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Quantitative Assessment of Water of Rudrasagar Lake, Tripura, India

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ABSTRACT

Rudrasagar Lake is one of the prominent tourist destinations in north eastern part of India which surrounds Neermahal Palace. It is also declared as Ramsar site (i.e. a wetland of international importance). The surrounding Lake area was initially developed based on the fishing activity in the lake, although later on people started agricultural activity too. People in the surrounded village area of the Lake mainly use groundwater for fulfilling their water demand, in spite of the presence of the Lake. Even for irrigation purpose groundwater is used. Moreover, treated water is not available to all the households in the nearby village area. Whereas the excess water of the lake is discharged into the river, through connecting Kachigang channel, without proper utilization. In this study a quantitative assessment of water of Rudrasagar lake has been done for possible use of drinking and Irrigation etc. For the evaluation of quantity of water, the hydrologic simulation model has been used using HEC-HMS software. From the observation of model discharge of the Lake water, for various season viz. Pre Monsoon, Monsoon and Post monsoon during the period 2006-2015, it has been found that minimum discharge is 0.41m3/s during pre monsoon and maximum discharge is 6.77m3/s during monsoon. So, using the available water, during pre monsoon 50 liters per person per day of water can be supplied to every household and during monsoon the quantity is above 135 liters. Beside this for irrigation purpose also the excess water may be supplied to the local farmer.

Key words: Rudrasagar Lake, surface runoff, hydrologic simulation model, HEC-HMS

INTRODUCTION

Rudrasagar Lake is located in the Melaghar of Sonamura Sub-Division in Tripura, India. The lake forms a geographical area of 2.4 km^2 and situated at a distance of about 52 km from Agartala, the state capital of Tripura. The lake is located in between 23° 29’ 00’’ N and 90° 01’ 00’’ E. Hydro morphologically, Rudrasagar lake is a natural sedimentation reservoir, which receives flow from three perennial streams namely Kemtalicherra, Noacherra and Durlavnarayan cherra[1] .After settling the sediment from the received flow, clear water discharges into the river Gumti through a connective channel namely Kachigang. The lake bed has been formed mainly by silt deposition. Surrounding hillocks are of soft sedimentary formation. Here, annual rainfall is of the order of 2500 mm with 4/5 flood peaks. Population of Rudrasagar Lake and Melaghar area is about 1.21 lacs as per available data [2]. Currently in the village area mainly groundwater is used for fulfilling water demand. Treated water is hardly available in the nearby area in spite of available source of water, which is discharged to the river without proper utilization. Even for irrigation purpose groundwater is used. In this regard the present study focuses on the quantitative assessment of water of Rudrasagar lake for possible use of drinking and Irrigation etc by the local people. For the evaluation of quantity of water of the study area the hydrologic simulation model (HEC-HMS) has been used.

DELINEATION OF LAKE WATERSHED

The catchment of Rudrasagar Lake is delineated with the help of Google Earth software which maps the Earth by the superimposition of images obtained from satellite imagery, aerial photography and geographic information system (GIS) onto a 3D globe. Google Earth uses digital elevation model (DEM) data collected by NASA's Shuttle

Radar Topography Mission (SRTM). In this study the name of the area i.e. Rudrasagar is entered in search option. Then using "add path" option lines has been drawn around the area. Thereafter, crest points of each lines has been marked and catchment area delineated. The area of a catchment formed has been found out by the help of "add polygon" option.

IDENTIFICATION OF LAND PATTERN USING IMAGE PROCESSING

After capturing the image of Rudrasagar lake catchment area from Google Earth the image is imported into image processing software .The Identification of geographical features and Percentage area of specific land use of the Imagery is determined with the help of Image-J software. From the percent area of specific land use pervious and impervious area are separated .The watershed area is mostly covered with four types of land use viz. forest, agricultural land, water body and settlement. It is showing that study area averagely has 22.34% impervious area and 77.66 % pervious area. The percentage of pervious area is around 3.47 times more than the impervious area.

