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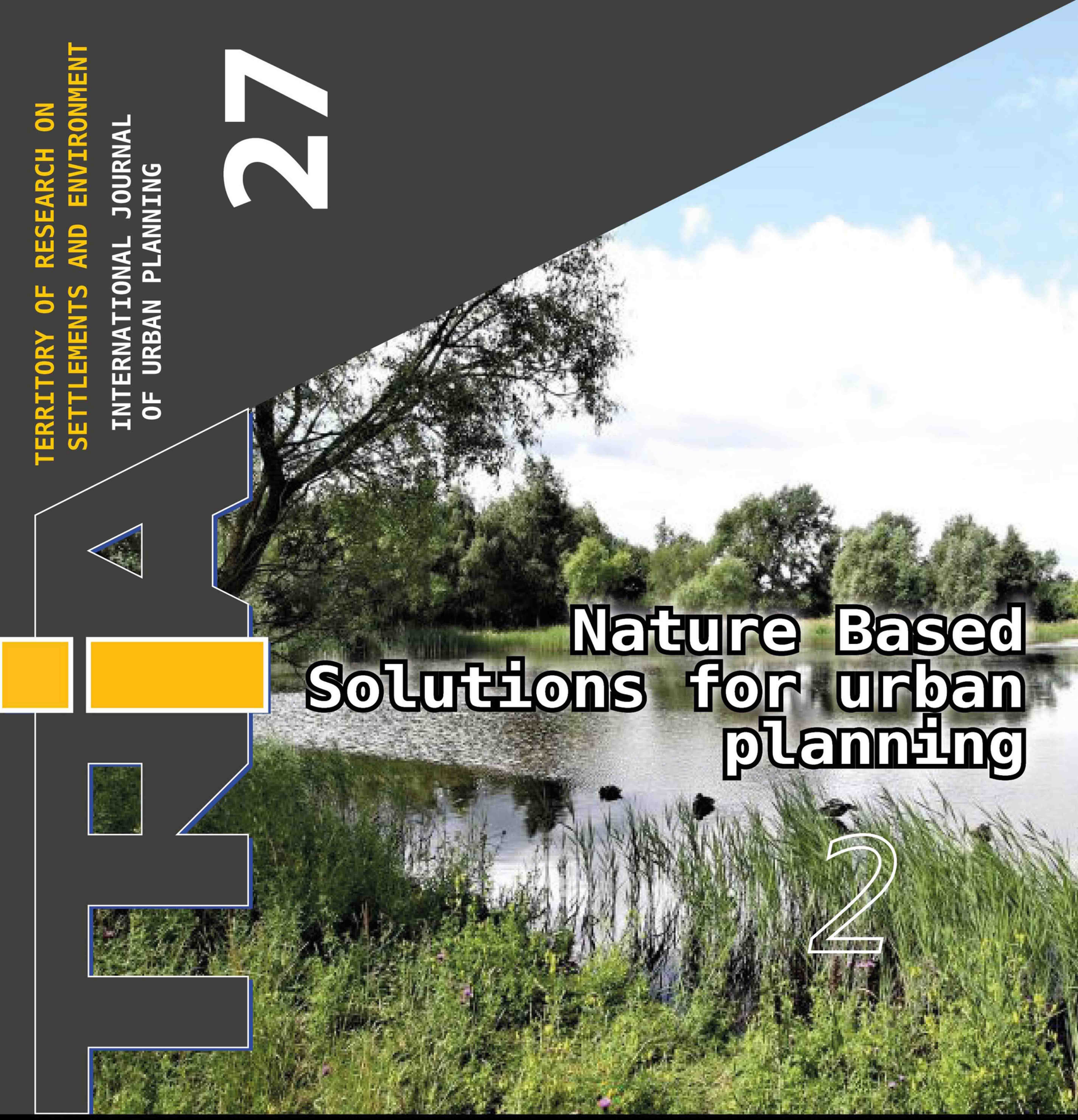

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TERRITORIO DELLA RICERCA SU INSEDIAMENTI E AMBIENTE
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abstract

Balance of ground water in urban to peri-urban sector: a case study of Berhampore block, Murshidabad district, West Bengal

