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Ground water depletion due to acquisition of agricultural land for city development: A case study of kolkata new town

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Abstract
This paper aims to understand how acquisition of agricultural land as well as destruction of irrigation system affects the ground water recharge in Kolkata New Town area. Kolkata New Town is a planned township project, developed to solve the 'crowding, congestion and squalor' problems of Kolkata Metropolis. 3075 hectare of land has been acquired for this purpose, of which 68.36% was agricultural land. The acquisition obviously led to forced livelihood change of the people who had been engaged to the acquired agricultural land. As well as the flora and fauna which survived within the agro-ecological system of this area are lost. Hence emergence of this new town, whatever may be the purpose of its building has brought forth many environmental damages. It is observed in this study that the area which was once well irrigated through RLIs (River Lifting Irrigation) has been acquired for a new city. The acquisition of agricultural land is now associated with i) a sharp fall of ground water level, ii) degradation of the quality of the ground water as well as iii) a high environmental cost due to halting of ground water replenishment through irrigation. Environmental services must be considered seriously before acquisition of rural land for urban purposes.

Keywords: new town, land acquisition, ground water recharge

Introduction
In need of housing of the growing population in large cities**,** agricultural land is often acquired by the Government for expansion as well as development of the new township. In this process, due weightage is rarely given on the ecological services which the agricultural fields cater. The ecological service that are maintained by the cultivation includes: decontamination of water and purification of air, flood easing, preservation of biodiversity, decomposition of wastes, soil and vegetation production and renewal, groundwater recharge, aesthetically pleasing landscapes. Overlooking of the ecological aspects in turn brings up several environmental crises in near future. This paper aims to understand how acquisition of agricultural land affects the environmental services particularly Ground Water Recharge with a case study of Kolkata New Town.

Objective
Objectives of this study are:
1. To overview the irrigation system which once persisted in the study area,
2. To view the temporal changes in rainfall and ground water level as well as its quality in the study area,
3. To estimate the maximum percolation depth of available surface water and its temporal variation,
4. To calculate the changes in volume of water which in turn recharge the ground water.

Methodology and Data Base
1. The total volume of water discharged from the midi RLI is calculated by multiplying number of RLI with the average volume of water discharged during pre-monsoon.
2. Height of the irrigated water of each irrigation process has been calculated dividing total volume of discharge by total command area under RLIs.
3. The standard rate of water percolation in the area of clayey loam soil with boro paddy cultivation is considered to estimate the amount of percolation which in long run could recharge the ground water.
4. The irrigated water which once recharged the ground water is priced to find out the cost caused by city development.

The following parameters are concerns to estimate the amount of percolation and its cost:
1. Amount of Pre Monsoon Rainfall (1997-2012),
2. ii)The Depth of Ground Water Level,
3. The Number of RLI, Discharge and Area Coverage of the Midi River Lifting Irrigation (RLI) system,
4. The Rate of Water Percolation at the time of boro rice cultivation in clayey loam soil.

Background of the Kolkata New Town Planning
Main intention behind the Kolkata New Town planning was to provide the buildable land for construction of the dwelling units for all income groups. In the year of 1990, it was estimated by the CMDA (Calcutta Metropolitan Development Authority) that the average annual additional need for housing in the CMA (Calcutta Metropolitan Area) was about 70,000 dwelling units. In 1993, The Department of Housing, Government of West Bengal constituted a Technical Committee in

collaboration with Indian Institute of Technology (IIT), Kharagpur for preparation of a preliminary report on New Town; in 1996 they submitted a report entitled 'Physical Structure and Master Land Use Plan'. In 1999 WBHIDCO was formed to do the infrastructure development in New Town. New Town Kolkata has been planned for an area of about 3075ha of lands of which 68.36% was agricultural land, including cultivated land, fishing grounds or veri and low lying paddy cum fishing ground. This cause the enormous amount of land title transfer.