ESTIMATION OF RUNOFF

In this study the software package Hydrologic Engineering Centre, Hydrologic Modelling System, HEC-HMS (Technical Reference Manual 2004 and user's 2000) has been used for finding water quantity of Rudrasagar Lake area. The HEC-HMS developed by Hydrologic Engineering Centre (HEC) of US Army Corps of Engineers, is well-known hydrologic model [3]. Evapotranspiration is one of the important parameter for finding out the flow using HEC-HMS software [4]. Evapotranspiration has been calculated by following Thornthwaite Formula using mean monthly temperature together with an adjustment for day-lengths.

$$E_t=1.6L_a\left(\frac{10T}{I_t}\right)^a \quad (1)$$

Where E_t=monthly Potential Evapotranspiration (PET) in cm
L_a= adjustment for the number of hours of daylight and days in the month related to the latitude of the place
T= mean monthly temperature ^oc

I_t= the total of 12 month values of heat index = $\sum_1^{12} i$ where $i= (T/5)^{1.514}$

a= an empirical constant $=6.75x10^{-7}\ I_t^3-7.71x10^{-5}\ I_t^2+1.792x10^{-2}I_t+0.49239$

Daily rainfall, temperature etc. for Rudrasagar lake area was collected from Meteorological department and was used for calibration and validation. The calibration error, expressed as a percent difference of simulated value with respect to observed value, was found to lie within the range of 0.1%-10%. The observed flow Hydrograph compared with the model output (simulated flow).

HYDROLOGICAL MODELING

For the evaluation of total flow the hydrologic simulation model is used [5-7]. The hydrologic model simulates precipitation and routing processes, both natural and controlled. The use of model requires input of daily/hourly rainfall, soil condition and hydro-meteorological data of the study location. In this present study daily rainfall data is given as an input. The schematic diagram of Hydrological Modelling and calibration procedure is shown in figure 1.

For water quantity assessment required for consumption of water, water flow is an important factor. So rainfall & temperature for a period of 10 years (Jan 2006 to Dec 2015) were collected from Meteorological department. Then Evapotranspiration has been calculated by Thornthwaite Formula. Thereafter using the HEC-HMS model, flow is calculated & model output has been found out.

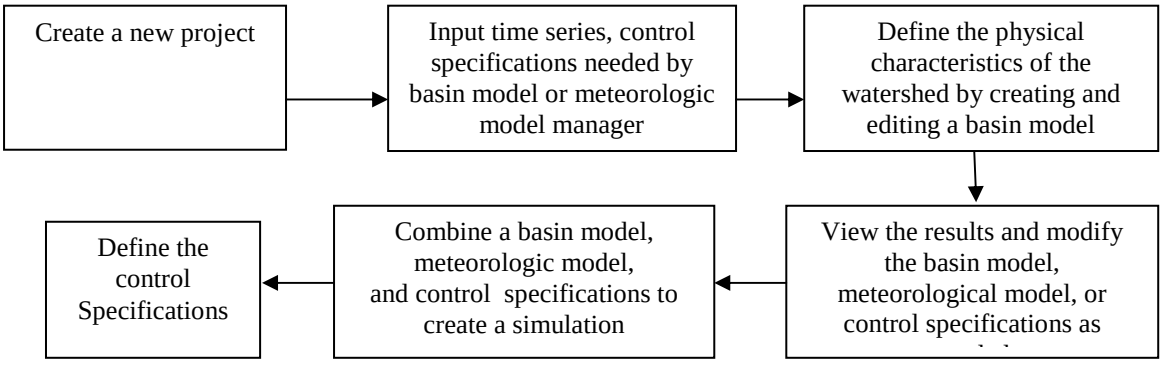

Fig.1 Schematic diagram of Hydrological Modeling

RESULTS AND DISCUSSION

From the hydrological model, flow of the Lake during the year 2006-2010 and 2011-2015 has been found out. Model flow for 2006 to 2010 is shown in figure 2. Season wise model flow from 2006 to 2010 and 2011 to 2015 has also been found out as shown in table 1 and 2 respectively. From the observation of model flow of various seasons viz. Pre Monsoon, Monsoon and Post monsoon during the period 2006-2015 it has been found that minimum flow was 0.40m^3/s during pre monsoon and maximum flow was 6.77 m^3/s during monsoon.

Population of Melaghar is about 1.21 lacs as per available data [2]. If water is supplied at least 4 hours per day during the lean season i.e. pre monsoon or post monsoon, than quantity of water per person per day will be about 50 litres. But during monsoon more than 135 litres of water per person per day may be supplied to the people residing Rudrasagar Lake area and Melaghar. For irrigation purpose also water may be used especially during monsoon season [8-9].

