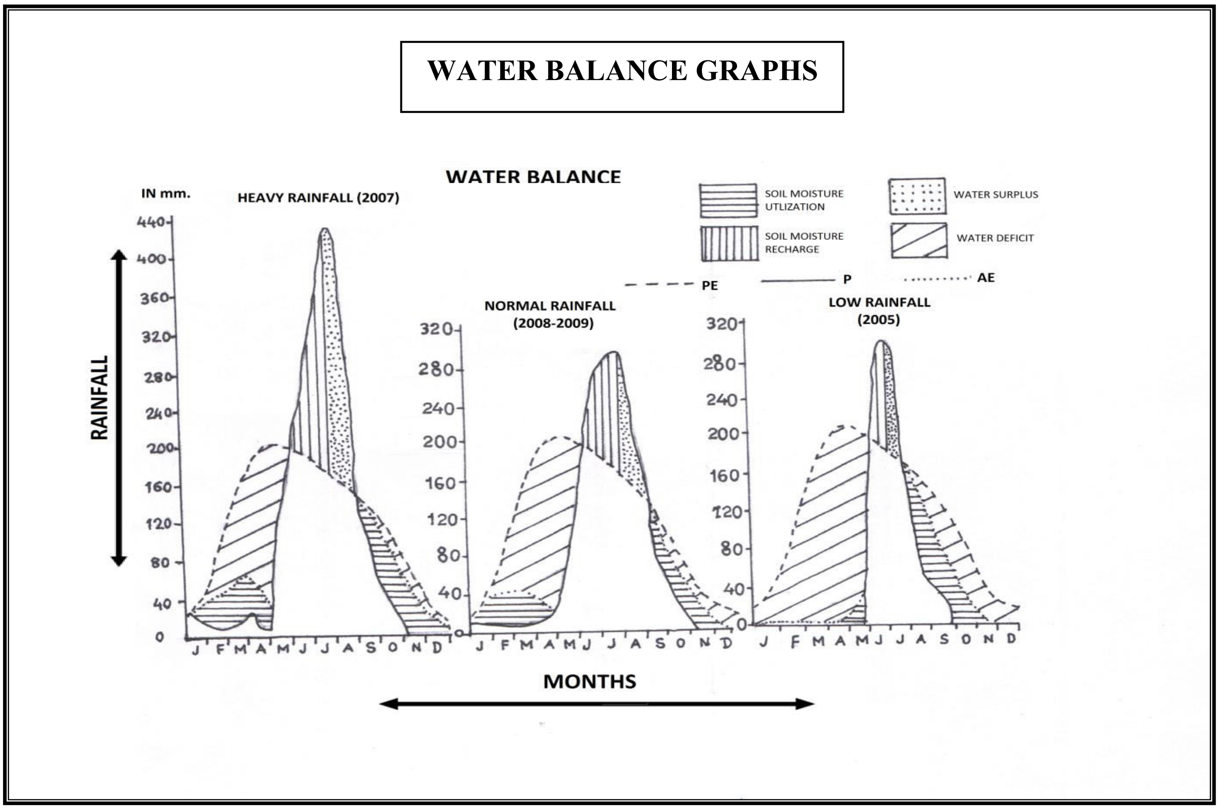


Fig.2

Hydrogeological structure:

The area of present study is Sriniketan Santiniketan Planning Area which is a part of Rarh area. Proceeding east ward of this area the area have mere undulation. The area is made up of the Gondwana sediments the territories, the laterite (both primary and detrital) and the alluvium. The Gondwana and the tertiaries probably extend below the detrital laterites and the alluvium. Throughout almost the entire area the surface is broken by a succession of undulations, the general trend of which is from North West to South East. Along the North of Ajoy to the south of Bolpur, the country is absolutely flat. The Sal in downstream is known as the Kopai river flows from north west to east south east and after crossing 250 ft contour line, flows north-west to east south-east. The Kopai meandering is a circle in a semi circle from west north west to east south east and finally to north east from 23^0 41'N and 87^0 37'30''E. From this point the right bank tributaries of the Kopai display severe scars of gully erosion. This has resulted in the badlands topography to the north of Binuria, Sriniketan, Surul, Santiniketan and Makarampur. Very interestingly, the badlands topography in this part does not extend below the 150 feet contour and the banks of the Kopai itself is free from the ravages of gully. There has been extensive gully erosion found above Santiniketan which is very similar to those above in between the Ahmedpur-Katwa Railway line below Labpur and the Bakreswar.

The area is well drained by Ajoy and Kopai running nearly west to east. The former makes the southern boundary and the latter makes the northern boundary. In the dry weather their beds are broad expanses of sand with narrow streams trickling down in meanders, but during the rainy season the water channels grow much broader and deeper, and after the heavy downpour in a few hours, occasionally overflow their banks downstream and inundate the surrounding area.

