Investigating the effect of calibration objective function on a flood forecasting system

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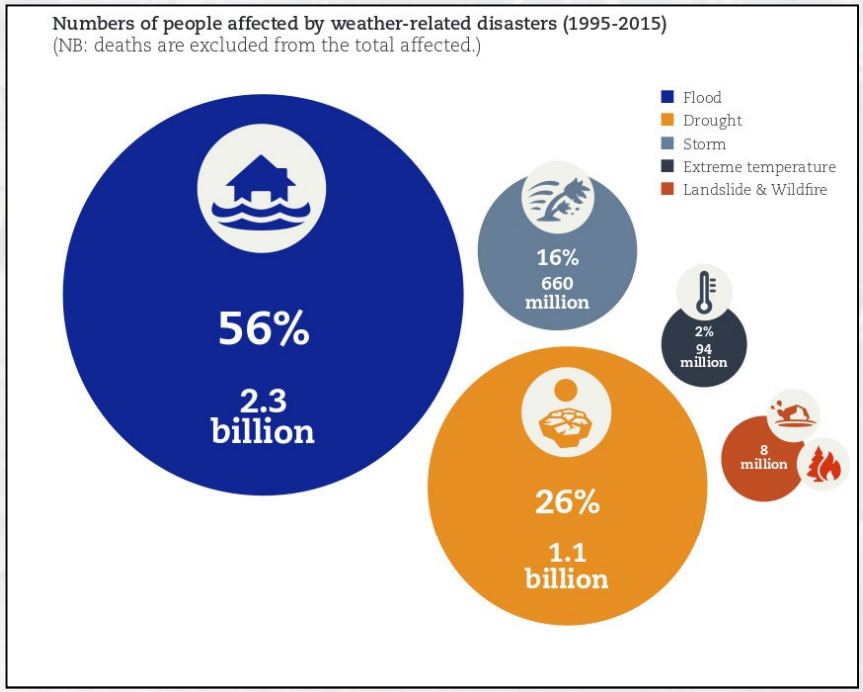
Introduction

- Disasters - a natural or human caused phenomenon causing disruption to the functioning of a community
- Flood – the most common natural disaster causes huge loss of lives, and damage to livelihood systems and public utilities

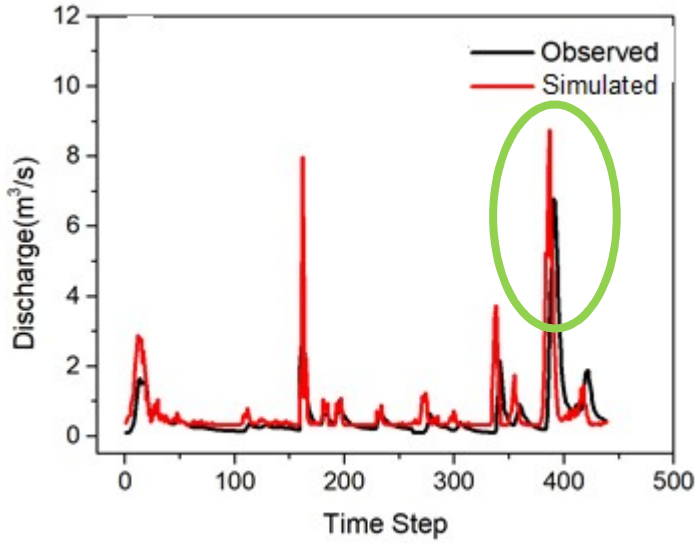


What is the Solution ?

- Understanding the level of risk and selection of appropriate flood control measures
- Accurate and reliable flood forecasting serves the purpose

Flood Forecasting Using Hydrological Models

- Flood forecasting models - generally achieved by applying
  - Various hydrological models
  - Hybrid models - combines the strength of different modelling aspects in hydrology
- A flood forecasting model aims to capture
  - The Peak Discharge
  - Time of peak