From water requirements hierarchy [10], it can also be observed that 50 Litre water per person per day is required for drinking, cooking, personal washing, washing clothes and cleaning home. So, during pre monsoon the said quantity i.e. 50 litres water per person per day may be supplied to the every house hold and in monsoon season there is no restriction of quantity of water supply, if all the household of Melaghar is covered.

Table-1 Model Flow Season Wise from 2006 to 2010

Flow (m^3/s) (Pre-Monsoon)					Flow (m^3/s) (Monsoon)					Flow (m^3/s) (Post Monsoon)				
2006	2007	2008	2009	2010	2006	2007	2008	2009	2010	2006	2007	2008	2009	2010
0.50	2.14	0.79	0.40	1.11	5.22	6.77	3.46	5.61	4.56	0.68	1.85	1.05	1.10	1.93

Table-2 Model Flow Season Wise from 2011 to 2015

Flow (m^3/s) (Pre-Monsoon)					Flow (m^3/s) (Monsoon)					Flow (m^3/s) (Post Monsoon)				
2011	2012	2013	2014	2015	2011	2012	2013	2014	2015	2011	2012	2013	2014	2015
0.41	1.15	0.83	0.79	2.06	4.70	4.88	5.32	5.00	6.11	0.42	0.75	1.04	0.57	0.48

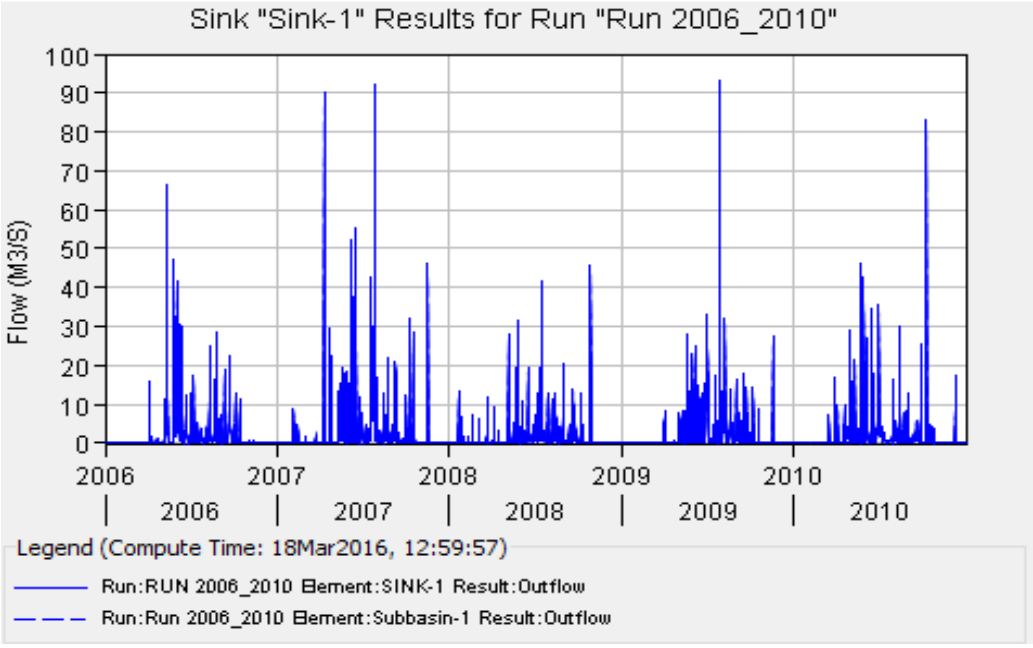

Fig. 2 Model flow Hydrograph of Rudrasagar Lake area 2006-2010

CONCLUSION

From the observation of model discharge of the Lake water, for various seasons viz. Pre Monsoon, Monsoon and Post monsoon during the period 2006-2015, it has been found that minimum discharge is 0.41m^3/s during pre monsoon and maximum discharge is 6.77m^3/s during monsoon. So, using the available water a treatment plant may be constructed to cater the need of the people of Rudrasagar area, after studying the quality of water of the lake. By

using the available water, during pre monsoon 50 liters per person per day of water can be supplied to every household and during monsoon the quantity will be above 135 liters. Beside this for irrigation purpose also the excess water may be supplied to the local farmer.

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