Compliance to reviewer (RC1) comments

Q1. L 24. Model of ARMA and model of copula, should put: model of copula and model of ARMA, following both the order of the title and the methodology.

Reply: We have incorporated the above suggestion in the revised manuscript and also given below.
"MODEL OF COPULA AND MODEL OF ARMA BASED STUDY OF CONTROLLED OUTFLOW AT FARAKKA BARRAGE"

Q2. L 43-45, the author speaks of Archimedean copulas. Why is not extreme copula used?

Reply: In this study, several copulas were attempted. As the calibration error was significantly reduced, the need for any additional other Copulas was not felt.

Q3. L 47: dependence of or extreme output. "or" must be removed

Reply: We have incorporated the above suggestion in the revised manuscript.

Q4. L 56-57 should be better rewritten.

Reply: L 56-57 is rewritten as follows:
The results obtained in the study, risk values at extreme analyzed values of controlled discharge and flood control capacity are not monotonic. It represents that simulations were completed for sets of only 10000 cycle elements and only 10000 cycles (Twaróg, 2016). Peak flow and hydrograph volume both can be jointly studied by bivariate approach (e.g., Goel et al. 1998; Yue et al. 1999; Favre et al. 2004; Shiau et al. 2007).

Q5. L 76 Balistrocchi, 2017, you should put Balistrocchi et al, 2017

Reply: We have incorporated the above suggestion in the revised manuscript and changed L 76 as follows:

Powerful tests developed inside copula framework allowed to investigate the empirical dependence structure in an accurate manner, especially with respect to the evaluation of tail dependencies (Balistrocchi et. al 2017).

Q6. L 139 Some of the expressions, for example Gumgel, should be revised and corrected

Reply: These expressions are taken from following publication.

"Galiani, S. (2003). Copula functions and their application in pricing and risk managing multiname credit derivative products. *University of London Master of Science Project.*"

For Gumbel copula please see page 11 of above paper. some screen shot of the paper are given below.

Gumbel Copula Let $\varphi(t) = (-\ln t)^{\theta}$ with $\theta \geq 1$. Then, using equation (9) we have[8]

$$C_{\theta}^{Gumbel}(u,v) = \varphi^{-1}[\varphi(u) + \varphi(v)] = \exp\left\{-\left[(-\ln u)^{\theta} + (-\ln v)^{\theta}\right]^{1/\theta}\right\}.$$

Clayton Copula Let $\varphi(t) = \left(t^{-\theta} - 1\right)/\theta$ with $\theta \in [-1, \infty) \setminus \{0\}$. Then, using (9) we have

$$C_{\theta}^{Clayton}(u,v) = \max\left[\left(u^{-\theta} + v^{-\theta} - 1\right)^{-1/\theta}, 0\right].$$

Note that if $\theta > 0$, then $\varphi(0) = \infty$, and we can simplify the above expression as follows

$$C_{\theta}^{Clayton}(u,v) = \left(u^{-\theta} + v^{-\theta} - 1\right)^{-1/\theta}. \qquad (10)$$

And also see page number 13 of this publication

In general, $\tilde{\mathcal{C}}$ consists not in one parametric family with different values of the parameters, but $\tilde{\mathcal{C}}$ is the set of different families, for example Gumbel, Frank, Cook-Johnson, etc. (see the table 4.1 of NELSEN [1998] for a list of Archimedean copulas). For each family, we could first estimate the parameters by IFM ou CML method in order to reduce the cardinality of $\tilde{\mathcal{C}}$. Note that if $\mathbf{C}$ is an absolutely two-dimensional copula, the expression of the log-likelihood is

$$\ell_t^c(\alpha) = \ln \varphi''\left(\mathbf{C}\left(u_1^t, u_2^t\right)\right) + \ln\left(\varphi'\left(u_1^t\right)\varphi'\left(u_2^t\right)\right) - 3\ln\left(-\varphi'\left(\mathbf{C}\left(u_1^t, u_2^t\right)\right)\right) \tag{59}$$

We consider our previous example with three copula families. The CML estimation gives the following results