The chief characteristics of all the streams described above is that they flow with tremendous velocity is the monsoon months carrying substantial volume of sand and silt, but become almost dry in winter. During the monsoon they often overflow their banks, damage crops and cause heavy soil erosion. Most of their water runs to waste.

Archaeans are the oldest rock formation in this area, its granitoid and schistose rocks having crystallised at least 900 million years ago, it is a continuation to the east of the peninsular Archaeans of the Chhotonagpur Plateau. These regions were subjected to great diastrophic movements and erosion through a considerable period, on the display denuded edges of the comforted Archaeans, the sedimentary formations of Purana age were deposited.

An exploratory bore hole was drilled to a depth of over 1500 meters at Bolpur under the Indo Stamial Project, but no oil worth commercial exploitation was found. At this borehole below a 65 meters thick square of gravel, sand and laterite interbeds, sedimentary rocks of tertiary and cretaceous ages, such a sandstone, conglomeratic sandstone. Clay shales of various colours and sandy limestone were found, these rocks indicate local alternations of deltaic, estuarine local alterations of deltaic, estuarine and shallow marine conditions during their deposition. At the depth of 1193 meters below the sea level these sedimentary rocks are underlain with the conformity by basaltic rocks presumably of the same age (upper Jurassic of lower Cretaceous as the Rajmahal Volcanic. The borehole penetrated 287 meters into the basalt before it was abandoned.

The basement complex in this area slopes east and south east. The shallowest subscale depth of the Cretaceous formation was registered at Bolpur. The sand percentage contours recorded maximum of 69% sand at Bolpur. The tertiary formation is associated with angiospermous fossil wood as at south west of Suri. Similar occurrences are noted in a well section in Bolpur. These apparently isolated patches of Tertiary rocks over a wide belt suggest the pressure of a continuous belt of Tertiary rocks in this part of the state.

Water table conditions

Ground water in the study area, atleast upto depth of about 100 m below ground ordinarily reached by tubewells, has been found to occur under water table conditions. The depth of water table exhibits both spatial and temporal variations. The influencing factors, in the former case, are obviously those which, at any place, do not themselves change so readily with time. The spatial variations in water table depth, although of a minor nature, do clearly reflect the influence of surface relief. The depth decrease away from the drainage divides towards main stream.

As commonly observed, water table is rarely a level surface but it presents distinct relief features. As mentioned earlier, the areal variations in the depth of water table mainly reflect the form of surface relief. It may be noted that ground water ridge underlies each of the main canals and a ground water valley underlies each of the main stream. Influent seepage former effluent seepage into surface water bodies is not significant enough to give rise to ground water ridges or valleys.

Estimation of ground water potential

Ground water recharge in the study area occurs mainly from local rainfall, surface water bodies, irrigated fields and ground water inflow, whereas, discharge occurs by pumping from wells and ground water out flow. Discharge by evapotranspiration is not significant in the area and ground water inflow is more or less equal to the outflow. Further water table fluctuations are being significantly influenced by recharge from local rainfall and discharge by pumping from tube wells.

(i) **Recharge from rainfall:** This is the product of three parameters of aquifers, rise in average annual water table and specific yield. In case of Adityapur village of Sriniketan-

Santiniketan Planning Area, the respective values of these parameters are 800ha. , 1.56 and 16%. Ground water recharge from rainfall is calculated as:
800 x 1.56 x 16% = 19.97 ha. m.

(ii) **Recharge from canals and tanks:** This has been computed by taking into account the product of four parameters, namely, average number of canals running days in a year, average wetted perimeter, length of canals and average rate of canal seepage. In case of Adityapur village the respective values are:
170 days, 11.6m, 8km. and 5 ha. m. Ground water recharge from canals would be as:
170 x 11.6 x 16 x 5 = 78880 ÷ 1000 = 78.88 ha.m.

Recharge from Tanks in the study area has been computed by taking into account product of the total number of tanks, average water spread per tank and seepage factor. In case of Adityapur village the respective values are: 3, 0.114 sq.km. and 50cm. Ground water recharge from tanks is calculated as:
3 x 0.114 x 50= 17.1 ha.m.

(iii) Recharge from irrigated fields: It has been computed by taking into account the average ground water released at the outlet and return seepage factor (35% of water applied to the fields). In case of Adityapur village the respective values are: 500 ha. m. And 35%. Ground water recharge from irrigated fields would be calculated as: 500 x 35% = 175ha m.

(iv) Ground water in storage: The amount of utilizable ground water available from storage in an aquifer has been estimated by taking into account the product of its three parameters: its area, thickness and specific yield. In case of Adityapur village corresponding values are: 800 ha.m., 30 m. And 16%, consequently the storage for Adityapur village is
800 x 30 x 16% = 3840 ha.m.