Calibration and Selection of Objective Function

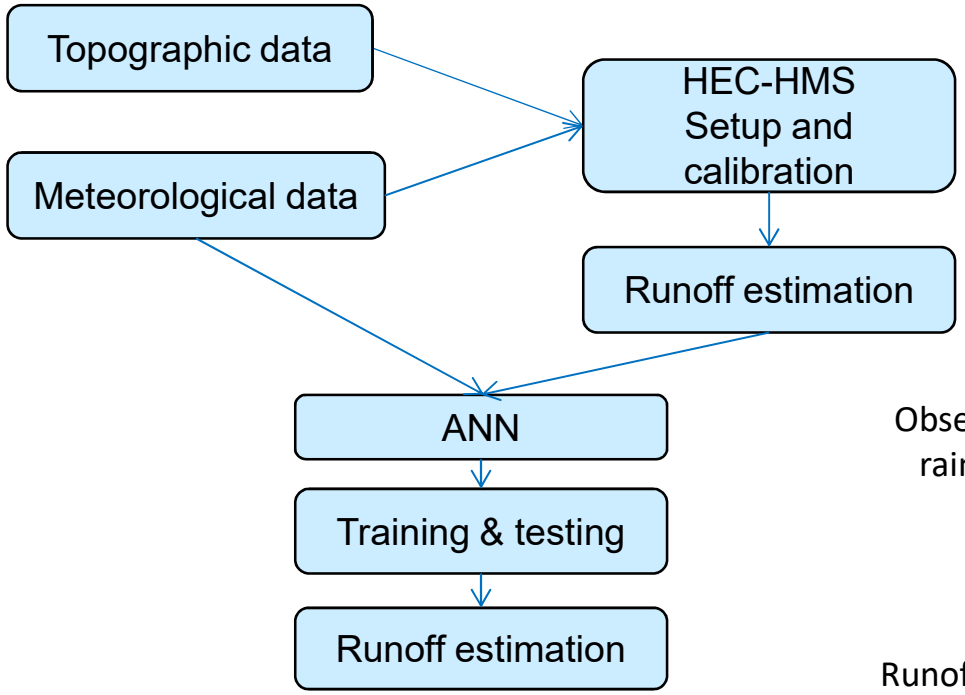
- Calibration- A process to find the optimal parameter set
- Calibration can be done using various objective functions
- Each objective function able to capture only a certain amount of information
- Understanding the effect of objective functions on the model and its parameters might help us to improve the model performance

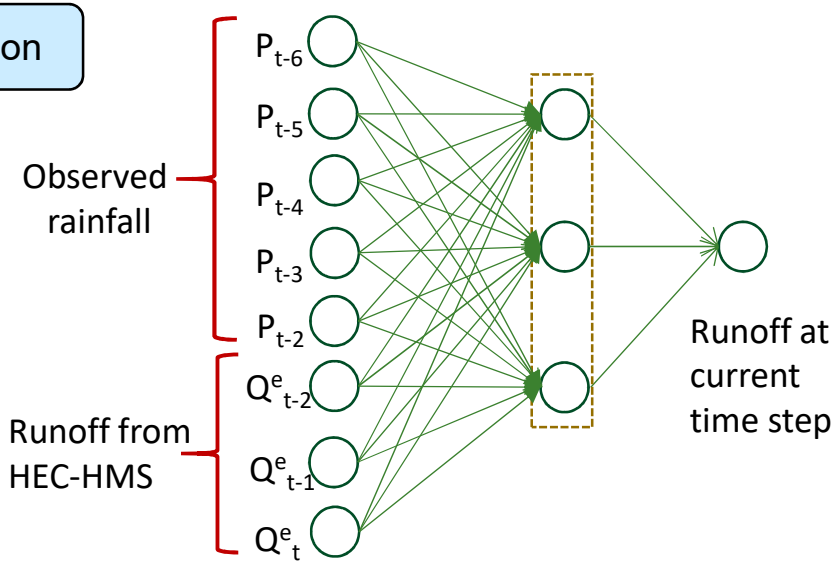
Objective of the Study

- To study the effect of objective functions on model calibration of a flood forecasting model

Developing a flood forecasting system

- A hybrid model – Combines a physically based model with a data driven model





Objective Functions considered

- Nash Sutcliffe Efficiency (NSE)

$$NSE = 1 - \frac{\sum_{i=1}^{N}[(Q_m)_i - (Q_o)_i)]^2}{\sum_{i=1}^{N}[(Q_o)_i - \overline{Q_o}]^2}$$

- Modified Peak Difference (MPD)