	Copula	$\varphi(u)$	$\mathbf{C}(u_1, u_2)$	$\hat{\alpha}_{\mathsf{CML}}$
C_1	Gumbel	$(-\ln u)^\alpha$	$\exp\left(-\left((-\ln u_1)^\alpha + (-\ln u_2)^\alpha\right)^{\frac{1}{\alpha}}\right)$	1.462803
C_2	Cook-Johnson	$\alpha^{-1}(u^{-\alpha} - 1)$	$\max\left(\left[u_1^{-\alpha} + u_2^{-\alpha} - 1\right]^{-\frac{1}{\alpha}}, 0\right)$	0.708430
C_3	Frank	$-\ln\left(\frac{\exp(-\alpha u)-1}{\exp(-\alpha)-1}\right)$	$-\alpha^{-1}\ln\left(1 + (e^{-\alpha} - 1)^{-1}(e^{-\alpha u} - 1)(e^{-\alpha v} - 1)\right)$	3.578972

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Frank Copula Let $\varphi(t) = -\ln \frac{e^{-\theta t}-1}{e^{-\theta}-1}$ with $\theta \in \mathbb{R}\backslash\{0\}$. Then, using (9) we have

$$C_\theta^{Frank}(u, v) = -\frac{1}{\theta}\ln\left[1 + \frac{\left(e^{-\theta u} - 1\right)\left(e^{-\theta v} - 1\right)}{e^{-\theta} - 1}\right].$$

We close the treatment of Archimedean copulae presenting a method to generalize our setting to a multivariate case. In doing this task we will follow the analysis suggested by Embrechts, Lindskog & McNeil [9], p. 37. For other approaches we refer the reader to Joe [15].

Q7. L 164-182, Must rewrite the text .Figures 1-3 and 2-4 are the same with different scale on the ordinate axis. In my opinion they should be placed in a unique way

Reply: Cumulative distribution function(CDF), Probability density function(PDF) and Probability distribution of data sets for pre monsoon period i.e., from Dec. -May 1949 to Dec. -

May 1968 are represented in (Figure 2), (Figure 4) and (Figure 6) respectively. Cumulative distribution function(CDF), Probability density function(PDF) and Probability distribution of data sets for post monsoon period i.e. Jun. -Nov. 1949 to Jun. -Nov. 1968 in (Figure 3), (Figure 5) and (Figure 6), respectively.

The violet colour represents the data points for pre monsoon and post monsoon periods and red colour represents normal distribution, green colour represents lognormal distribution, etc as shown in Figures 2-7. Figures 3 and 4 represent cumulative distribution function of data points along with all distributions in pre monsoon seasons (Dec.- May 1949 to Dec.-May 1968) and post monsoon seasons (Jun. - Nov. 1949 to Jun. - Nov 1968), respectively.

Figures 3-4 represent Probability density function of data points along with all distributions in pre monsoon seasons (Dec.- May 1949 to Dec.-May 1968) and post monsoon seasons(Jun. - Nov. 1949 to Jun. - Nov 1968), respectively. Select the standard distribution which is best fit for original data sets. Violet colour of Figures 6-7 represent the data points and other colour represents the various distributions of mean monthly discharge of pre monsoon seasons (Dec. - May 1949 to Dec. -May 1968) and post monsoon seasons (Jun.-Nov.1949 to Jun. -Nov. 1968) respectively. Selection of the distribution function can be based the best fit for original data sets.