Subrata Biswas

Abstract

In the age of urbanization, scarcity of ground water is a vital problem. It affects the human civilization very badly. Some irrational activity of human society, especially in the urban area put a great impact on the recharge of aquifer which in turn promote the condition of 'greater demand-smaller supply' of ground water and made it as water thrust zone. This paper attempts to find out the difference between use and abuse, evaluate the different necessity and mode of utilization of ground water and finally find some steps to overcome from the dead full situation of water scarcity. Primary data collected Bishnupur Lake (urban) and Ajodhyanagar Mouza (peri-urban) of Berhampore block of Murshidabad district, West Bengal is used as study area. The data are analysed with the help of Geoinformatics and Sample statistical technique. The study finds that both the peri-urban and urban areas require water for daily use but the rate of ground

water recharge from rain is exponentially high in peri-urban areas compared to urban and thus peri-urban area must have maintain their open space in a planned manner as the supply line of ground water. Thus attention towards the peri-urban area to mitigate water crisis in the urban areas had to be given for balancing peri-urban-urban interaction and development.

Keywords:
Urbanization, Water scarcity, Water thrust zone

Bilancio delle acque sotterranee nel settore urbano e periurbano: un caso di studio del quartiere di Berhampore, distretto di Murshidabad, Bengala occidentale

Nell'era dell'urbanizzazione, la scarsità di acque sotterranee è un problema vitale. Colpisce duramente civiltà umana. Alcune attività illogiche della società umana, specialmente nell'area urbana, hanno avuto un grande impatto sulla rigenerazione della falda acquifera che a sua volta si lega ad un concetto di "maggiore domanda-minore offerta" di acque sotterranee in relazione alle zone di faglia acquifera. Il presente contributo tenta di scoprire la differenza tra uso e abuso, valutare la diversa necessità e modalità di utilizzo delle acque sotterranee e infine trovare alcuni elementi per superare la situazione di grave carenza idrica. I dati principali raccolti a Bishnupur Lake (area urbana) e Ajodhyanagar Mouza (area peri-urbana) del quartiere di Berhampore nel distretto di Murshidabad, West Bengal, sono usati come campo di studio. I dati vengono analizzati con l'ausilio della Geoinformatica e della tecnica statistica campionaria. Lo studio rileva che sia le aree periurbane che quelle urbane richiedono acqua per l'uso quotidiano, ma il tasso di rigenerazione delle acque sotterranee da fonti pluviali pioggia è esponenzialmente alto nelle aree periurbane rispetto a quelle urbane e quindi l'area periurbana deve mantenere il proprio spazio aperto in maniera organizzata al pari dell'andamento di recupero delle acque sotterranee. Pertanto, l'attenzione verso l'area periurbana per mitigare la crisi idrica nelle aree urbane doveva essere indirizzata per bilanciare l'interazione e lo sviluppo periurbano-urbano.

Parole Chiave:
Urbanizzazione, Scarsità d'acqua, Faglia acquifera

Balance of ground water in urban to peri-urban sector: a case study of Berhampore block, Murshidabad district, West Bengal

Subrata Biswas

Introduction

In the present day world, not only the human civilization but also the whole biosphere depends upon the ground water. Thus the use of ground water is common and necessary. But the concerning fact is the misuse of ground water especially in urban sector. Thus water scarcity is a major problem towards our society. It put a greater impact in the urban area due to the unplanned urbanization. Basically the demand of ground water is found in both peri-urban and urban area but the problem regarding water scarcity is more prominent in urban area. Therefore scarcity of water brings a serious threat towards the human civilization. In fact it also estimated that the next third world war will occur for scarcity of ground water.

In this scenario, discharge-recharge equilibrium play a vital role to support the proper ground water supply and as the urban area has low amount of open space for recharging aquifer, the surrounding peri-urban sector has greater importance regarding this issue as peri-urban sector has huge amount of open space for infiltration. Now we try to establish the peri-urban-urban interaction in terms of water scarcity and proposed some steps to minimise the urban sector become a 'water thrust zone' in recent future.

Review of literature

• According to World Health Organization, "Water from beneath the ground has been exploited for domestic use, livestock and irrigation since the earliest times. Although the precise nature of its occurrence was not necessarily understood, successful methods of bringing the water to the surface have been developed and groundwater use has grown consistently ever since."

• As per the report of WTO, "The origin of fresh groundwater is normally atmospheric precipitation of some kind, either by direct infiltration of rainfall or indirectly from rivers, lakes or canals. Groundwater is, in turn, the origin of much stream-flow and an important flow component to lakes and oceans and is, therefore, an integral part of the hydrological cycle."