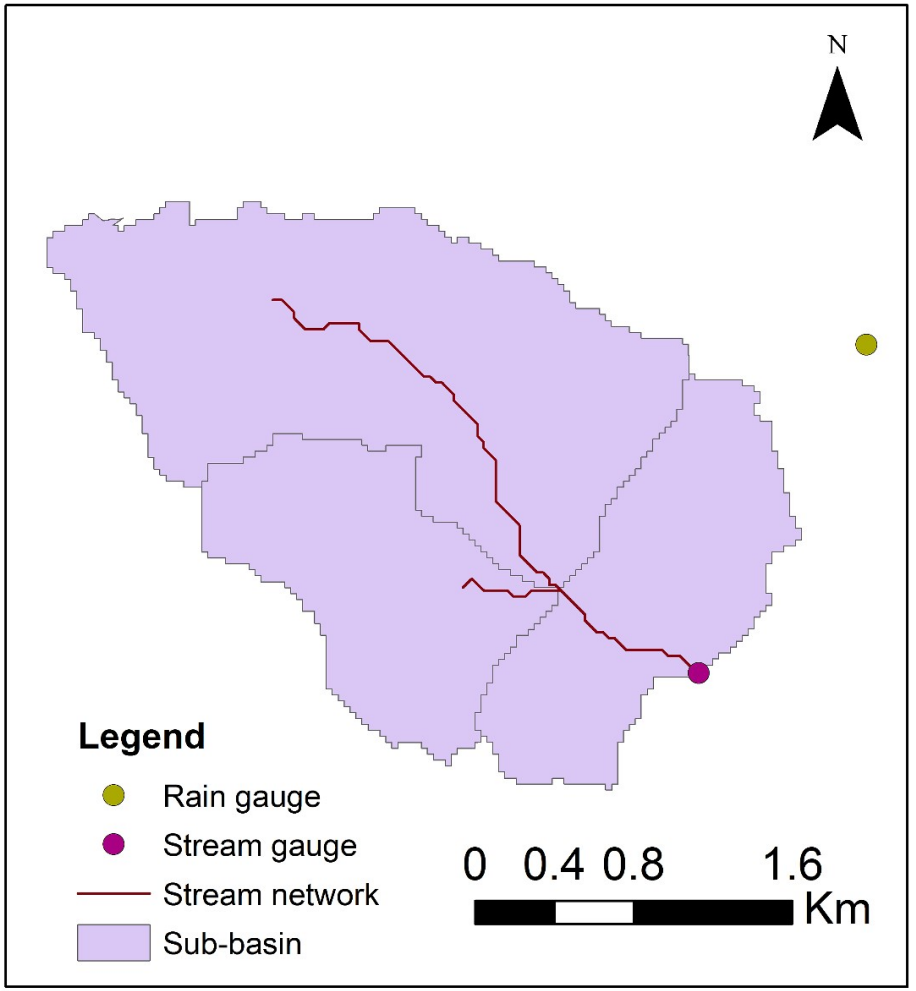
$$P_{diff} = \frac{|Q_{m,p} - Q_{0,p}|}{Q_{o,p}} * 100$$

Combinations Used

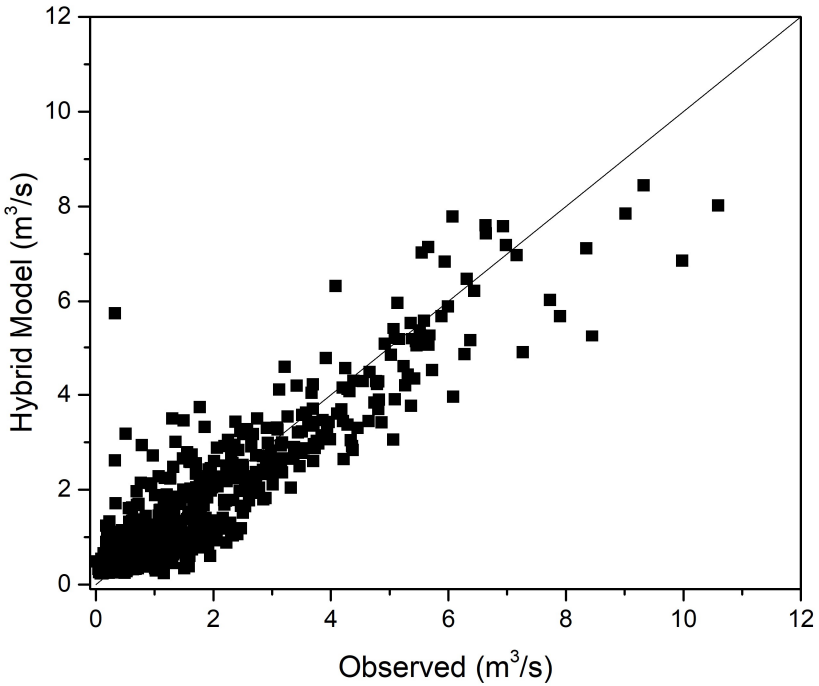
- Nash Sutcliffe Efficiency
- Modified Peak Difference
- Nash Sutcliffe Efficiency and Modified Peak Difference

