GROUND WATER UTILIZATION AND CROPPING PATTERN: A GEOGRAPHICAL INVESTIGATION IN HUGLI DISTRICT IN WEST BENGAL

Shyamal Dutta*

Abstract
Irrigation is the most important input required for successful cultivation of new seeds. Adoption of High Yielding Varieties (HYV) and intensification of agriculture in a country like India without the availability of irrigation is not possible. Indian agriculture is a gamble in the hands of monsoon since groundwater utilization may be considered as one of the important sources of irrigation throughout the year to supply water for proper seed germination in agricultural fields in India in general and every state in particular. This article is an integrated draft to focus on the present day situation of the correspondence between groundwater utilization and cropping pattern on block level in the Hugli district in West Bengal, India. After applying different methods and techniques (Pearson's product moment correlation coefficient, Residual analysis *etc.*) it has been concluded the aforesaid area has a positive but low correspondence between these two variables. Therefore the upward increase of cropping intensity in various blocks is not governed by the groundwater utilization alone. So, there are other physical, socio-economic as well as institutional factors too.

Key words: Irrigation, Groundwater Utilization, Cropping Intensity, Residual Analysis

Introduction

Human effort to fight nature's niggardliness in the supply of water to agriculture takes the form of irrigation in the first attempt. The Major function of irrigation is to mitigate the impact of irregular, uneven and inadequate rainfall with wide fluctuations from year to year. It averts serious and semi-famine conditions. It also supplements supply of rainwater in the monsoon months of country like India where rainfall in most regions in the monsoonal months of June to September (Bansil, 1981). The additional supply of water makes possible harvesting of two or three crops of cultivation of crops requiring perennial water supply. Irrigation has assumed an increasing significance under Indian agriculture in the context of the new technologies where HYV and multiple cropping patterns are being practiced. Water requirements are continually increasing with rapid industrialization and increased agricultural production, and the demands are generally met from surface as well as from underground water resources. In areas where the possibility of further utilization of surface water is limited, depending on the underground water reserve increases. Although the availability of groundwater is still very limited for irrigation, it is more or less assured because it is largely under human control. The development of agriculture in our country has been possible by the introduction of HYV seeds, assured irrigation and other agro-inputs.

*Assistant Teacher, Gadadharpur Bazar Jr. High School, Birbhum: 731234 (W.B., India)

Therefore alternative to surface irrigation i.e., tapping groundwater for irrigation may be considered as one of the inputs. The protective irrigation has an important bearing on the expansion and shrinkages of cropland. In this section an attempt has been expended whether the utilization of groundwater has any correspondence to the growth of gross cropland in the aforesaid region.

Location and Hydrogeology

The area under study is located between the River Hooghly on the east and the Damodar on the west. It is bounded on the south by the River Rupnarayan and in the north by the district of Burdwan. The project area covers approximately 4625 km^2 and lies between latitudes 22°N and 24°N and longitudes 86°E and 88°E. The soil in the west of the area is characterized by the presence of laterite. However, from the eastern bank of the River Dwarkeswar the land is typically characterized by an alluvial terrain with a gradual slope from north to south. In the south, marine clays and clayey fine sands predominate. Subsurface lithologies up to a depth of 300 m. from the surface comprise mainly of clay, silt and sand of different grades varying from fine to coarse, occasionally mixed with fine gravel. Potential granular horizons occur mostly within the first 150 m. The lithologies also show that granular zones occur at a greater depth as one goes from north to south. The total thickness of the aquifer varies from 30 to 40 m. In addition to the deeper potential aquifer, there is a near-surface aquifer within a depth of 40—50 m, suitable for small diameter shallow tubewells. However, deviations from this general trend occur in the western and southern parts of the territory (Bhattacharjee, 1979). Groundwater occurs in a thick zone of saturation within the alluvium. It exists in water table conditions in the entire northern part due to the absence of effective confining clay beds. In the south the groundwater is confined or partially confined, depending on the presence of clay beds of varying thickness above and below the aquifer (Bhattacharjee, 1979).

