# FORCASTING OF RESERVOIR YIELD CAPACITY BY SELECTING DIFFERENT CLIMATIC PARAMETERS

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***Abstract* -** Water yield is inflated by hydrological parameters like precipitation and is impacted by different global climatic parameters. In this study, an expectation of reservoir yield of 'Upper Bhima River Basin ' from the Maharashtra State of India has endeavored. The global climatic input parameters, to be specific El Nino-Southern Oscillation (ENSO) file and Equatorial Indian Ocean Oscillation (EQUINOO) file are utilised for the forecast. The Genetic Programming (GP) and Artificial Intelligence (AI) tools have been utilized through Software 'Discipulus' for this purpose. Upper Bhima basin comprises of numerous dams and harnessing water for irrigation, hydro-power and household employment. Inflow, outflow, water use and losses of all reservoirs are taken into consideration while calculating actual yield Upper Bhima River Basin. Five combinations of input variables for predicting reservoir yield were tested to arrive at the best input variable combination for better predictions. From the analysis, it is discovered that models created utilizing GP build up a sensibly great relationship between atmospheric factors (climate variables) and basin yields. The best combination of ENSO and EQUINOO gave co- relationship coefficient r = 0.9726 between observe driver basin yield and anticipated river basin yield, which seems attractive for such a mind-boggling complex system.

***Key Words*: ENSO, EQUINOO, Genetic Programming, Artificial Intelligence, EQWIN**

## 1. INTRODUCTION

The yield of any river basin mainly depend upon the amount of precipitation, a occupying space of rainfall over catchment, catchment characteristics and losses due to water losses (evapotranspiration, seepage, infiltration). Distribution of rainfall over a large catchment is not even. It depends on the geology of the region, climatic conditions patterns and further meteorological parameters. This results in varying discharges at different places river basins and varying river basin scale yields year to year. During monsoon, heavy rainfall in some of the regions results in flood condition and then again a portion of the districts face dry spell circumstance (drought situation). To mitigate impacts of erratic rainfall and related varying river basin yield, proper water management techniques are required to be implemented/ executed. A dependable stream flow conjecture a couple of weeks ahead of time can reasonably improve the overseeing of water assets frameworks in the country just as urban zones (Chiew et al. 2003). If the assessments of river basin scale yield are known well in advance, then it helps water managers to decide the amount to be allocated for irrigation, hydropower, industry, domestic and other purposes. It additionally helps farmers to decide cropping pattern over the year. Hence, this study attempts to correlate the river basin yield with various climatic parameters, so that annual river basin yield can be anticipated in advance to help water administrators for proper planning of water resources throughout the year and operation of storage reservoirs accordingly

## 2. PREDICTORS FOR RESERVOIR YIELD

El Nino-Southern Oscillation is a worldwide coupled sea climate occasion and connected with the Pacific Ocean marks, El Niño and variety of the pressure field, between the eastern and western pieces of the Pacific Ocean (Southern Oscillation). Carelessness of ENSO file makes anticipating it of incredible interest. It is recognizably associated with yearly, occasional, territorial climatic impacts on large areas. ENSO is the most essential known wellspring of between yearly irregularity in climate and atmosphere around the globe.

Equatorial Indian Ocean Oscillation (EQUINOO) is the atmospheric component of the Indian Ocean Dipole (IOD) mode (Gadgil et al., 2003; 2004). The oscillation between convection and pressure gradient over the Indian Ocean During summer monsoon session is EQUINOO. Zonal wind index (EQWIN) is considered as an index of EQUINOO. Impact of EQUINOO and ENSO on streamflow has been talked about by different analysts everywhere throughout the world. The relationship between the streamflow and La Nina events in the United States has been developed by Dracup and Kahya (1994).Eltahir (1996) examined El Nino and inconstancy of the stream of the Nile River.Piechota et al. (1997) examined western U.S. streamflow and air dissemination designs amid ENSO. Chiew et al. (1998) examined the impact of ENSO on precipitation, streamflow, and dry season of Australia.

