BRCORP
TECHNOLOGY | INNOVATION | INDUSTRY

International Journal of
Advanced Structures and Geotechnical Engineering
ISSN 2319-5347, Vol. 03, No. 03, July 2014

Study on Meteorological Data and Consumptive Irrigation Requirement for four Upazilas in Rajshahi

M. K. BHUIYAN, B. AHMED, M. A. A. IMRAN
Department of Civil Engineering, Rajshahi University of Engineering & Technology, Rajshahi, Bangladesh
Email: bulbulruet@gmail.com

Abstract: The nature of land surface is different in different areas in Bangladesh. Rajshahi is a city in western Bangladesh. It is located in the north-west part of the country and situated on the northern banks of the river Padma. This study was conducted for four upazilas such as Godagari, Paba, Durgapur and Puthiaupazila in Rajshahi district of Bangladesh to estimate the consumptive use and consumptive irrigation requirement for various earth surface. As Penman's method provides more accurate result so that it was used in this study. In this study data was collected from the zonal office of Barind Multipurpose Development Authority (BMDA), Rajshahi and Bangladesh Meteorological Department, Meteorological complex, Agargaon, Dhaka.
From the data analysis the maximum value of consumptive use is 7.31 mm/day in the month of May, 2012 for water surface and the minimum value of consumptive use is 1.09 mm/day in the month of December, 2012 for bare land. The maximum value of consumptive irrigation requirement is 7.01 mm/day for water surface in Godagari, Durgapur and Puthiaupazila. Consumptive use and as well as consumptive irrigation requirements are higher for water surface and lower for surface of bare land due to effect of evaporation.

Keywords: *Consumptive use, consumptive irrigation requirement, Penman's method*

1. Introduction:

Bangladesh is an agro based country and irrigation is essential to meet the agricultural demand. The design of irrigation system is essential to meet the water demand of plant growth during the period of insufficient water. In the area limited scope to conserve rain water for irrigation and lack of modern agricultural technology resulted in agricultural and socio-economic backwardness. Irrigation is the artificial application of water to the land or soil. It is used to assist in the growing of agricultural crops, maintenance of landscapes, and re-vegetation of disturbed soils in dry areas and during periods of inadequate rainfall. Additionally, irrigation also has a few other uses in crop production, which include protecting plants against frost, suppressing weed growing in grain fields and helping in preventing soil consolidation. In contrast, agriculture that relies only on direct rainfall is referred to as rain-fed or dry land farming. Irrigation systems are also used for dust suppression, disposal of sewage and in mining. Irrigation is often studied together with drainage, which is the natural or artificial removal of surface and sub-surface water from a given area.

Water requirement of crop is the quantity of water regardless of source, needed for normal crop growth and yield in a period of time at a place and may be supplied by precipitation or by irrigation or by both.

Water is needed mainly to meet the demands of evaporation, transpiration and metabolic needs of the plants, all together is known as consumptive use. Since water used in the metabolic activities of plant is negligible, being only less than one percent of quantity of water passing through the plant, evaporation and transpiration, i.e. evapotranspiration is directly considered as equal to consumptive use. In addition to evapotranspiration, water requirement includes losses during the application of irrigation water to field (percolation, seepage, and run off) and water required for special operation such as land preparation, transplanting, leaching etc.

Water requirement of any crop depends on crop factors such as variety, growth stage, and duration of plant, plant population and growing season. Soil factors such as temperature, relative humidity, wind velocity and crop management practices such as tillage, fertilization, weeding, etc. Water requirement of crops vary from area to area and even field to field in a farm depending on the above-mentioned factors.

Climate is the most important to decide the rate of evapotranspiration. Several empirical formulas are available to estimate evapotranspiration from climate data. FAO expert group of scientists has recommended four methods for adoption of different regions of world. All of these methods Penman Method provide more accurate result.

2. Study Area:

Rajshahi is a city in western Bangladesh and the divisional headquarters of Rajshahi Division as well as the administrative district that bears its name and is one of the seven metropolitan cities of Bangladesh. Silk of Rajshahi was of great quality once upon a time, so this city is often referred to as Silk City and Education City for its calm environment. Rajshahi is located in the north-west part of the country and has an estimated population of 853,000 people. Its total area is 96.69 km^2 (37.33 $mile^2$) and is situated on the northern banks of the river Padma (or Ganges which is one of the major rivers of the Indian subcontinent).