The Study Area

The New Town project area is located on the Hooghly river basin and consists of fertile alluvial soil. The texture of the soil is silt and clayey loam. The terrain is flat and is gently sloping south-southeast ward. The land acquisition was done by the BL&LRO (Block Land and Land Reforms Office) of N & S 24 Parganas, West Bengal. At present New Town Kolkata spreads over Rajarhat and Bhangor II block of N and S 24 Parganas of West Bengal (Fig: 1)

Irrigation System before Land Acquisition

In the year of 1975 the RLI scheme was introduced in the local canals like Bagjola, Krishnapur and Nowai, as a part of 20 point programme of the Central Govt. Particularly the Bagjola Canal is under this project area where 15 number of Midi RLI were installed. After the installation of RLIs, almost all the cultivated land turned into 'tin fasali jami' (three cropped land).Three crops of paddy were cultivated, such as aman, boro, and aus. Besides, the villagers used to grow varieties of vegetables (peas, cabbage, cauliflower, brinjal, tomatoes etc.) in their upland field. Till (sesame), pulses and mustard are the other cash crops. During monsoon season, when the low-lying lands were filled up with rain water, numerous local varieties of fishes became abundant. So till 1999, the area was cultivated extensively. At the time of acquisition, 9 RLIs in Rajarhat Block were active which had irrigated 360 $ha^3$of agricultural lands. The RLI water was needed only for boro rice cultivation during pre monsoon season (March, April and May).

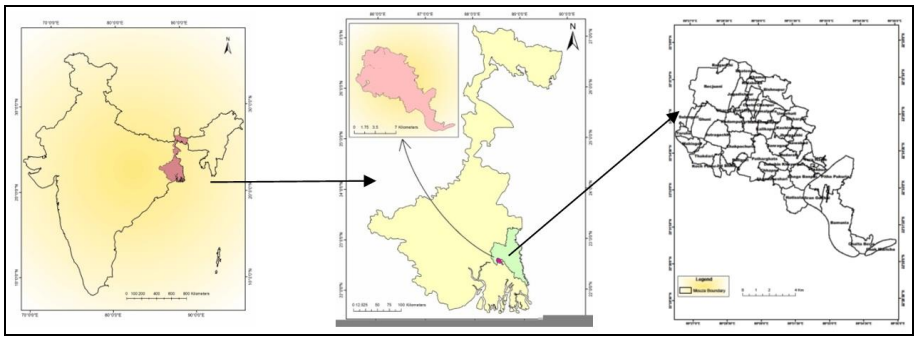


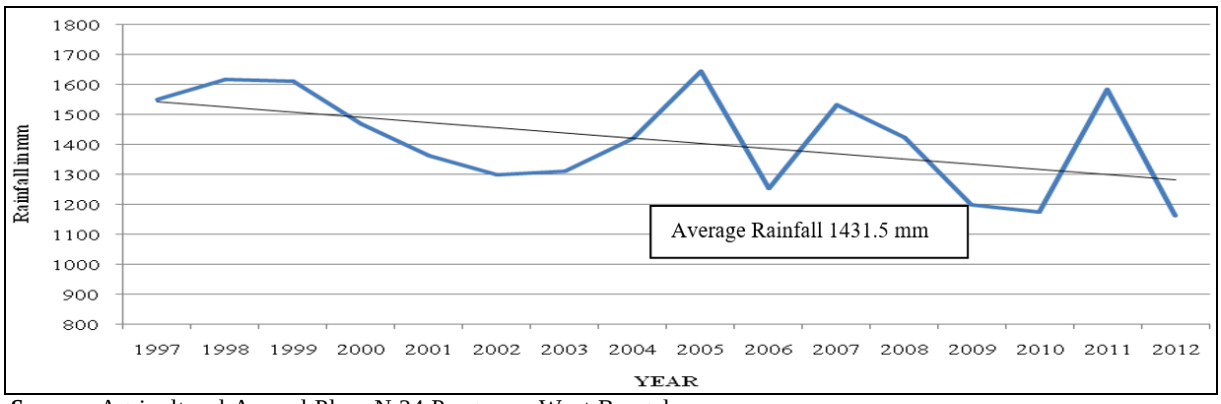
Fig 1: Location of Kolkata New Town

Rainfall and Ground Water Characteristics (Before and After the Land Acquisition)

The temporal variation of the rainfall of the Project area during the period of 1997 to 2009 (Fig-2), shows a decreasing trend of rainfall particularly after land acquisition (1999). The average rainfall during this period is 1431.15mm where as the average rainfall during the period of 1970-1997 was 1679.10 mm (Agro meteorological Division, Government of West Bengal). Transfer of green field into built-up area may be one reason of decline of local rainfall.