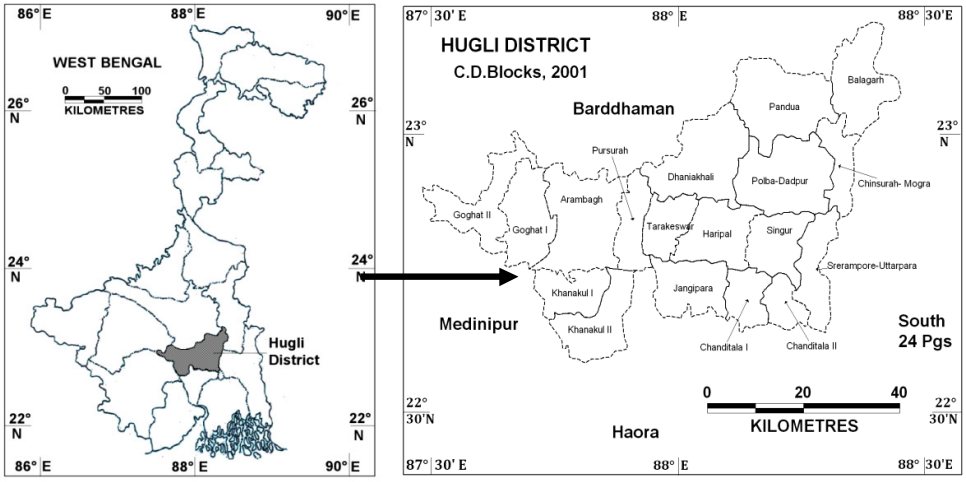

Figure 1: Location Map of the Study Area

Materials and Methods

This entire work is mainly based on secondary data *i.e.*, collected from District statistical Handbook of Hugli District (2008), District Census Handbook of Hugli District (2001), West Bengal State Water Investigation Directorate (SWID), District Gazetteer of Hugli District and many others literatures and research papers (Table No. 1).

After collecting block level data of Net sown area (NSA) and Gross cropped area (GCA), cropping intensity has been calculated by following formula:

$$\textit{Cropping Intensity} = (GCA/NSA) \times 100$$

Block level utilization of ground water in irrigation purpose has been calculated from the data provided by West Bengal State Water Investigation Directorate (SWID) in a report in November, 2010. Considering these two variables, Product moment correlation coefficient (Karl Pearson's method), regression analysis and residual analysis have been done with the Microsoft Exel-2007 software. Finally, different thematic maps also have been prepared with the help of MapInfo Professional-7.0 software to ascertain the magnitude of these two variables and their spatial implication.

Results and Discussions

On the basis of the percentage utilization of ground water in irrigation sector relative to total available ground water resources of the area, four categories of groundwater utilization regions may be distinguished as very low, low, medium and high (Fig. no. 2).

Groundwater Utilization Regions

a. **Very Low Utilization:** Among the eighteen blocks in the Hugli District, five blocks i.e., Dhaniakhali, Haripal, Chinsurah-Mogra, Chanditala II and Khanakul II are included in this category where the groundwater utilization becomes below 20% relative to available resources.

b. **Low Utilization:** In these categories seven blocks *i.e.*, Pandua, Balagarh, Polba-Dadpur, Singur, Srerampore-Uttarpara, Jangipara and Chanditala I are included with the percentage values ranging between 20.1 to 40.

c. **Medium Utilization:** This grade is represented by five blocks namely Goghat I and II, Arambagh, Khanakul I and Tarakeswar with the values between 40.1 to 60.

d. **High Utilization:** This is recorded only in a block *i.e.*, Pursurah where the percentile value exceeds 60.