The hard red soil of this area is vary significant in comparison to the other part of the country (BMDA).

The Rajshahi district is located in between 24 degree 23 minute to 25 degree 15 minute north latitude and 88 degree 2 minute to 88 degree 57 minute east longitude.
Rajshahi consists of 9 upazilas, 35 wards and 175 mahallahs. The upazilas of Godagari, Paba, Durgapur and Puthia in Rajshahi district are selected as the study area.

3. Research Methodology:

The Penman equation (1998) has, however, more recently been introduced for determining the consumptive use of different areas or different segments of a basin, depending upon the type of vegetation covering each sub-basin. The advantage with this equation lies in the fact that the different specified values of coefficient of reflection (albedo), a factor used in this equation, are available for different types of areas, which can be used in Penman's equation to consumptive use (i.e. Potential evapotranspiration, PAT) values for different segment of command area.
Penman's equation, incorporating some of the modifications suggested by other investigators, is given as:

$$E_t = \frac{A.H_n + E_n.\gamma}{A+\gamma} \quad (3.1)$$

Where, E_t = Daily potential evapotranspiration.
A = Slope of the saturation vapour pressure vs. temperature curve at the mean air temperature.
H_n = Net incoming solar radiation or energy

$$= H_c(1-r)\left(a + b * \frac{n}{N}\right) - \sigma * T_a^4(0.56 - 0.092ea*0.10+0.90*nN \quad (3.2)$$

Where, H_c = Mean incident solar radiation at the top of the atmosphere on a horizontal surface, expressed in mm of evaporable water per day.
r = Reflection coefficient (albedo) of the given area.
a = 0.29cos ϕ
b = 0.52
n = actual duration of bright sunshine in hours.
N = maximum possible hours of bright sunshine
σ = Stefan-Bolzman constant = $2.01*10^{-9}$mm/day
T_a = mean air temperature in °K
= 273+°C
e_a = actual mean vapour pressure in the air in mm of Hg.

$$E_a = 0.35\left(1 + \frac{V_2}{160}\right)(e_s - e_a) \quad (3.3)$$

Where, V_2 = mean wind speed at 2 m above the ground in Km/day.
e_s = saturation vapour pressure at mean air temperature in mm of Hg.
e_a = actual mean vapour pressure of air in mm of Hg.
C.I.R. = C_u-R_e
Where, C.I.R. = consumptive irrigation requirement.
C_u = Consumptive use.
R_e = Effective rainfall.

4. Data Collection:

Monthly rainfall data, Maximum and Minimum temperature, humidity, wind velocity, actual sunshine hours data and latitude have been collected from the zonal office of Barind Multipurpose Development Authority (BMDA), Rajshahi and Bangladesh Meteorological Department, Meteorological complex, Agargaon, Dhaka-1207. Possible sunshine hours, mean monthly solar radiation have been collected from Garg, S. K. (1976)-Irrigation Engineering and Hydraulic Structures.

5. Graphical Representation:

Consumptive use at a place may vary throughout the day, throughout the month and throughout the year. The monthly variation of consumptive use for various earth surface are represented graphically from figure 1 to 4.