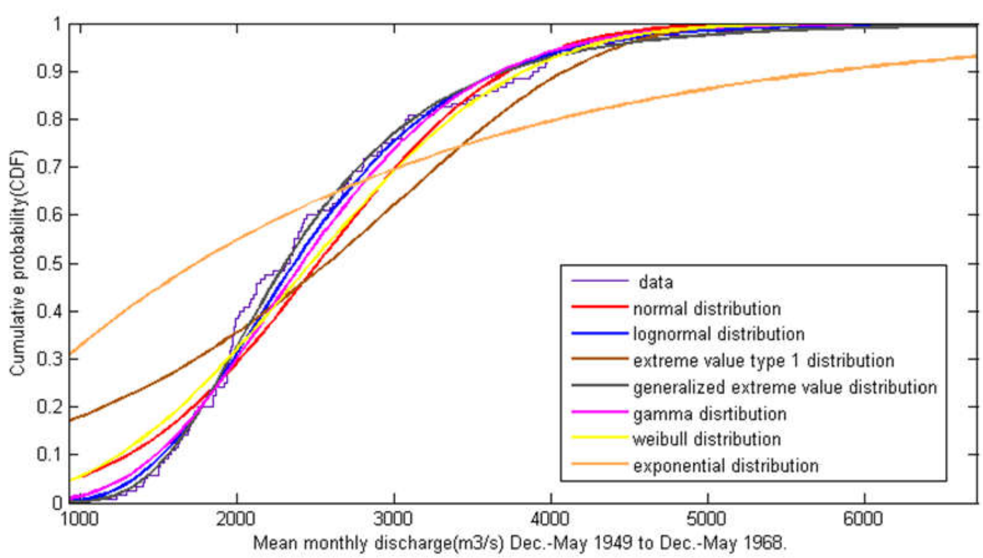


Figure 2. CDF of mean monthly discharge(m^3/s) Dec. -May 1949 to Dec. -May 1968.

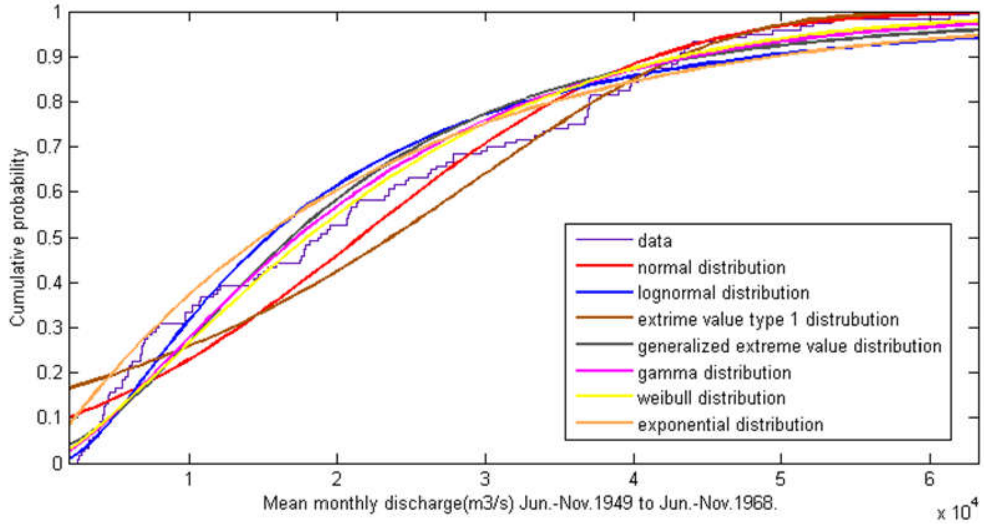


Figure 3. CDF of mean monthly discharge (m^3/s) Jun. -Nov. 1949 to Jun. -Nov. 1968.