Table 1: Block wise Distribution of Groundwater Utilization & Cropping Intensity Hugli District, 2008

C.D. Blocks	Percentage of GW utilization in Irrigation to total available resources, 2008	Net Sown Area in hec. (2001) [A]	Total cropped area (hec.) [B]	Cropping Intensity [B/A*100]
Dhaniakhali	18.38	14339.37	42419.00	295.82
Pandua	31.07	14456.22	44936.00	310.84
Balagarh	39.72	20562.82	30330.00	147.50
Chinsura-Mogra	13.97	8497.26	5670.00	66.73
Polba-Dadpur	39.28	8152.15	43537.00	534.06
Tarakeswar	53.24	21614.91	22103.00	102.26
Haripal	19.70	21166.92	30636.00	144.74
Singur	27.04	14115.53	22706.00	160.86
Jangipara	23.22	3828.37	24334.00	635.62
Chanditala I	29.92	21741.92	13179.00	60.62
Chanditala II	18.21	13556.06	3672.00	27.09
Srerampore-Uttarpara	20.13	10765.56	774.00	7.19
Goghat I	41.07	1561.14	27673.00	1772.61
Goghat II	59.86	6791.60	36134.00	532.04
Arambagh	48.56	3146.64	48844.00	1552.26
Khanakul I	43.80	12710.73	29101.00	228.95
Khanakul II	14.99	11826.64	12973.00	109.69
Pursurah	81.59	10324.95	20342.00	197.02
Total	**34.75**	**219158.79**	**459253.00**	**209.55**

(Source: West Bengal State Water Investigation Directorate (SWID), Nov.2010 & District Statistical Handbook of Hugli District, 2008)

High rate of exploitation of groundwater is being encountered only in a single block (*i.e.*, Pursurah) and therefore it may be assumed that other forms of irrigations (*e.g.*, surface irrigation) are not favoured in this block. On the other hand, Medium to low utilized zones in respects of groundwater gives the possibility of other forms of irrigation being utilized sufficiently.

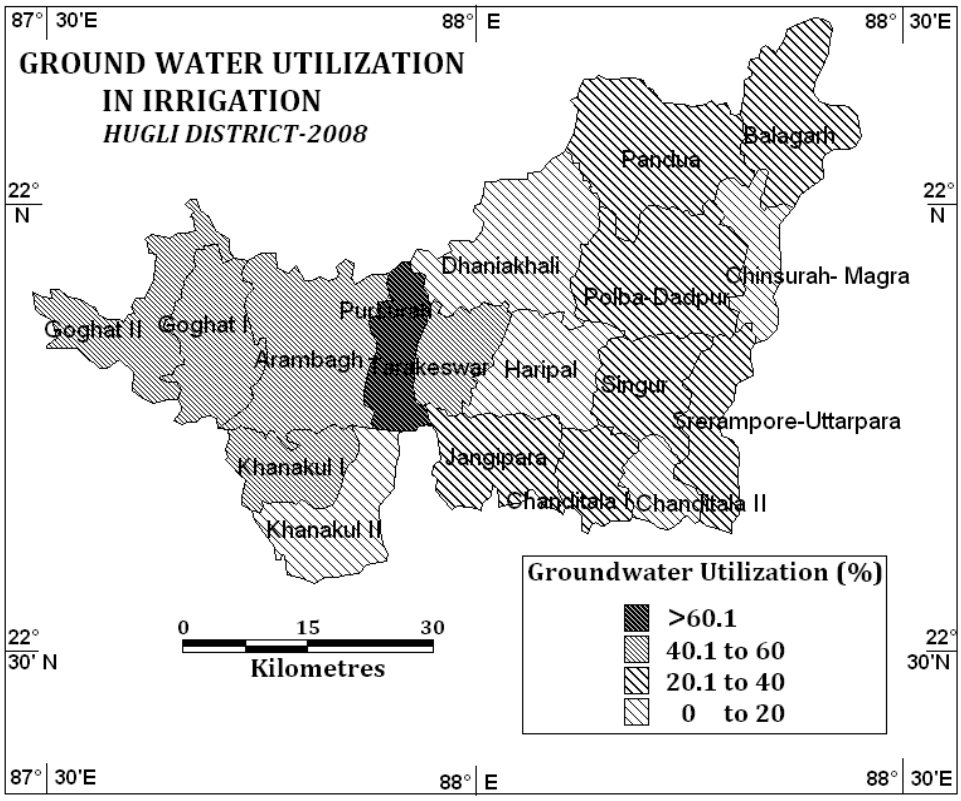

Figure 2: Block wise Groundwater Utilization in percentages in Hugli District, 2008