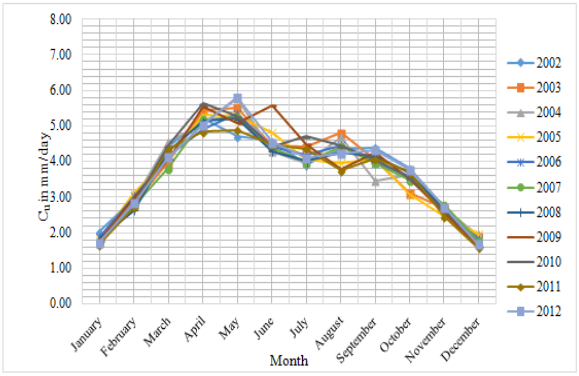

***Figure 1**: Monthly variation of C_u for agricultural land surface*

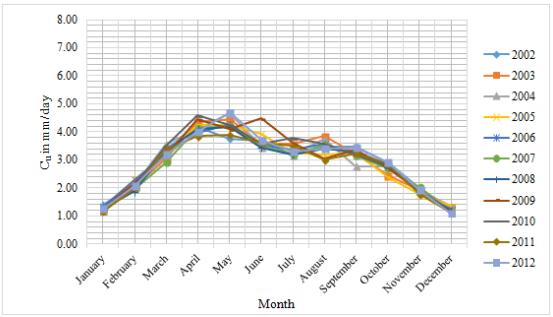

***Figure 2**: Monthly variation of C_u for bare land surface*

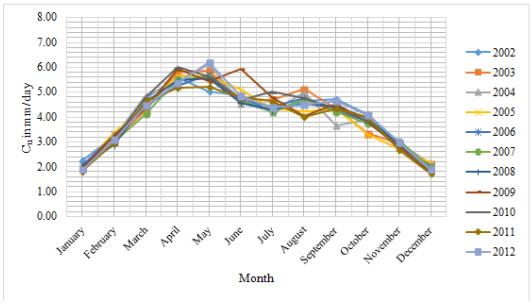

***Figure 3**: Monthly variation of C_u for forest land surface*

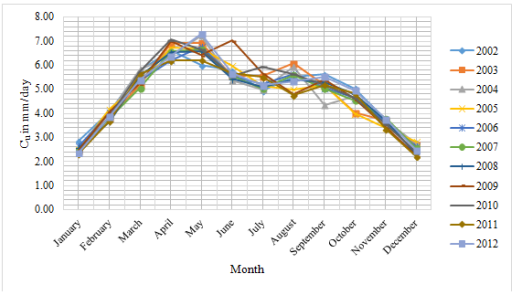

***Figure 4**: Monthly variation of C_u for water surface*

Due to variation of rainfallthe consumptive irrigation requirementvary place to place. The monthly variation of consumptive irrigation requirements in Godagariupazila for various earth surface are represented graphically from figure 5 to 8.

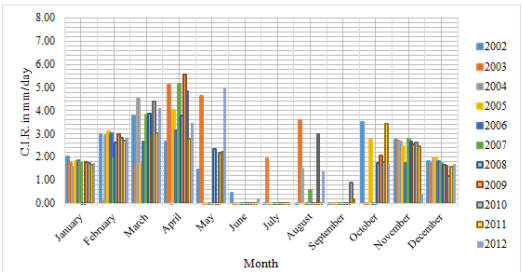

***Figure 5**: Monthly variation of C.I.R. for agricultural land surface*

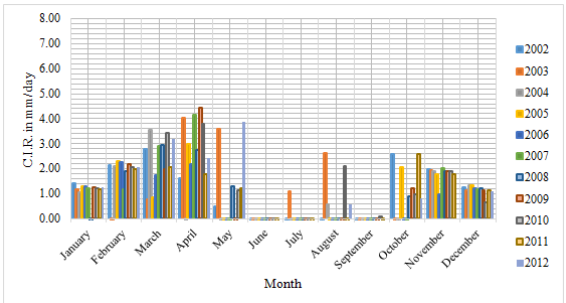

***Figure 6**: Monthly variation of C.I.R. for bare land surface*

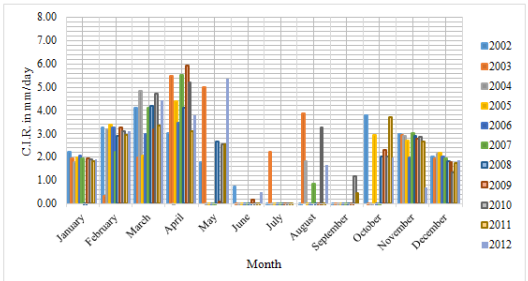

***Figure 7**: Monthly variation of C.I.R. for forest land surface*

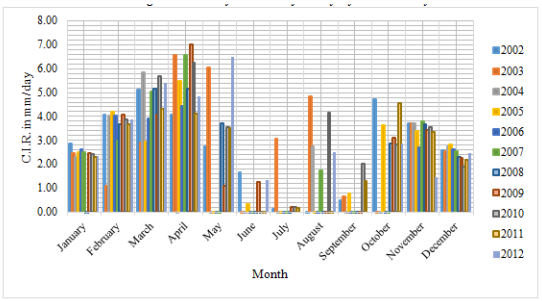

***Figure 8**: Monthly variation of C.I.R. for water surface*

The monthly variation of consumptive irrigation requirements in Pabaupazila for various earth surface are represented graphically from figure 9 to 12.