The precipitation over the Indian subcontinent relies on the ocean surface temperatures, pressure and wind designs created in the Pacific Ocean and the Indian Ocean, with the development time of over 3 months before the beginning of Indian Summer Monsoon. ENSO and

EQUINOO are the worldwide climatological parameters that impact the Indian summer rainstorm precipitation and henceforth the basin scale stream (S.S. Kashid and Rajib Maity; 2009; Chiew et al. 1998).In this investigation, endeavor has been made to set up a relationship amongst ENSO and EQUINOO with Basin scale stream of upper Bhima waterway basin and to foresee yearly stream basin scale yield. The man-made reasoning device GP is executed through DISCIPULUS tool stash for expectations.

## 3. AREA OF STUDY

The total river basin area of the Bhima is 48,631 square kilometers, out of which 75% lie in the state of Maharashtra. The banks of Bhima River are densely populated and form a fertile agricultural land. The Bhima River also causes floods due to heavy rainfall, it receives during the monsoon. The Bhima River rises in the Western Ghats and flows south-eastward through Maharashtra and Karnataka. It has a total length of 861 km and falls into Krishna River about 26 km north at Raichur at an altitude of 343 meter. About 137 km from its source Bhima River receives from its right the cabined waters of the Mula River 5 and Mutha from Poona and about 29 km lower the Ghod River joined on its right bank. Nira River rises in the Western Ghats and then by run for a length of 74 km. The Bhima River runs along the boundary between Maharashtra and Karnataka. In this reach, it receives the water from the River Sina, which rises near Ahmednagar. For the last 299 km of its course the Bhima River flows in Karnataka. The total catchments area of the Bhima River is 76614 km2. The total length of the study area is 142.18 km. The major flood affected villages are 63 and pilgrim city Pandharpur is located on the right bank of Bhima River. Selected sites are highly affected by flood. Many villages and stretches on right and left bank side of the Bhima River major changes have been observed. The Bhima River is one of the main tributaries of the river Krishna, which forms a large river basin in the southern peninsula of the Indian subcontinent. The Bhima River has a vast basin comprising of about six million hectares, and flows from west to east passing through the states of Maharashtra and Karnataka, before meeting the river Krishna, which flows further south to the state of Andhra Pradesh where it meets the Indian Ocean. The basin consists of four municipal corporations with a total population of 6,224,807 (Indian Census, 2001). Main occupation is agriculture. River Bhima originates through moist deciduous forests in the Western Ghats of India, which are one of the 12 biodiversity hot spots of the world. The basin is rich in biodiversity with six wildlife sanctuaries. Community conserved areas known as the 'Devrais,' (sacred groves) are also crucial sanctuaries for rare and endangered biodiversity as are man-made ecosystems (mostly wetlands created by dams).

Flooding is common phenomena in Bhima River basin. Since 1876, the flow in the Bhima River has exceeded flood stage for 18 times. The Maharashtra State Government has been declared a flood disaster area many times in Bhima River basin since 1876, 1896, 1922, 1952, 1956, 1958, and 1961, most recently in 1983, 1994, 1997 and 2005, 2006. However, historical flood event and related damage are never recorded. The heavy rainfall occurs more frequently in many regions around the world. Flash flood are caused by heavy rainfall always happen suddenly with poor 2 predictability and short time for warning. These are the main causes for the flood related losses. The destructive powers of such floods are so strong that they not only damage encountered assets and infrastructures, but also decline river ecosystem and environment. Meanwhile, fluvial flood due to heavy rains in urbanized areas are getting more and more serious. Especially in developing countries, such risks have been increasing due to the intensification of human activities, rapid urbanization; accelerate development in high-risk areas etc. The objective of this flood study is to explore the socio-economic development and how to support the capacity building in a broad way to control the growth of the flood hazard effectively.

Upper Bhima stream basin (K-5) stretches out over the scopes from 17.18 N to 19.24 N and longitudes from 73.20 E to 76.15 E, with all-out catchment zone of 45335 square km (Source MWIC report vol.- II, pg. no. 285 and 309). The Bhima stream is a real tributary of Krishna waterway. The stream basin incorporates 23 noteworthy and 9 medium dams. The Ujjani dam is the greatest multipurpose dam with supply limit of 3114.1 million cubic meters at full store level 496.83 m above mean ocean level. The areas of the considered for study is as shown in fig.1.