Cropping Intensity Regions

Normally an overall increase of gross cropped area in the net sown area is discernible over the region. This indicates that the double and multiple croplands are being served by assured water supply in terms of irrigation. The unique picture is that in Pursurah block where the groundwater utilization is maximised (*i.e.*, 81.59%), the percentage of gross cropped area also records high (*i.e.*, 197.02) compared to the other blocks thereby signifies a positive relationship between the groundwater utilization and the cropping intensity. This is in the general the pattern of the district.

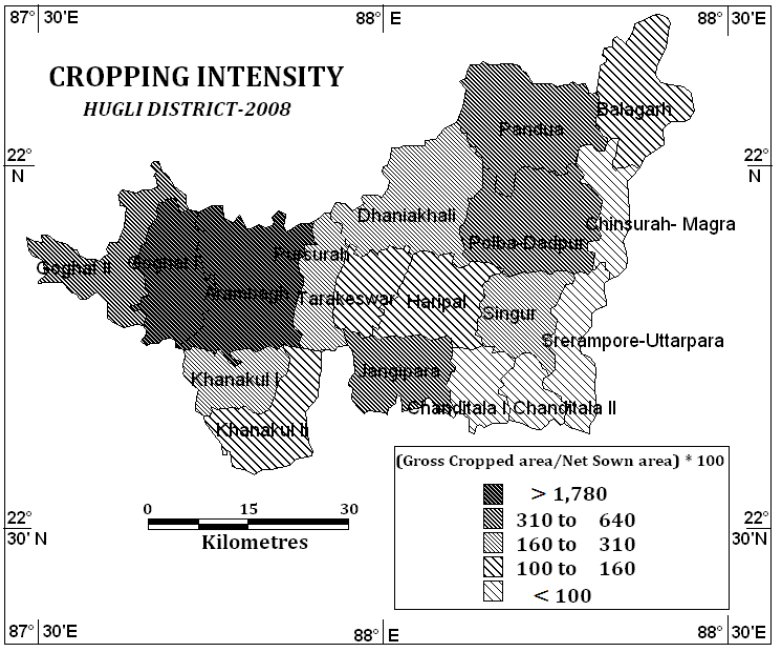

Figure 3: Block level Cropping Intensity in Hugli District, 2008

Table No. 1 Block wise Cropping Intensity in Hugli District, 2008

Cropping Intensity	Value in Percentages (GCA/NSA*100)	Number of Blocks	Name of the Blocks
Low	0-100	4	Chanditala-I &II, Chinsurah-Mogra, Srerampore-Uttarpara
Moderate	100-160	4	Haripal, Tarakeswar, Balagarh, Khanakul-II
High	160-310	5	Goghat-II, Khanakul-I, Dhaniakhali, Pursurah, Singur
Very High	310-640	3	Jangipara, Pandua, Polba-Dadpur
Very Very High	>640	2	Goghat-I, Arambagh

(Source: District Statistical Handbook of Hugli District)

Degree of Correspondence and Residual Analysis

In this part of analysis percentages groundwater utilization and cropping intensity have been assessed as independent (x) and dependent variables (y) respectively (Fig. No.4). From the arrangement of dots and orientation of best fit line ($y_c = a+bx$), it is clear that both the variables are positively correlated. The calculated value of Pearson's product moment correlation coefficient (0.27) for the district as a whole and block in particular signifies that the correspondence is by no means strong. Therefore, the upward increase of cropping intensity in various blocks is not governed by the groundwater utilization alone. There are other sources of water supply *e.g.*, culverts, causeways, river lifts, dug well, tanks, abandoned river beds, *jhil*s, *bill*s and more important irrigation canals upon which depend the irrigation facility so as to increase the cropping intensity of the respective blocks over the area (Fig. no. 5).