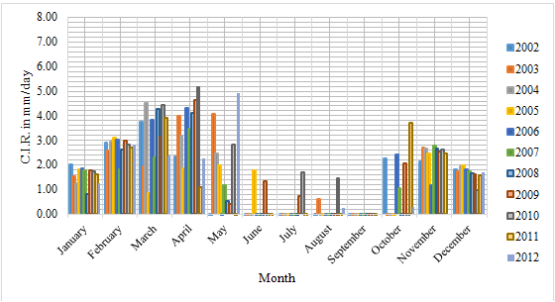

***Figure 9**: Monthly variation of C.I.R. for agricultural land surface*

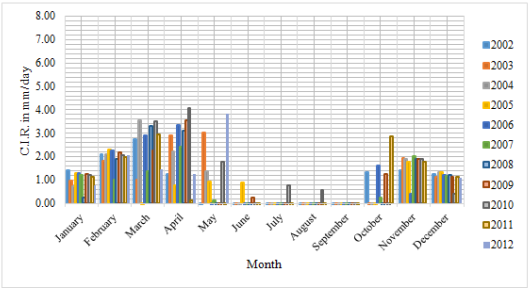

***Figure 10**: Monthly variation of C.I.R. for bare land surface*

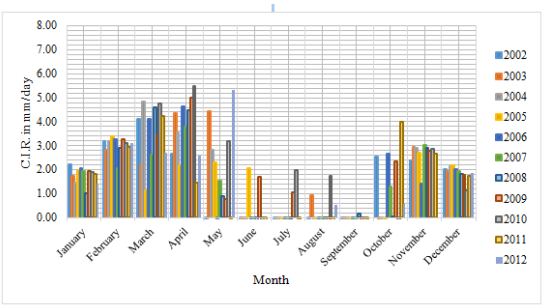

***Figure 11**: Monthly variation of C.I.R. for forest land surface*

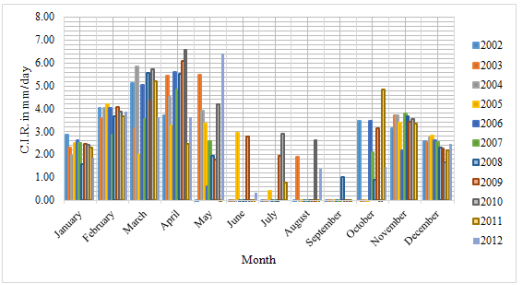

***Figure 12**: Monthly variation of C.I.R. for water surface*

The monthly variation of consumptive irrigation requirements in Durgapur upazila for various earth surface are represented graphically from figure 13 to 16.