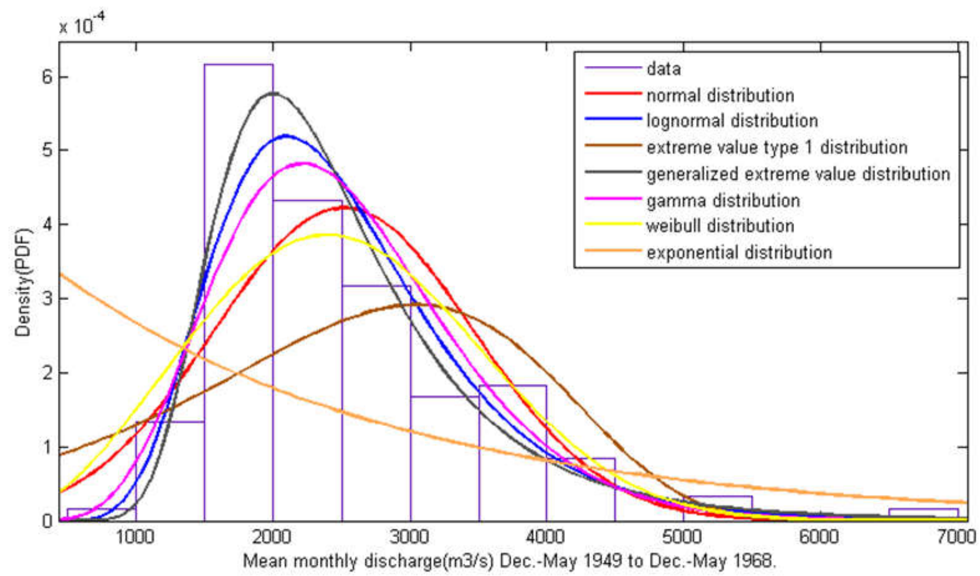


Figure 4. PDF of mean monthly discharge(m^3/s) Dec. -May 1949 to Dec. -May 1968.

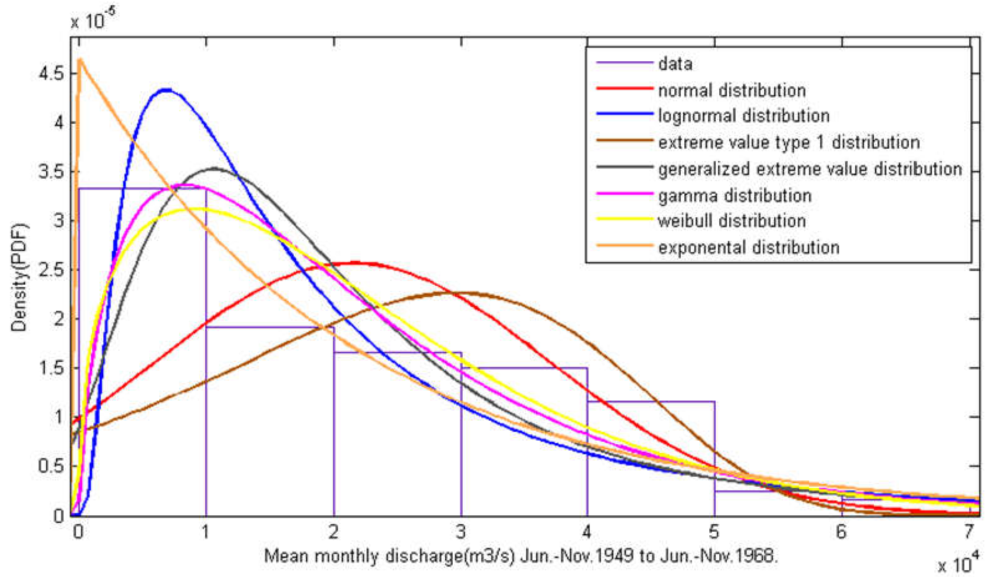


Figure 5. PDF of mean monthly discharge (m^3/s) Jun. -Nov. 1949 to Jun. -Nov. 1968.