(v) Discharge of ground water: ground water discharge in the study area occurs mainly by pumping from wells. Pumping is being carried out by different types of wells, which are public tube wells, private tube wells, pump sets and masonry wells. The average discharge for each type of well is 16, 2.2, 1.4 and 0.5 ha. m., respectively. The total volume of ground water pumped for irrigational and non-irrigational purposes comes to 3640.35 ha. m.

Table 3: Average annual ground water recharge from different sources (HA M.) In Sriniketn-Santiniketan planning area

Name Of The Villages	Average Annual Ground Water Recharge From Different Sources (In ha. M.)					Ground Water Storage (utilizable ground water) (ha. m.)	Discharge Of Ground Water (ha. m.)
	Rainfall	Canal	Tank And Others	Irrigated Fields	Total Recharge		
Adityapur	19.68	78.88	17.1	175	310.34	3840	321.3
Sian	19.05	85.29	16.2	174	313.59	3925	371.25
Ballavpur	18.72	88.55	15.05	179	320.04	2571	357.09
Binuria	17.23	85.17	17.11	171	307.74	3104	355.04
Surul	19.25	81.52	10.1	91	221.12	1052	391.25
Mehedipur	19.11	80.51	12.5	172	303.23	2950	379.22
Chandanpur	17.8	75.82	14.59	171	297.01	2978	322.57
Bolpur	19.9	80.58	5.19	25	150.57	1057	404.11
Kalikapur	18.75	82.11	15.36	152	286.97	2987	338.25
Bandhgora	19.5	70.21	5.21	25	139.42	1069	400.27
Total	188.99	808.64	128.41	1335	2650.03	25533	3640.35

Source: Srinikrtan-Santiniketan planning area, 2010

Conclusion and Suggestions

It has been observed that five villages namely Bolpur, Bandhgora, Surul, Mehedipur and Sian record over utilization and remaining record under-utilization of ground water. These five villages mentioned above have crossed their safe limit (rainfall recharge in heavy rainfall year) but there is significant unutilized ground water potential to meet out the future water demand of the area. There is urgent need for adoption of water conservation practices in the area especially to check the irrigation water losses. A proper development of surface ground water resources of the area could be affected by adoption of an irrigated plan based on conjunctive use of the resources, so that, at any time during a year, a deficit in one may be appropriately made up from a surplus in the other. However, with the almost full utilization of the surface water potential, the large unutilized ground water potential could be tapped for meeting the ever-increasing water demand of the area. A water resource development plan should be implemented in the study area so as to bring about its integrated development without environmental degradation.

References

1. *Narain, Hari, (1965): Air Borne Magnetic Survey, Proceedings of Seminar on Earth Sciences Pt. 1- Geophysics, Indian Geophysical Union, Hyderabad, 119-129.*
2. *Singh, R.L. (Ed.1971): India – A Regional Geography, National Geographical Society of India, Varanasi, 246.*
3. *Thornthwaite, C.W. and Mather. J.R. (1957): Instructions and Tables for Computing Potential Evapotranspiration and Water Balance, Publication in Climatology, Drexalinstt. of Technology, Centerton, New Jersey.Vol.8 (1).*
4. *O'malley, L.S.S. (1911): Bengal District Gazetteers, Calcutta Bengal Secretariat Book Depot.*
5. *Chakravarti, Pranab Kumar (2006): Society Development and Environment, Tourism in West Bengal: Potentials and Strategies for Development, Progressive Publishers, Kolkata, pp. 305-316*
6. *Colin, Michael Hall and Stephan, Page. (2006), "The Geography of Tourism and Recreation: Environment, Place and Space." Routledge.*
7. *Bhattacharya, Arundhati (Dec, 2011): Bhugolika, Eco-Tourism in Sundarban, Bangiyo Bhugol Mancha, Kolkata, pp. 21-24*
8. *Sarkar, Bipul Chandra (July, 2012): Bhugolika, Heritage Based Tourism in Koch Bihar District, Bangiyo Bhugol Mancha, Kolkata, pp. 7-14*
9. *Identification of Tourism Circuits across India- Interim Report, West Bengal, April 2012, Submitted by IL&FS Infrastructure, Submitted to Ministry of Tourism, Government of India.*
10. *Taware Pandurang (2008): "Indian Rural Economy", Agritourism in India, The Icfai University Press, Hyderabad, pp. 148-159*
11. *Gangapadhya, Basudeb. (2000): "Paschimbanga Parichya", Sisu Sahitya Samsad, Kolkata, pp. 38-43, 52-68, 101-107*
12. *Chakraborty, S. C. (2007): "Natural Hazards and Disaster Management", Pragatishil Prokashak, Kolkata, pp. 136-141*