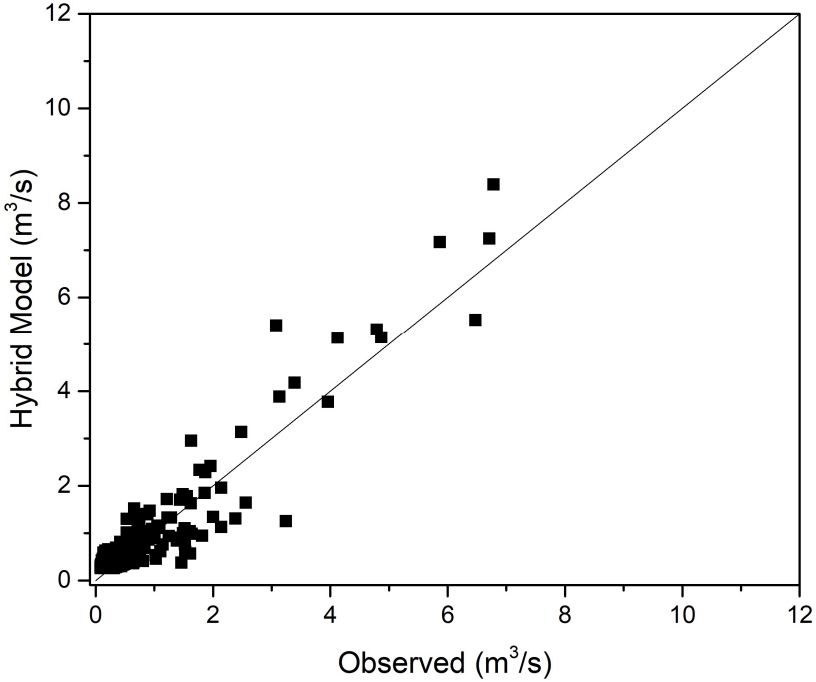
Study Area – Mills Avenue Watershed

- Greenville county - South Carolina – USA
- Area – 6.85 Km²
- Length of river – 3.3 Km
- Annual avg rainfall -1260 mm
- Mean annual temp - 16.4ºC