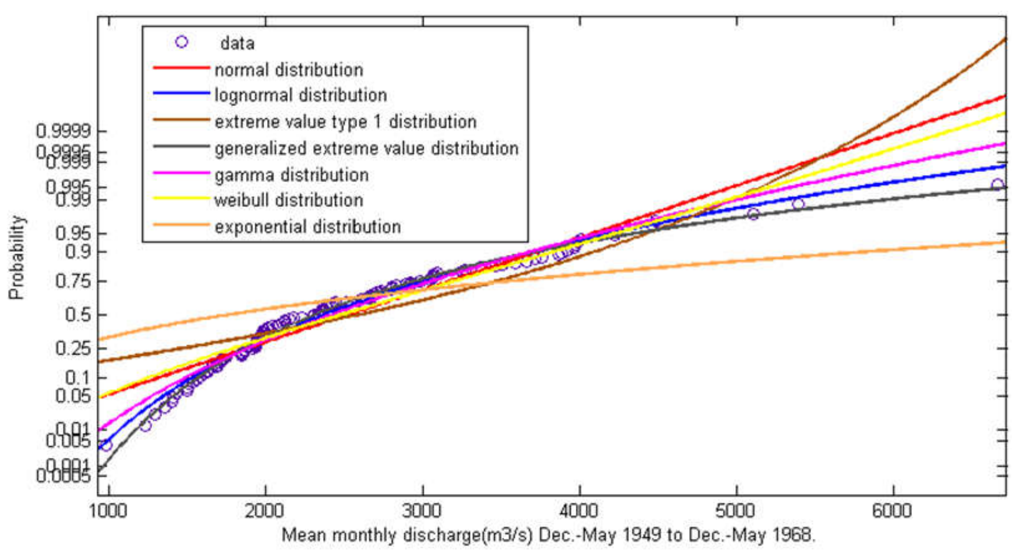


Figure 6. Probability of mean monthly discharge (m^3/s) Dec. -May 1949 to Dec. -May 1968.

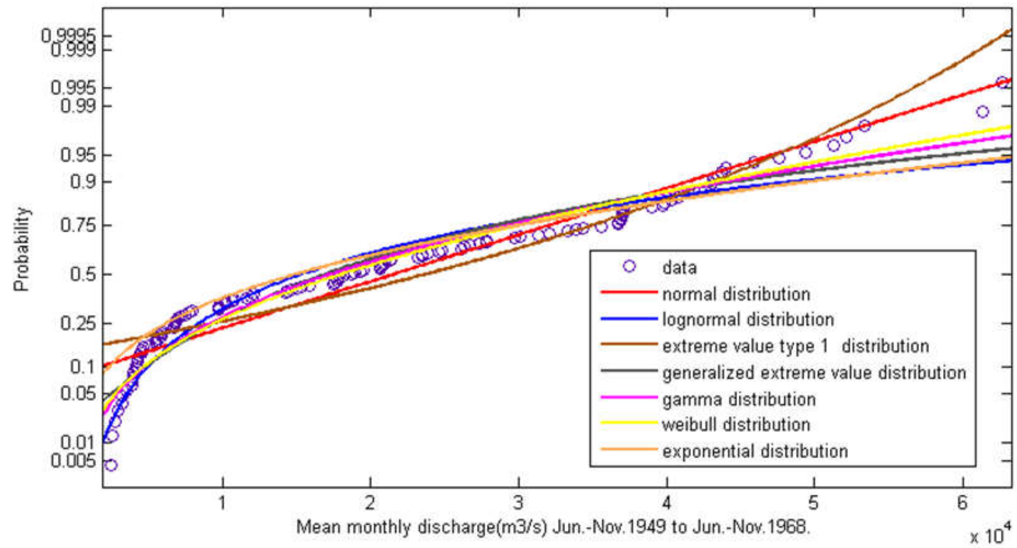


Figure 7. Probability of mean monthly discharge(m^3/s) Jun.-Nov.1949 to Jun. -Nov. 1968.

Q8. Section 4.3 and 4.4 Two tests have been used to determine the goodness of fit of the marginal distributions. In my opinion, the use of AIC and BIC is more advisable than K-S. In fact in the K-S test, the marginal distribution of Dec-May is not very adequate while in the AIC and BIC it's better. What comments do you suggest?\

Reply: Most of the time for goodness of fit of the marginal distributions AIC and BIC gives more reliable results but for safer side we also check for K-S test. In this study AIC and BIC are showing better results.

Q9. Section 5 In my opinion you should put a table with the values of the parameters of the copulas used, as well as the value provided by the Cramér-von Mises statistics.
See package of R, for example

Reply: The values of parameters of the copulas are shown in Table 5. Mostly Cramér-von Mises test of goodness-of-fit to a specified continuous univariate probability distribution but in our case bivariate distribution is used.