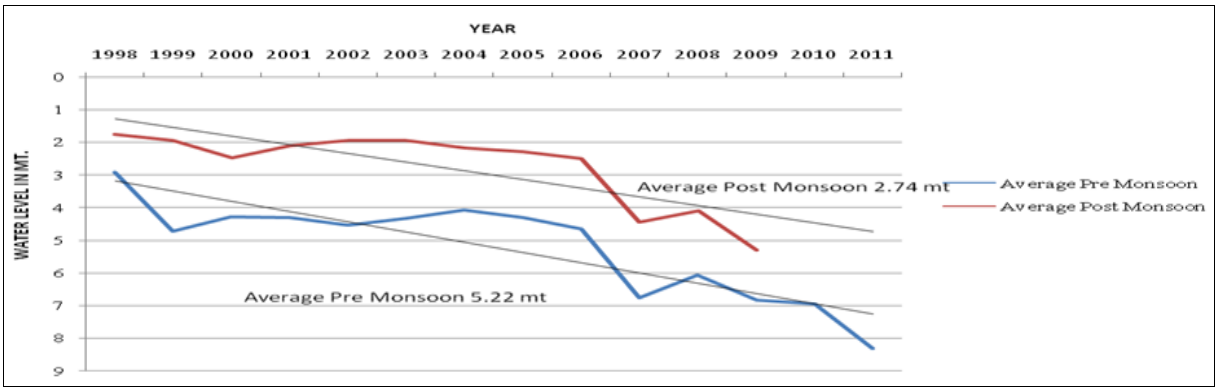
Change of Ground Water Level

The average of the pre and the post monsoon water level is 6.06 mt. and 4.1 mt. respectively (1998- 2011). But the level of ground water is gradually falling down in both pre and post monsoon season since 1998 (Fig 3).



***Source*:** Agricultural Annual Plan, N 24 Parganas, West Bengal

Fig 2: Temporal Rainfall Variations



***Source*:** State Water Investigation Department, Kolkata

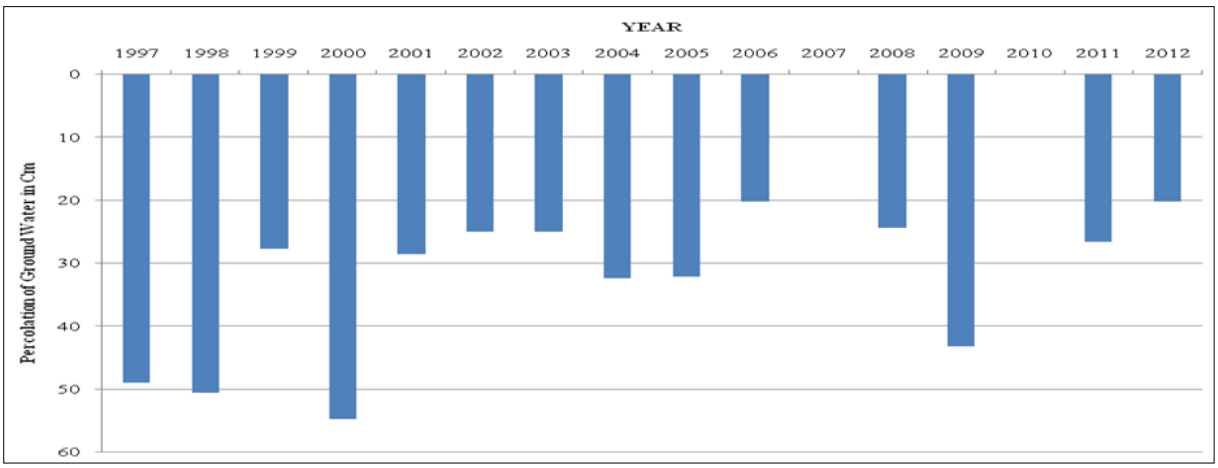
Fig 3: Temporal Changes of Ground Water Level