• Thomas C. Winter, Judson W. Harvey, O. Lehn Franke, and William M. Alley in their paper 'Ground Water and Surface Water A Single Resource' stated that that ground water is safe for consumption without treatment. Concerns about the quality of ground water from wells near streams, where contaminated surface water might be part of the source of water to the well, have led to increasing interest in identifying when filtration or treatment of ground water is needed.

• Stephen Foster in his paper,' Ground water in Urban Development: A review of

linkage and concerns' stated that 'Urban population growth in Asia and Latin America is occurring on a scale, and at a rate, unprecedented in human history. Many of the cities are sited on unconfined or semi-confined aquifers, depend on groundwater for much of their water-supply, and apply or dispose of most of their liquid effluents and solid residues to the ground. Urbanization causes radical changes in groundwater recharge, modifying existing mechanisms and introducing new ones.'

• In the paper, IMPACT OF URBANISATION ON GROUNDWATER stated that About 17.4 m3 /s of drinking water is provided to the city from surface reservoirs in neighbouring catchments; further resources for water supply have to be developed for this further growing city. One potential additional source is the aquifer beneath the city, which was developed stepwise during the last few years..

• B.M.Jha, Chairman & S.K.Sinha in their paper Towards Better Management of Ground Water Resources in India stated that the annual replenishable ground water resource of country has been estimated as 433 billion cubic meter (bcm), out of which 399 bcm is considered to be available for development for various uses. The irrigation sector remains the major consumer of ground water, accounting for 92% of its annual withdrawal.

Objectives

• Differentiate between use and misuse of ground water.

• Evaluate the necessity of ground water and their different mode of utilization of ground water in peri-urban and urban area.

• Find some steps to overcome from such dead full situation.

• Finally this paper tries to bring some questions to all to put some extra bit of attention towards the water scarcity issue.

Methodology

To prepare this paper, intensive technique was followed. Primary data are collected by the intensive survey in the peri-urban as well as urban area. For collection of primary data from urban sector, surrounding area of Bishnupur Lake is selected whereas for peri-urban area, Ajodhyanagar mouza is selected from Berhampore block.

For preparing primary data base in the peri-urban area, we chose the Random Sampling Technique. Following Random Sampling Technique we select twenty tube wells throughout the Ajodhyanagar Mouza with their Latitudinal and Longitudinal value. Then the water depth is determined from the sample sites by calculating the number of pipe used in those tube wells for water extraction. Similar process is followed in the urban area in eastern part of Bishnupur Lake. Additionally in the western part of it, the locations of thirteen flats are traced as they have the major responsibility for lowering ground water level. Besides this, for taking the perception of village and town

dwellers fifty individual surveys done from the each sector.

For computation of changeable nature of water availability in urban and peri-urban area and determining the most consistent area (urban or peri-urban) regarding water availability issue, Co-efficient of Variation technique of statistics was followed. Formula of Co-efficient of Variation-

$$C.V. = \text{Standard Deviation/Arithmetic Mean } X100.$$

$$\text{Where, } Sdx = \sqrt{((\sum(x-\bar{x})\,2/N)}$$

$$\bar{x} = \sum x/N$$

To collect the co-ordinates, GPS equipment play a vital role where as TNTmips play its role to complete the different maps. Then to construct the secondary database, I depend upon some books, journals, news paper, and open source of internet.

Selection of study area

We take the Ajodhyanagar mouza as peri-urban sample site and Bishnupur lake surroundings as urban sample site from Berhampore block due to following reasons –

I. Berhampore town is the nodal point of Murshidabad districts as it is the administrative town.

II. It has the greater intensity to capture the marginal peri-urban area in rapid and unscientific manner.

III. Population density and total population is much greater in this block, thus it denote a remarkable water consumption area which in a future surely marked as “Water Thrust Zone” or facing the problem of water scarcity.

IV. Selection of two micro level spots from urban and peri-urban area is determined on basis of presence of homogeneity in terms of ox-bow Lake: Bishnupur Lake and Chaltia bill which have great significant role in controlling the ground water table.