Table 5. **: Statistics in calibration and validation test.**

Statistics	**Calibration Test**	**Validation Test**
MSE	0. 00206	0. 00147
R^2	0. 94	0.9

Q10. Section 5. The authors have carried out a copula study but at no time have I observed the correlation of the initial data. What values of dependence (Tau-kendall, Rho Sperman) does the initial sample have? And the generated sample?
Dependence graphs should be included (k-plots, Chiplots, etc.)

Reply: We incorporated your kind suggestions and the dependence values of initial sample and generated samples are given below. Also, chi square plot will be included in revised manuscript .

Sample name	Tau-kendall	Rho Sperman
Initial sample	-0.1164	-0.2013
Generated sample	-0.1216	-0.1812

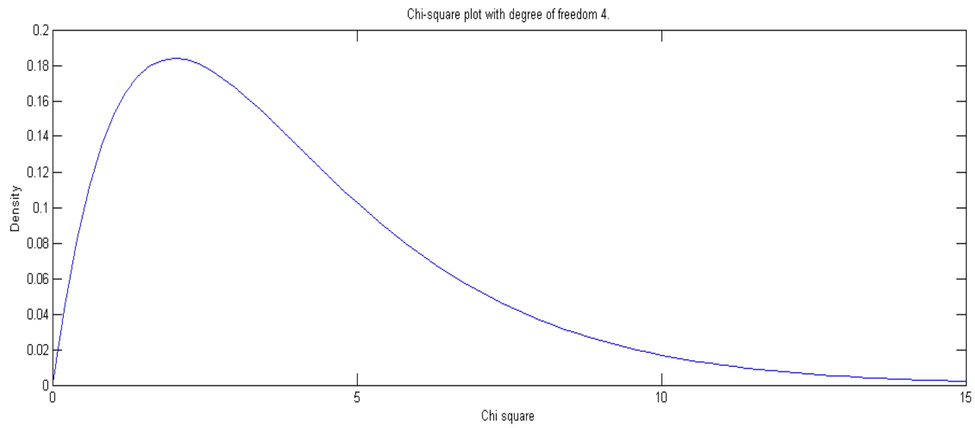


Figure : Chi-square plot of observed outflow discharge data.

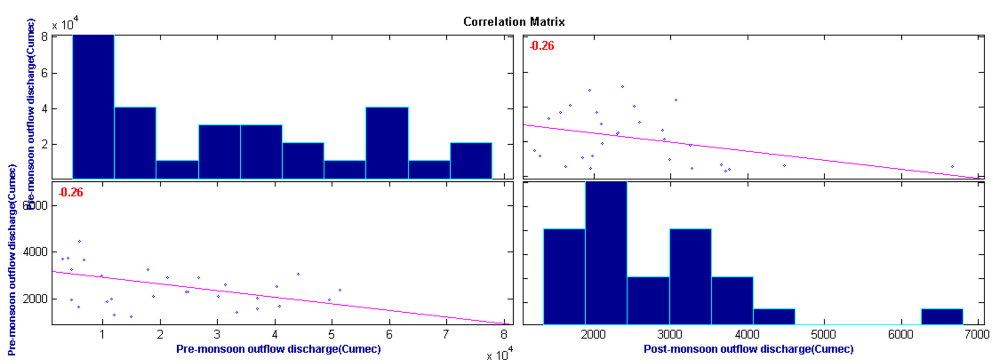
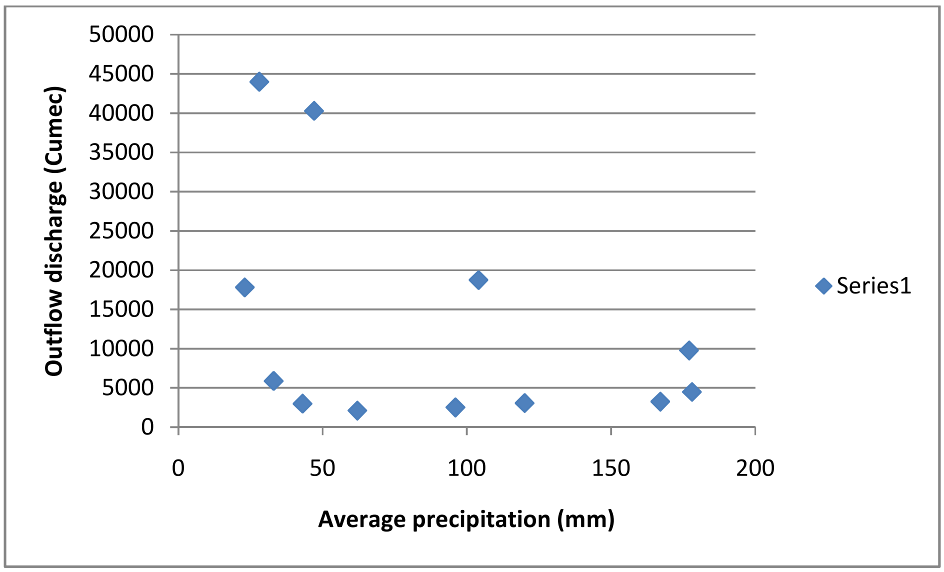