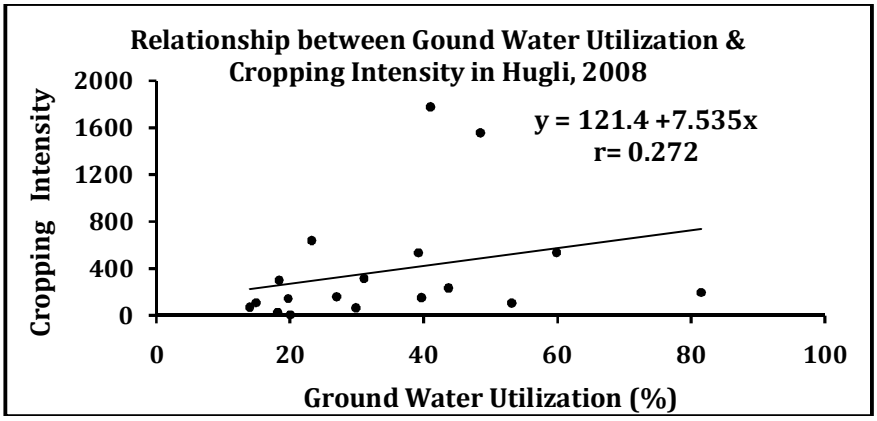

Figure 4

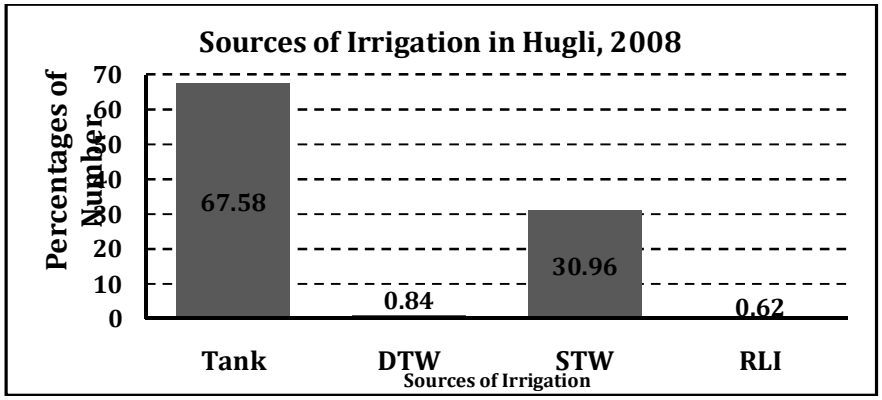

Figure 5

Residual mapping is attempted to portray the zones of strong and weak correspondences between the two variables. The higher values of the residuals denote lesser correspondence between these two variables which reflects in the thematic map as darker shading (Fig. no.6). Thus it is evident that rather strong correspondence having residual +200 to -200 is found in the east central part (Polba-Dadpur, Dhaniakhali, Haripal, Pandua and Chinsurah-Mogra) and in some area of the south-western Hugli (Goghat II & Khanakul II). The lesser correspondence zone coincides with the central to west-central part (Pursurah, Arambagh, Tarakeswar) where residual values are greater than ±400.Among the whole region adjoining to Hugli River in the south-eastern part of the district have the moderate level of correspondence where residual value ranges between 200 to 400 and -200 to -400.