Ground water discharge – Recharge situation in urban area

To examine the situation of ground water mobility in the urban area, we take both sides (eastern and western) of Bishnupur Lake as our study area. Both side of this Lake situated in Berhampore Municipal area but typically those two areas of east and west part of Bishnupur Lake got different urban facility. The eastern part of the Lake acts as the transitional sector of Berhampore Municipal with adjacent peri-urban area where as the western part characterised by rapid urbanization. We take the reading (primary data) choosing Bishnupur Kalibari as landmark in the eastern part of the Lake. Regarding the water scarcity issue the depth of tube well pipe, provide important information. The data base regarding to the tube well wise water label shown by the table 1.

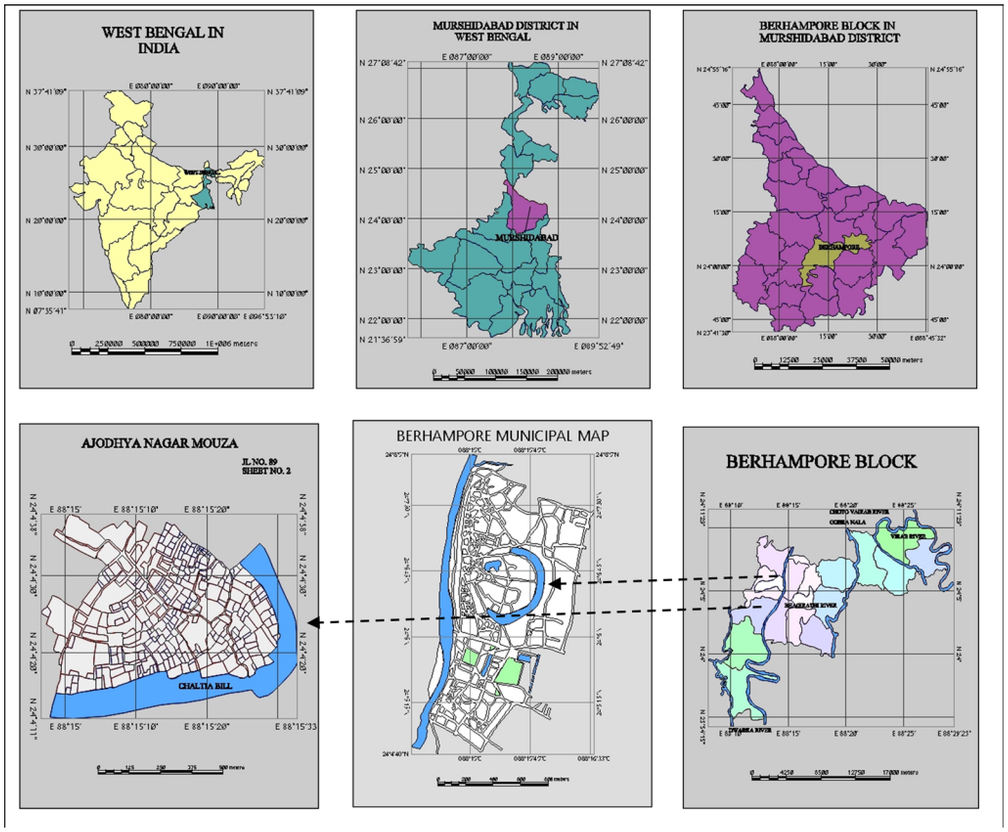


Fig. 1 – Location map of the study area.

Due to the presence of Bishnupur Lake, the upper layer availability of ground water is great; simultaneously this area is not marked by any kind of over urbanization activities such as flat culture, numerous schools building etc. The total value of pipe length of twenty randomly selected tube wells in this area is 1890 feet and the average value is 94.5 feet. This area get nearly same amount of ground water supply throughout the year. Besides this the area also facilitated by the municipality water supply that has the ability to fulfill the need of ground water to the local people.

On the other hand the western part of Bishnupur Lake is characterised by huge force of urbanization. In fact now a day, this area (Kantanagar and Indraprastha) treated as another upcoming centre of Berhampore town. Mainly the Indraprastha area is marked by huge flat culture that has a fatal impact on ground water storage. Here is a short list provided with the co-ordinate value to show the dense construction of flat in a shorter area.