Figure: K-plot of Pre-monsoon and Post-monsoon outflow discharge data.

Q11. Section 7. The authors have also used an ARMA model, would not it have been appropriate to use an ARMAX model including rain as an exogenous variable?

Reply: Farakka barrage is located near the bay of Bengal. The flow at Farakka is the result of precipitation over the entire basin. The possibility to relate outflow at Farakka with average precipitation (available at link https://en.climate-data.org/north-america/canada/british-columbia/ganges-11997/) was also explored (see figure given below). However, the trend was not well defined to suggest inclusion of precipitation as one of the input variables.



Q. It should include some graphics showing the location of the Farakka dam.

Reply: We have incorporated the above suggestion in the revised manuscript.

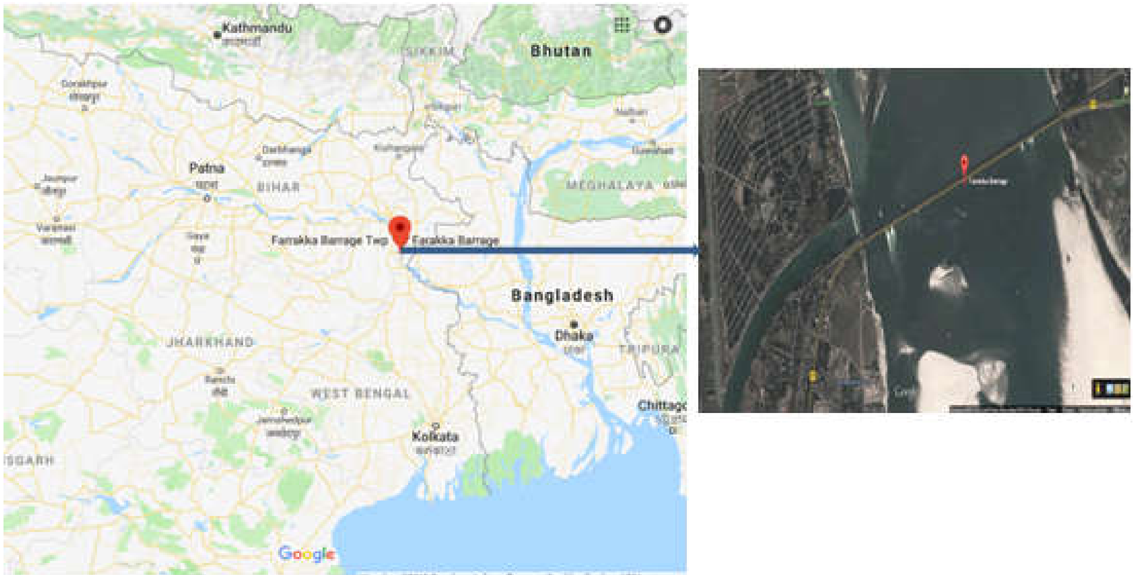


Figure1. Google image and loaction of Farrakka barrage.

Authors would like to thank the reviewer for his useful comments.