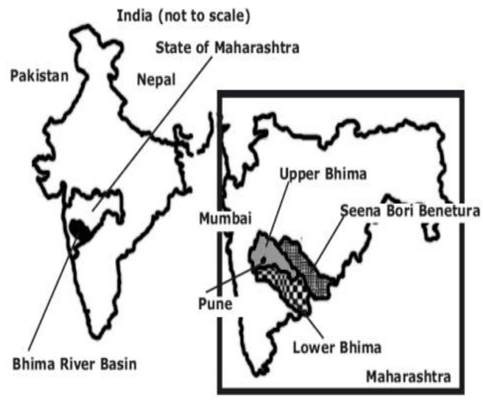


**Fig. 1: Upper Bhima river basin**

## 4. METHODOLOGY

The software Discipulus is used for this project. The input data given to this software is Annual Data, i.e. Average annual yield and Actual annual yield with combinations of predictors. This Discipulus directly work on the correlation coefficient, and from that, we will know the best combination of input variables.

GP is the most perceived and utilized system for the investigating relationship between input and output parameters of rainfall and runoff. The Discipulus take the input data in three phases, i.e. Training, Validation, Application / Testing respectively.

## 5. DATA

Month to month yield of the considerable number of reservoirs from K-5 basin is used from the water year 1976 to 2014. Training has to be provided with about 50% of the data from the available data, i.e. out of 39 years of data, training should be filled up with 19 years data. In the same manner, validation has to be provided with about 25% of the data from the available data, i.e. out of 39 years of data, training should be filled up with 10 years data. And in the last Application / Testing has to be provided with about 25% of the data from the available data, i.e. out of 39 years of data, training should be filled up with 10 years data.

## 6. BEST MODELS

For the expectation of annual yield of K-5 basin, the different combinations of input climatic factors ENSO files of various time steps, and EQUINOO files at various time steps and the normal annual yield of K-5 basin are given as inputs. Henceforth yearly stream basin scale yield AY is demonstrated as following

AY= f { Yavg, (ENt-1 , ENt-2 , ENt-3 ), (EQ t-1 , EQt-2, EQt-3 ),(MEIt-1, MEIt-2,MEIt-3)}

Similarly, all 5 models were arranged and tested for Annual yield analysis. Their combinations are as beneath.

| Variable No. | Variable Name | Input Variable Combinations | | | | |
|---|---|---|---|---|---|---|
| | | M1 | M2 | M3 | M4 | M5 |
| 1. | EN (t-1) | ✓ | | | | |
| 2. | EN (t-2) | | ✓ | ✓ | | |
| 3. | EN (t-3) | | ✓ | | ✓ | |
| 4. | EQ (t-1) | ✓ | | | | |
| 5. | EQ (t-2) | | ✓ | ✓ | | ✓ |
| 6. | EQ (t-3) | | ✓ | | ✓ | ✓ |
| 7. | MEI (t-2) | | | | | ✓ |
| 8. | MEI (t-3) | | | | | ✓ |

**Table 1 Combinations of input parameters with output basin yield.**

Water year starts from June month so't' is assumed as a month of June hence, t-1 = May, t-2 = April, t-3 = March

## 7. RESULTS

| Model No. | Model Name | Value of 'r' | |
|---|---|---|---|
| | | Training | Testing |
| 1. | M1 | 0.9709 | 0.5644 |
| 2. | M2 | 0.9203 | 0.7597 |
| **3.** | **M3** | **0.9726** | **0.6479** |
| 4. | M4 | 0.9612 | 0.4916 |
| 5. | M5 | 0.7867 | 0.6166 |

**Table 2. Values of Correlation co-efficient (r)**

## 8. CONCLUSION

The present study discovers that models created utilizing GP build up a sensibly great relationship between atmospheric factors (climate variables) and reservoir yields. The best combination of ENSO and EQUINOO gave co-relationship coefficient r = 0.9726.

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