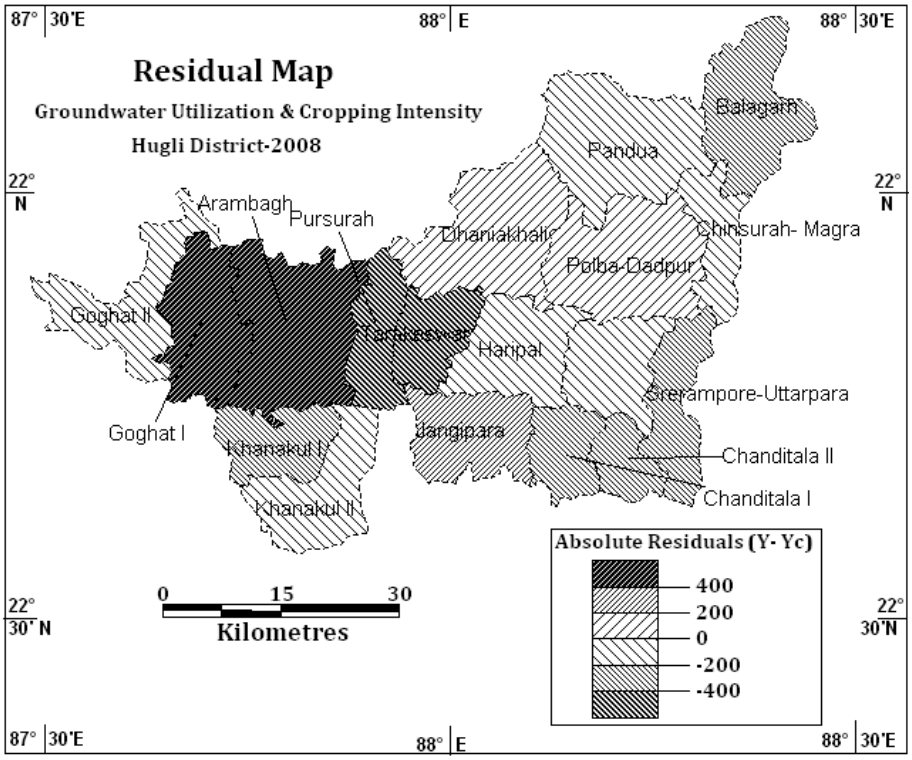

Figure No. 6 Residual analysis between Groundwater Utilization (%) and Cropping Intensity in Hugli District, 2008

Conclusion

Percentage increase of the cropping intensity *i.e.*, percentages of total cropped land to net sown area is not the result of a single economic factor but the combination of natural, human and cultural factors. Over Hugli utilization of groundwater ranges from low to high. It is worthwhile to note that the correspondence between these two variables is however, marked in those areas where

the supplementary facilities from canal, rivers and other sources are lacking. Though in whole district other source of surface irrigation prevailed but exploitation of groundwater to meet the water demand in agricultural field is also taken places at a medium rate (35-40% of available resources). So, it should maintain to check the use of groundwater, because due to urbanization and suburban effect concretalization takes place, which reduce the groundwater recharge and will restrict the future use. So it would be better to use surface water resources to meet the irrigation demand. In urban area and suburban blocks rain water harvesting techniques (*e.g*., roof-top RWH, dug well to store rain water *etc*.) may effective to reduce the use of groundwater.

References

Bansil, P.C., (1981), Agricultural Problems in India, Oxford & IBH Publishing Co., New Delhi.

Bhattacharjee, B.K. (1979), Hydrogeological study of potential groundwater in the two southern districts of West Bengal, India, The hydrology of areas of low precipitation (Proceedings of the Canberra Symposium, December 1979; Calcutta, India. IAHS-AISH Publ. No. 128.

Chakraborty, B.K. (1985) Groundwater utilization vis-a-vis cropland of Hooghly-Some Considerations, The Concepts and Methods in Geography (ed.), Institute of Geography, Burdwan University, West Bengal, India.

District Statistical Handbook, 2008. Hugli, Published from Bureau of Applied Economics & Statistics, Govt. of West Bengal. India

Hussain, M., 2009. Systematic Agricultural Geography, Rawat Publications, New Delhi.

West Bengal State Water Investigation Directorate (SWID), A Report on Accelerated Development of Minor Irrigation (A.D.M.I) Project in West Bengal, Environmental Assessment, Annexure (Part II), November 2010.