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Reservoir Evaporation Forecasting. A case Study on Sardar Sarovar Dam

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ABSTRACT

Determining evaporation rates is essential for efficient management of reservoirs and water resources, particularly in water-scarce countries such as India. Around 40% of water is evaporated from storage reservoirs in India. This paper analyses evaporation rates from a large water supply reservoir in Navagam Gujarat India, under current climate and predicted climate change conditions using least square. Data of sardar sarovar dam has been used for the forecasting. Prediction for a span of 10 years is made staring from 2020 to 2030. The forecasted values of evaporation were then compared with data of year 1967 to 1977. The results showed that the evaporation rates from the study reservoir will increase in the future.

Keywords : Evaporation, Sardar sarovar dam, least square method, Narmada River.

1. INTRODUCTION:

India and most semi-arid countries around the world rely on water stored in reservoirs for drinking water supply and food production. However, the rates of evaporation in these countries can be exceedingly large. In India, around 23% of its total water storage capacity is lost per year due to high rates of evaporation. Concerns over India's future open water evaporation rates are increasing due to the threat of a changing climate. In fact, there are indications that the meteorological factors involved in the process of evaporation will be significantly affected as a result of increasing greenhouse gas (GHG) emissions. As a result of the change in climate, particularly the increase in surface air temperatures, evaporation is also expected to increase throughout India.

2. STUDY SITE AND METEOROLOGICAL DATA FOR SIMULATIONS:

The Sardar Sarovar Dam is a gravity dam on the Narmada River near Navagam, Gujarat in India. It is the largest dam and part of the Narmada Valley Project. It is the 30th largest dams planned on river Narmada. Sardar Sarovar Dam (SSD) is the largest structure to be built. It has a proposed final height of 163 m (535 ft) from foundation. The project will irrigate more than 18,000 km^2 (6,900 sq mi), most of it in drought prone areas of Kutch and Saurashtra. It is located at (21°49′49″N 73°44′50″E / 21.83028°N 73.74722°E Coordinates: 21°49′49″N 73°44′50″E / 21.83028°N 73.74722°E) .This dam has a volume of 9,500,000,000 m^3 and a surface area of 375.33 km^2, with a maximum height of 163 m.

The meteorological data from the nearest official weather station, located at Sardar Sarovar Dam, was provided by the dam authority. These are the nearest station with a considerably long, reliable and consistent set of historical meteorological data. Daily data from 01/01/1990 to 31/12/2010 were used for trend analysis to compose the baseline (or present-day) scenario. These set of data help for the accurate trend analysis.

2.1 METHOD OF LEAST SQUARES

The least squares method is used to find the best linear relationship between two variables. In forecasting methods, time is the in depended variable and the value of the time series is the depended variable. It is a mathematical method and with its help trend line is fitted to the data in such a way that it satisfies two conditions:

1 $\Sigma(Y-Y_c) = 0$

i. e. the sum of derivation of the actual values of Y and the computed values of Y is zero

2 $\Sigma(Y-Y_c)^2$ is least

i. e. the sum of the squares of the squares of the derivation of the actual and computed values least from this line.

The method of least square may be used to fit a straight line trend or a parabolic trend.

The straight line trend is represented by the equation

$Y_c = a+b*x$

Where Y_c is used to designate the trend values to distinguish them from the actual Y values, a is the Y intercept of the Y variable when X= 0.

b represents the slope of the trend line or amount of change in Y variables that is associated with a change of one until in X variables.

The X variable of time series represents time.

The values of constants a and b can be determined by the following equation:

$\Sigma Y = Na + b\Sigma X$

$\Sigma XY = a\Sigma X + b\Sigma X^2$

Where N represents number of years for which data are given.

3. SIMULATIONS

All simulations are done to estimate the trend for Sardar Sarovar Dam's evaporation rates which were performed using least square method. For the present-day simulation, daily observed meteorological variables from 2002 to 2012 were

used. For the future simulations, one distinct 10-year periods were chosen, 2020 to 2030.

4. RESULTS AND DISICUSION:

Table of trend equation

Average monthly evaporation	Y=7.041421234-0.017169308*X
Daily evaporation	Y = 6.526272514-0.000385404*X
Yearly evaporation	Y = 2189.365524-36.75960714*X
All January month evaporation	Y=119.7192-0.58107*X
All February month evaporation	Y=133.9709+0.653393*X
All March month evaporation	Y=196.3968+1.139571*X
All April month evaporation	Y=244.9226+1.946929*X
All May month evaporation	Y=339.3722-4.21411*X
All June month evaporation	Y=221.3956-4.56654*X
All July month evaporation	Y=135.1193-5.272*X
All August month evaporation	Y=99.57981-3.43989*X
All September month evaporation	Y=129.1237-3.538834*X
All October month evaporation	Y=205.9341-5.66193*X
All November month evaporation	Y=200.7078-7.78939*X
All December month evaporation	Y=147.6737-4.45146*X

Using this trend analysis the future predictions are done and it shows that the evaporation increases for each month due to global warming. It is highest for the summer months of March, April, May and June. It is also observed that there is a gradual decrease in the rates of evaporation in the months of monsoon season.

REFERENCES

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