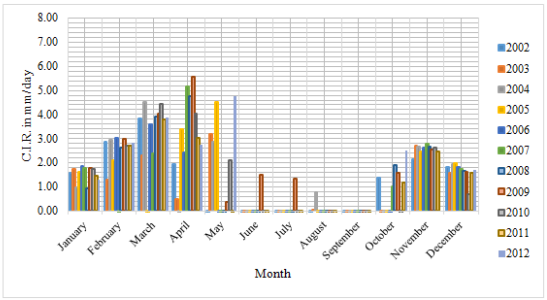

***Figure 13**: Monthly variation of C.I.R. for agricultural land surface*

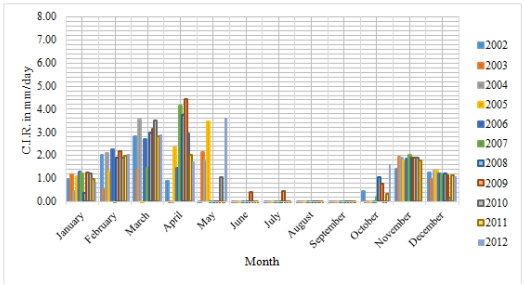

***Figure 14**: Monthly variation of C.I.R. for bare land surface*

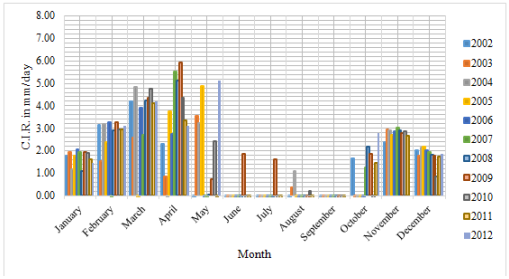

***Figure 15**: Monthly variation of C.I.R. for forest land surface*

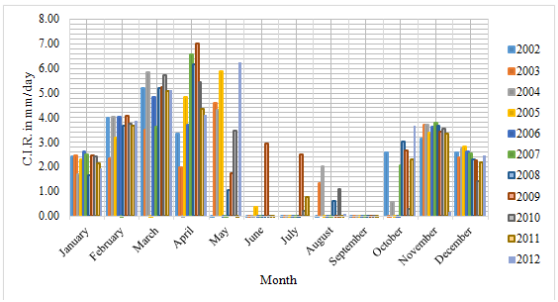

***Figure 16**: Monthly variation of C.I.R. for water surface*

The monthly variation of consumptive irrigation requirements in Puthiaupazila for various earth surface are represented graphically from figure 17 to 20.

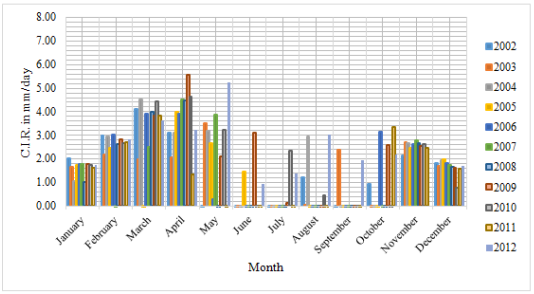

***Figure 17**: Monthly variation of C.I.R. for agricultural land surface*

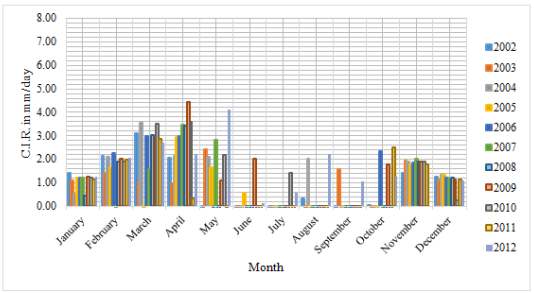

***Figure 18**: Monthly variation of C.I.R. for bare land surface*

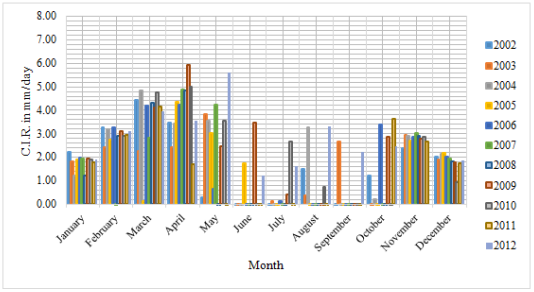

***Figure 19**: Monthly variation of C.I.R. for forest land surface*

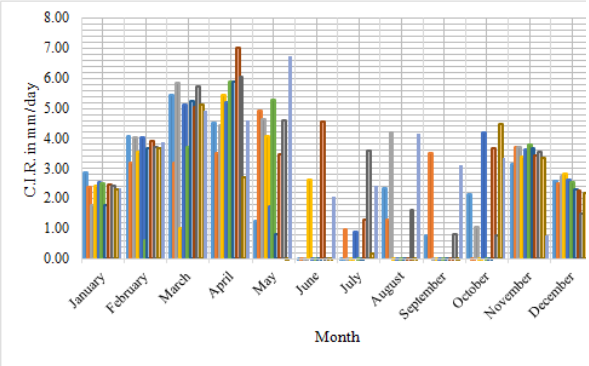

***Figure 20**: Monthly variation of C.I.R. for water surface*

6. Conclusions:

In this study, consumptive irrigation requirements for various earth surface were determined. From the data analysis, the maximum value of consumptive use is 7.31 mm/day in the month of May, 2012 for water surface and the minimum value of consumptive use is 1.09 mm/day in the month of December, 2012 for bare land. The maximum value of consumptive irrigation requirement is 7.01 mm/day for water surface in Godagari, Durgapur and Puthiaupazila and the negative value of consumptive irrigation requirement indicated that no requirement of water. From analysis it is found that maximum irrigation water is required in the month of March and April due to less rainfall and no additional water is required in the month of June and July due to excessive rainfall. Consumptive use is maximum for water surface due to more evaporation and thus consumptive irrigation requirement is also maximum. Consumptive use is minimum for surface of bare land due to less evaporation and thus consumptive irrigation requirement is also minimum.