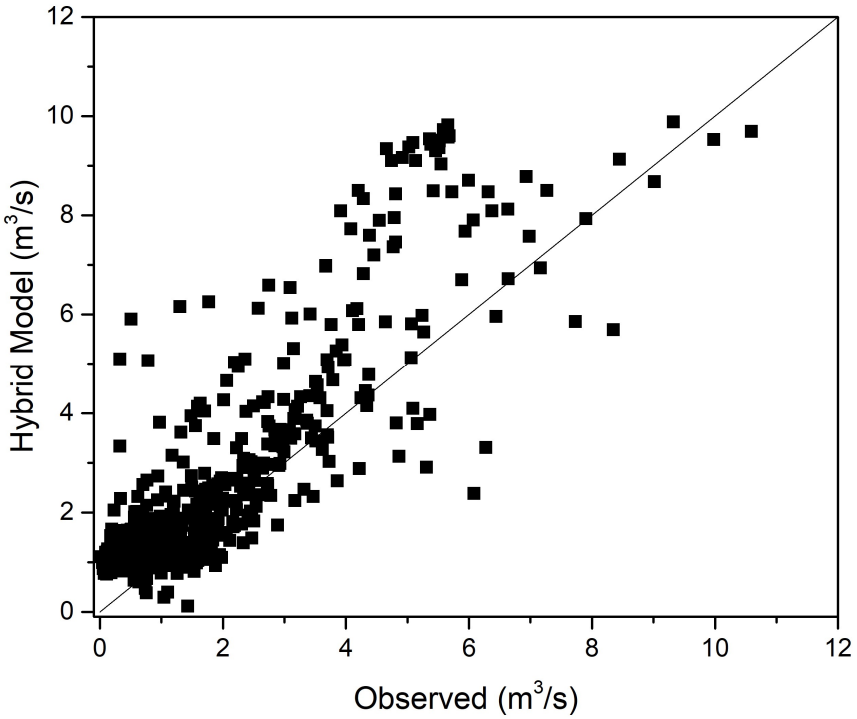


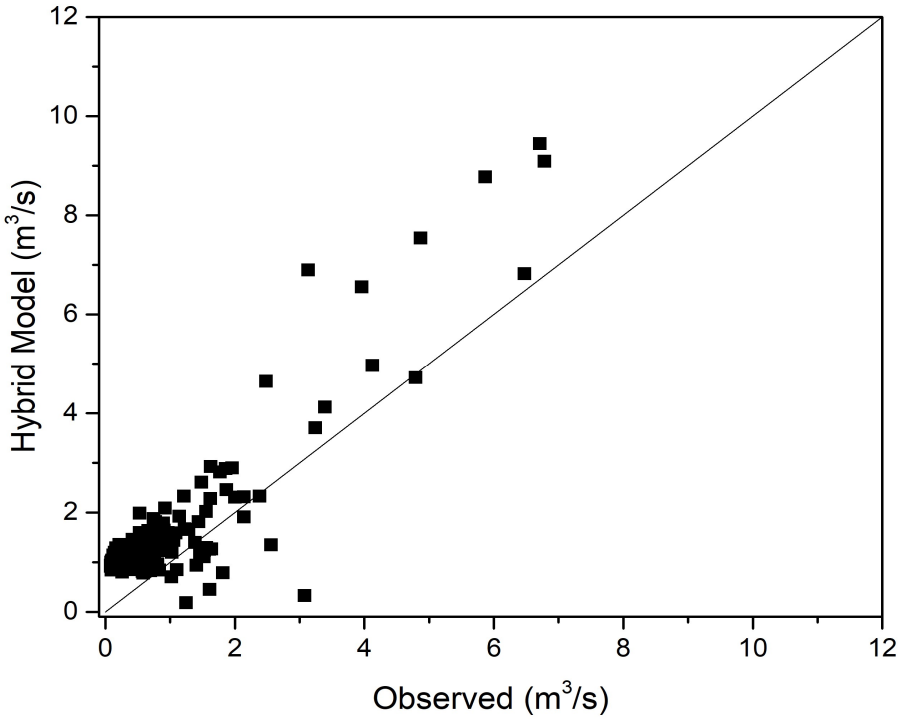
Nash Sutcliffe Efficiency



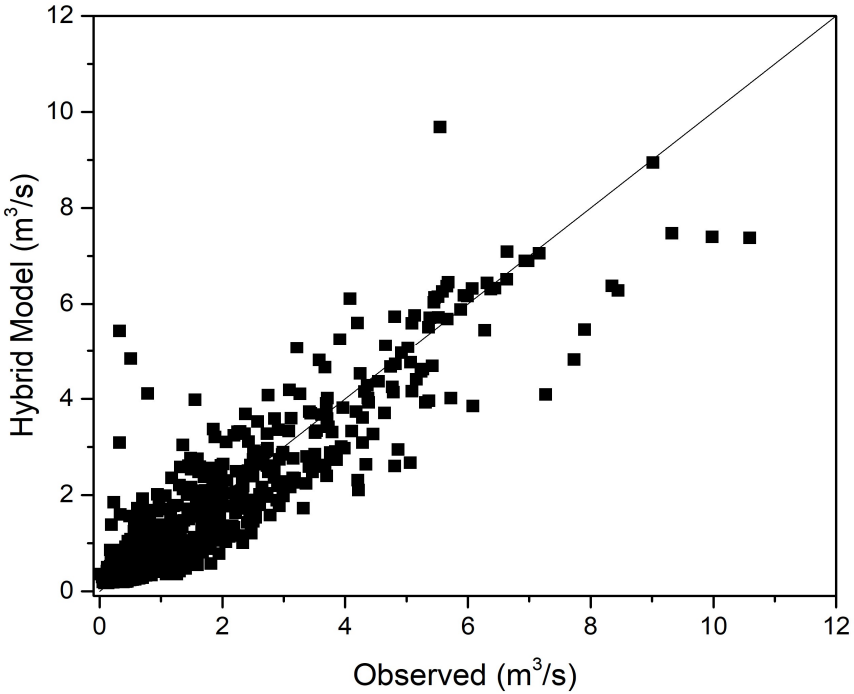