These flats generally consists large number of population which has consume a huge amount of ground water per day. If the direct consumption of a person is 4 litre per day and a flat consist average 100 people, then 4000 litre is consumed by one flat per day and (4000 × 30 days) = 1,20,000 litre per month. In fact the original consumption is much greater than the aforesaid numerical value. To fulfill the huge demand nearly all of the flats used the submersible pump for ground water extraction. Thus as a combine

Tab. 1 – Tabulation for water lavel in urban areaarea. Source: Field survey

Sample no.	Latitudinal value	Longitudinal value	Water Depth (feet)
1	24°06.454'N	88°16.047'E	120
2	24°06.458'N	88°16.057'E	100
3	24°06.431'N	88°16.038'E	240
4	24°06.412'N	88°15.953'E	120
5	24°06.406'N	88°15.957'E	110
6	24°06.349'N	88°16.039'E	40
7	24°06.351'N	88°16.046'E	50
8	24°06.343'N	88°16.027'E	40
9	24°06.323'N	88°16.066'E	40
10	24°06.351'N	88°16.020'E	50
11	24°06.359'N	88°15.933'E	130
12	24°06.357'N	88°15.950'E	120
13	24°06.237'N	88°16.150'E	30
14	24°06.224'N	88°16.141'E	120
15	24°06.222'N	88°16.103'E	100
16	24°06.197'N	88°16.054'E	130
17	24°06.174'N	88°16.031'E	100
18	24°06.177'N	88°16.028'E	100
19	24°06.177'N	88°16.040'E	100
20	24°06.153'N	88°16.004'E	50
Average water depth			94.5

work of all flat the lower layer of this region is badly affected and this affected the local house holders poorly. Now a day they are pressurised for the extraction of ground water from 40 feet for their house consumption which is not in a good quality. Besides these the presence of numerous schools also promotes the condition as they also carry a huge number of populations.

According to some respondent of the region, due to establishment of those flats, the municipality water supply also affected. Few years ago or before the flat culture, due to the sufficient force of water was available and it would easily reached to the second floor

Flat sample number	Latitudinal value	Longitudinal value	Remark
1	24°06.557'N	88°15.551'E	Nearly all of the flats are characterised by submersible pump which directly responsible for the lowering of ground water label a lot in the urban sector.
2	24°06.358'N	88°15.380'E	
3	24°06.459'N	88°15.225'E	
4	24°06.465'N	88°15.222'E	
5	24°06.557'N	88°15.166'E	
6	24°06.554'N	88°15.119'E	
7	24°06.623'N	88°15.073'E	
8	24°06.636'N	88°15.104'E	
9	24°06.562'N	88°15.114'E	
10	24°06.373'N	88°15.262'E	
11	24°06.323'N	88°15.363'E	
12	24°06.314'N	88°15.381'E	
13	24°06.009'N	88°15.396'E	

Tab. 2 – Tabulation for centralization of flats in urban area (western part of bishnupur lake). Source: Field survey

where as at present it has little or no chance to reach the first floor and unconscious use of submersible pump in this area.

From the above discussion, finally we considered that due to the huge population pressure, as a whole, the urban area need huge amount of ground water per day, per week, per month and per year. And the aquifer has to be recharged meteoric water as quick as possible. But the original scene is different. Due to the urbanization oriented construction work like road construction, settlement etc covered the maximum area of this urban sector which act as the barrier to recharge the ground water and another important barrier is the construction of wall surrounding the open field (Barrack square, YMA, FUC, Stadium) produce the barrier to infiltrate the meteoric water towards the aquifer. Finally it brings the disparity between discharge and recharge in urban sector.

Ground water discharge – Recharge situation in peri-urban area

To evaluate the ground water oriented issue in the peri-urban sector, we sclected the Ajodhyanagar mouza, J.L no. – 89, sheet no. - 2 as our study area. This area situated in the south of Berhampore Municipal area. In fact, this area stays beside the Chaltia bill. Although this area is designated as Gram Panchayat (G.P.), but it sometime treated as semi urban area.

To take the primary data from this area we select twenty tube wells randomly and determined the depth of water level in this area. The data base regarding to the tube well wise water level shown by the following table.