Reasons behind the Lowering of the Ground Water Level

After land acquisition, the RLI scheme has been withdrawn by the Govt. In presence of the RLI, the area received irrigated water in addition to rainfall. It facilitated the recharging of the Ground Water.

The concretization of the area for the development of the New Town and the demolition of the RLIs affect severely the percolation of the water. Moreover till 2015, The Public Health Engineering Department, Government of West Bengal met the demand of water, by using the underground water. In pre- monsoon period irrigation from RLIs make soil over saturated and during monsoon season the soil water recharge the ground water as gravity flow.

The estimated maximum water percolation during 1997 to 2012 (Fig-4) gradually decreases. The Acquisition of agricultural land causes the loss of irrigation facilities which lead to the loss of Ground Water. The waste water of the Bagjola Canal was used for irrigation purpose. It was



***Source*:** State Water Investigation Department, Kolkata (*2007, 2010 data not found)

Fig 4: Changes in Estimated Maximum Water Percolation

estimated that 198million liter of water from this canal was lifted for irrigation during the year of 2001. Following the standard percolation estimate (Received Water X Bulk Density (i.e., 1.4)) for irrigated Boro paddy cultivation in clay loam soil, 53.5 million litre water (i.e 27% of total discharged water,pp 6, Fatema Aftab) might be percolated down and dampen the soil. The agricultural activities filter the waste water biologically.

Besides these, cost of degradation of quality of groundwater due to least percolation along with excessive withdrawal of ground water is also immense. The Specific Conductivity, Total Dissolved Salt, and Total Hardness as CaCo3 of the ground water level is increased (Table: 1).With increasing TDS, the electrical conductivity (EC) or salinity has been increased. Water with a TDS above 500 ppm and Total Hardness as $CaCo_3$ above 200 ppm is not recommended for use as drinking water (Indian Standard Drinking Water Specification, 2015).

The other ecological services that are obstructed due to urbanization are as follows: The Bagjola and Krishnapur canal are used as the drainage of waste water flowing from neighboring urban centers. Rapid urbanization in the New Town area has caused heavy siltation in the Bagjola and Krishnapur canal, depth of silt at places as high as 1.5 meters (pp 60, Chakrabarty Kakali *et al.*, 2015) [2]. This is responsible for the flooding conditions of the New Town Kolkata (TOI, August

Table 1: Quality of the Ground Water

Pre Monsoon	Specific Conductivity umho/cm at 25^0 C	TDS PPM	Total Hardness as CaCo3 ppm
2004	715	457.5	290
2005	Data not Found		
2006	650	416	105
2007	1555	1017.5	800
2008	1055	675	805
2009	Data not Found		
2010	1146	733.4	325
2011	1213.3	816	255

***Source*:** State Water Investigation Department, Kolkata

25, October 10, 2011). There is a loss of edible flora and fauna due to agricultural land acquisition. Furthermore agricultural land around the city could act as Green Belt for the city.

Conclusion

It is observed in this study that the infrastructures which had been evolved through time as per people's need and State's efforts in pre New Town time became either defunct or were destroyed. There is loss of the public property due to demolishing of the RLIs, which cost INR 2.4 million (Government's estimation of the cost of installation of medium RLI at present value, Jalasampad Bhawan, N 24 Pgs, Barasat). Percolation of irrigated water which once enriched the ground water comes to halt. As a result, ground water level is felling down as well as the quality of the ground water is deteriorating. Ground water depletion and deterioration are serious problems for many other planned townships in India. Ecological Cost of acquisition of agricultural land for urban development must be considered with due importance.

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