References:

[1] Azizur, M.R. (2006) - M.Sc. thesis on - Estimation of Potential Recharge and Ground Water Resources - A Case Study in Low Barind Area, Bangladesh. University Applied Sciences Cologne, Germany.

[2] Bangladesh Meteorological Department, Dhaka.

[3] Das, S.K. (2007) - M.Sc. thesis paper on - Study of Irrigation Efficiencies and Crop Water Requirement in Various Crops UnderBarind Area, BUET, Dhaka.

[4] Dhamge, M.N.R., Badar, A.M. and Baiswarey, N.Z. (2008) - Crop water requirement by modified Penman method using Hymos. The Indian Society for Hydraulics (ISH), Volume-14, Issue-3, pp. 28-42.

[5] Garg, S.K. (1976)-Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 2- B, Nath Market, NaiSarak, Delhi.

[6] Habib, M.A. (2001) worked on - Evaluation of ground water potentiality in Barind area (Godagarithana) Rajshahi.

[7] Haque, M.I.Z. and Hossen, M.M. (1997) worked on - Irrigation Requirements of Various Crops UnderBarind Area.

[8] Islam, M.M. and Rahman M.S. (2012) thesis paper on - Study on Water Requirements for different crops (Rice, Potato, wheat) in Barind Area, Rajshahi.

[9] Israelsen, W.O. et el (1962) - Irrigation Principles and practice. John Weilly and Sons, Inc. New York, London, Sydney.

[10] Khan, M.A.A. and Pramanik, M.M.I. (1995) worked on - Study of different water distribution system in irrigation project.

[11] Liamas, M.R. and Santos, P.M. (2003) worked on - Intensive Groundwater Use: Silent Revolution and Potential Source of Social Conflicts.

[12] Mahmood, N. and Ahmed, R.N. (1992) worked on - Determination of Water Requirements and Response of Wheat to Irrigation at Different Soil Moisture Depletion Levels.

[13] Mahmud, N.N. (1996)-M.Sc. thesis on - Irrigation Requirement of Various Crops Under G-K Project.

[14] Michael, A.M. (1978) - Irrigation Theory and Practice, vikas publishing house(p) Ltd. 57G, Masjid road, Jangpura. New Deihi.

[15] Modi, P.N. (1988) - Irrigation Water Resources and Water Power Engineering, Standard Book House, 1705-4 Naisarak, Delhi.

[16] Nabi, M.N. (2000) worked on - A Study of the Quality of Irrigation Water in Barind Area.

[17] Raghunath, H.M. (1985) - Hydrology, Principle, Analysis, Design. New Age International Ltd. New Delhi.

[18] Rahman, M.S. (2004) worked on - Study of Irrigation by Ground Water in Barind Area.

[19] RajshahiBarind Department, Rajshahi.

[20] Rajshahi Meteorological Department, Shampur, Rajshahi.

[21] Reddi, P.J. (1986) - A text book of hydrology, Laxmi publications (P) Ltd. New Delhi.

[22] Sarma, S.K. (1984) - Principals and Practice of irrigation Engineering, S. Chand And Company Ltd. Ram Nagar, New Delhi.

[23] Shiferaw, B.A., Wani, S.P. and Rao, G.D.N. (2003) - Irrigation Investments and Groundwater Depletion in Indian Semi-arid Villages: The Effect of Alternative Water Pricing Regimes. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Volume-2, Issue-1, pp. 1-19.

[24] Tamanna, A.D. and Shuchana, I.K. (2011) thesis paper on - Study on Meteorological Data and Crop Water Requirement of Different Crops in Barind Area Before and After BIADP, in Rajshahi.

[25] Terrell, B.L. and Johnson, P.N. (1994) worked on - Economic Impact of the Ogallala Aquifer: A Case Study of the Southern Plains of Texas.Website: en.wikipedia.org