Sample no.	Latitudinal value	Longitudinal value	Water Depth (feet)
1	24°04.493'N	88°15.407'E	40
2	24°04.513'N	88°15.334'E	40
3	24°04.514'N	88°15.346'E	40
4	24°04.437'N	88°15.360'E	40
5	24°04.429'N	88°15.338'E	40
6	24°04.366'N	88°15.298'E	60
7	24°04.318'N	88°15.336'E	40
8	24°04.358'N	88°15.303'E	40
9	24°04.363'N	88°15.304'E	100
10	24°04.382'N	88°15.253'E	60
11	24°04.376'N	88°15.265'E	120
12	24°04.285'N	88°15.158'E	60
13	24°04.371'N	88°15.072'E	50
14	24°04.358'N	88°15.034'E	60
15	24°04.418'N	88°15.057'E	40
16	24°04.411'N	88°15.058'E	40
17	24°04.430'N	88°15.042'E	40
18	24°04.427'N	88°15.043'E	60
19	24°04.516'N	88°15.116'E	60
20	24°04.511'N	88°15.118'E	50
Average water depth			54

Tab. 3 – Tabulation for water level in peri-urban area. Source: Field survey

From the above data base we consider that this area characterised by the availability of upper layer ground water due to presence of Chaltia Bill. Thus the maximum tube well uses the first layer to get ground water. Although the agricultural field in this area is marked by the use of submersible pump but it has little impact on the ground water

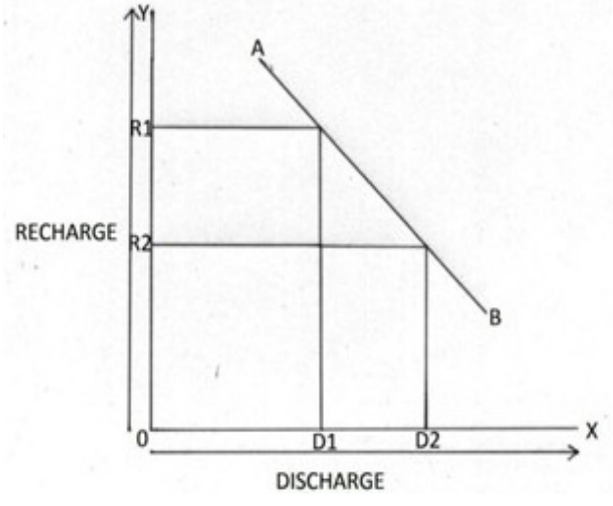
scarcity as this area is also associated with irrigation system from Lake Water. The total length of pipe of our randomly selected tube wells is 1080 feet and its average value is 54 feet. This result clearly shows the availableness of upper layer ground water in this region.

From the above analysis we find that, due to the less population pressure in peri-urban sector, the area is marked by less amount of ground water demand by the local people for their daily utilization but this area has a greater intention to use the ground water for the agricultural purpose. As the peri-urban area often characterised by open space like agricultural field, pond, down area etc. this area provide the proper geographical condition for the infiltration process which in turn maintain the proper discharge-recharge balance in that particular region.

Now we show the discharge – recharge relation in urban and peri-urban area respectively with figure 2 and 3.

Fig. 2 (on the left) – Inverse discharge-recharge relation in the urban area.

Fig. 3 (on the right) – Positive discharge-recharge relation in the rural area.



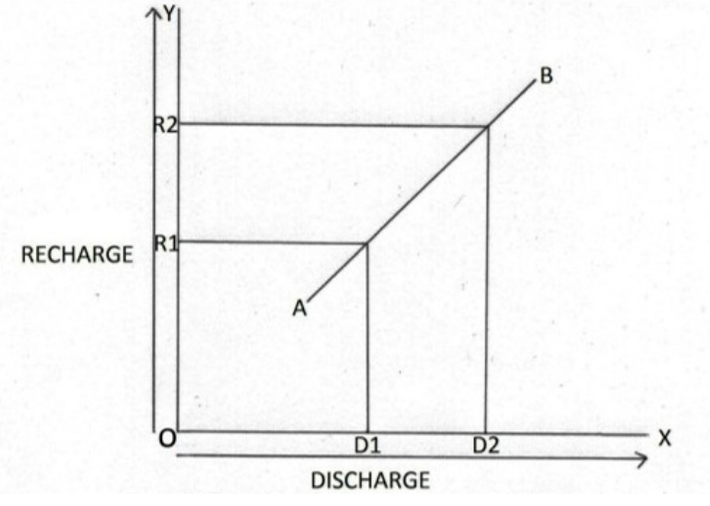
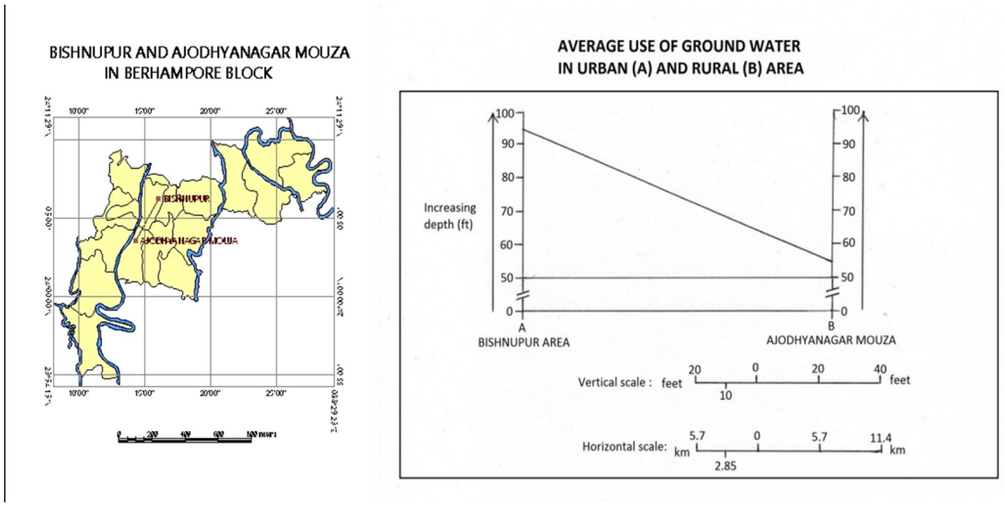


Fig. 4 – Average use of ground water depth in urban and peri-urban area



In the figure 2, urban area when discharge accounts OD1, the amount of recharge is OR1. But after some year when discharge reach to OD2 then the recharge amount is OR2. It shows the reverse relation between discharge–recharge of ground water in urban sector. On the other hand in figure 3, peri-urban area when discharge accounts OD1, then the recharge amount is OR1. Next when the discharge increases up to OD2, the recharge also increases up to OR2. That shows the positive relation between the discharge–recharge of ground water in peri-urban area.

From the calculation of primary data structure, we get the average water depth is 94.5 feet in urban area and 54 feet in peri-urban area where as the value of the Standard Deviation of the both sector are:

Tab. 4 – Water depth in Bishnupur Lake Surrounding(Urban Area) and Ajodhyanagar Mouza (Peri-urban area).

Bishnupur Lake Surrounding(Urban Area)	**Ajodhyanagar Mouza (Peri-urban area)**
$Sdx = \sqrt{((x-\bar{x})^2/N)}$ $=\sqrt{(45695/20)} \quad =47.79906$	$Sdx = \sqrt{((x-\bar{x})^2/N)}$ $=\sqrt{(8680/20)} \quad =38.57902$

There fore the Co-efficient of Variation of respective urban and peri-urban area are:

Tab. 5 – Co-efficient of Variation in Bishnupur Lake Surrounding(Urban Area) and Ajodhyanagar Mouza (Peri-urban area).

Bishnupur Lake Surrounding(Urban Area)	**Ajodhyanagar Mouza (Peri-urban area)**
$C.V. = (Sdx/\bar{x})X100$ $=(47.79906/94.5)X100$ $=50.58102$	$C.V. = (Sdx/\bar{x})X100$ $=(20.83267/54)X100$ $=38.57902$

From the above statistical analysis, the value of Co-efficient of Variation is greater in Bishnupur Lake surrounding (urban area), thus this area considered as high amount of changeable nature of water availability where as Ajoyadhanagar Mouza (peri-urban area) has the lower level of Co-efficient of Variation. Hence, this area indicate stable condition and act as more consistant nature in terms of ground water availability.

Threats of water scarcity in recent future

1. Capturing of peri-urban area by the process of urbanization is a vital problem in this condition. As the urban area is covered by settelment, road that are basically restrict the infiltration. Later on, this condition provide lower amount recharge of ground water.

Example: present day Kolkata Metropolitan originate from three small villages named Kolkata, Sutanuti and Gobindapore.

2. Flat culture is one of the most important threat in present day scenario. Basically

those flats are multistoried building that consists several families. Thus the flats have huge pressure of population that have sudden requirement of ground water. To fulfill their requirement the flats often use the submersible pump but the use of those pumps in town area is truely illegal. The frequent use of those pumps are very harmfull for the lower layer ground water.

For evidence of the above statement, one respondent Mrs. Sumita Ghosh told that after construction of flat beside her house she have to change her 100 feet depth tube well into 40 feet due to unavailability of ground water.

3. Another problem in the town sector is the destruction of openness of field. Generally the open space in the town area is very little. If that area is barricaded by concrete in the name of gorgeous looking of the city, it put a bad impact on the surface run off which in turn put negatively impact on the ground water recharge.

For evidence of the above statement we consider four fields from Berhampore Municipal area characterised by such problem recently. But in past when the fields are open no such problems are arising. A chart is provided to support the above view.

Finally the urban sector are characterised by imbalanced discharge – recharge due to various activity of human beings. Often they utilised the ground water in such a way that it will finished very soon. Thus this unscientific way of ground water utilization generate fatal ground water condition for the future generation and provide the unstill condition in terms of water sustainability.

Steps toward the sustainable balance of ground water between peri-urban and urban area

There are three dimensional steps regarding to the sustainability of ground water. The dimensions are as follow.

A. Steps against the problem in urban area.

B. Steps against the problem in peri-urban area.

C. Combined steps for both peri-urban and urban area.

A. Steps against the problem in urban area:

i. Major portion of the town area has a long history and maximum of them are originated from a small village. Therefore, the expansion of area is a natural characteristic of urban sector that directly promote the number of population as well as the rising demand of ground water. Therefore, the unplanned technique of urbanization must be restricted.

ii. To maintain the sustainability in the urban sector in terms of ground water, the proper management only be done by plan full way and this thought creates the plan city in later stage like Kalyani. Therefore the number of plan city must be increased in terms of ground water restoration as it provides maximum amount of open space for ground water recharge.

iii. Now a day, the waste of rain water in the urban area is a common matter and in the age of shortage of ground water, it brings a greater threat to human society. Therefore

Tab. 6 – Analysis on the sample sites.

Name of sample site (field)	Co - ordinates		Supporting photographs
	Latitude	Longitude	
BARRAK SQUARE	24°05.726' N	88°15.037' E	
YMA	24°05.411' N	88°15.318' E	
FUC	24°05.856' N	88°15.286' E	
STADIUM	24°05.566' N	88°15.499' E	

the rain water harvesting in both private and public (in adjacent field) point of view, must be incorporated.

iv. The municipality must have taken some more strict steps towards the flat owners in terms of using the submersible pump. Some rules and regulation must be made and implied in a systematic manner. Besides this, the public awareness also increased

against the flat culture.

v. Now a day, the marginal part of urban area marked by the small scale water plant. These water plant also characterised by the use of submersible pump which directly lowered the ground water level. Presently some illegal small scale water purifying plant also developed in between the urban area. Therefore administration as well as the local people must have aware from the condition.

vi. Proper management of existing water body also play a vital role. Maximum time it is noticed that the existing water bodies are loss its volume due to miss management. Thus, this technique has a vital role to play in present day scenario.

B. Steps against the problem in peri-urban area:

i. Present day is marked as the age of peri-urban area development. But somehow, this developmental work put some negative impact on the ground water storage. Thus the sustainability in developmental work is very much important in the peri-urban sector.

ii. Peri-urban area also characterised by some pond, lake or dighi and open field. Now we have to take some initiatives to the proper maintenance of those area because those area generally marked by the infiltration ground.

iii. In the peri-urban area, scientific accumulation of non – degradable wastage like plastics materials must required. Otherwise it acts as a barrier to infiltrate the rain water recharge the ground water storage.

iv. In the agricultural field, the crop rotation in terms of water thrust must be needed. In a long term basis, it provide a sustainability to the balance of recharge – discharge in ground water.

C. Combine steps for both peri-urban and urban area:

i. A vital role should have played by the government and non – government organization for awakening the people about the fatalness of ground water scarcity in present and forthcoming days.

ii. Bring the public awareness a lot in peri-urban area to use of ground water

Conclusion

However now a day, water scarcity is considered as a major problem, thus we have to look after it with a greater importance. Basically the division of peri-urban and urban sector is a culturally developed division above the earth surface. But scarcity of ground water is such a dangerous problem which does not maintain the manmade barrier like urban or peri-urban area. Thus in future, it brings major threats toward the human civilization. That's why, to restrict this serious threat the people of both urban and peri-urban area have to play some additional role in terms of water scarcity. Finally this fatal problem put a serious question toward us. The question is as follow:

"Which one is most necessary task in today's world? – developed the urban life style or survive the biotic element of society including human beings."

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