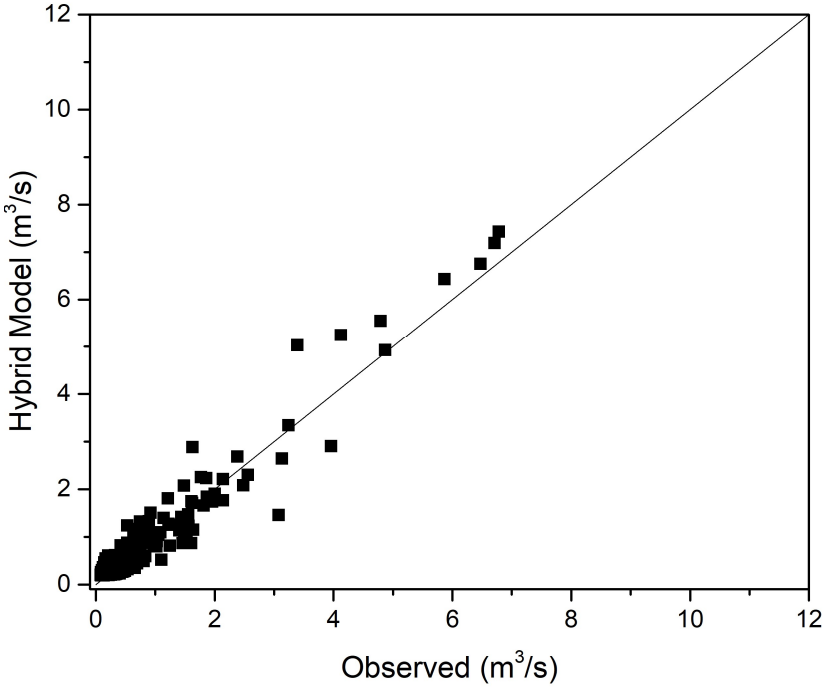
Modified Peak Difference





Nash Sutcliffe Efficiency & Modified Peak Difference



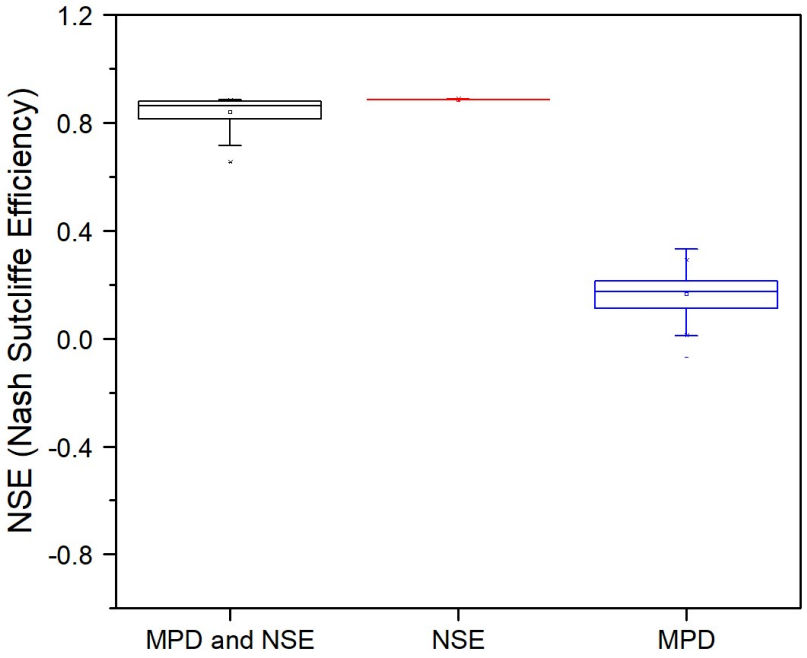


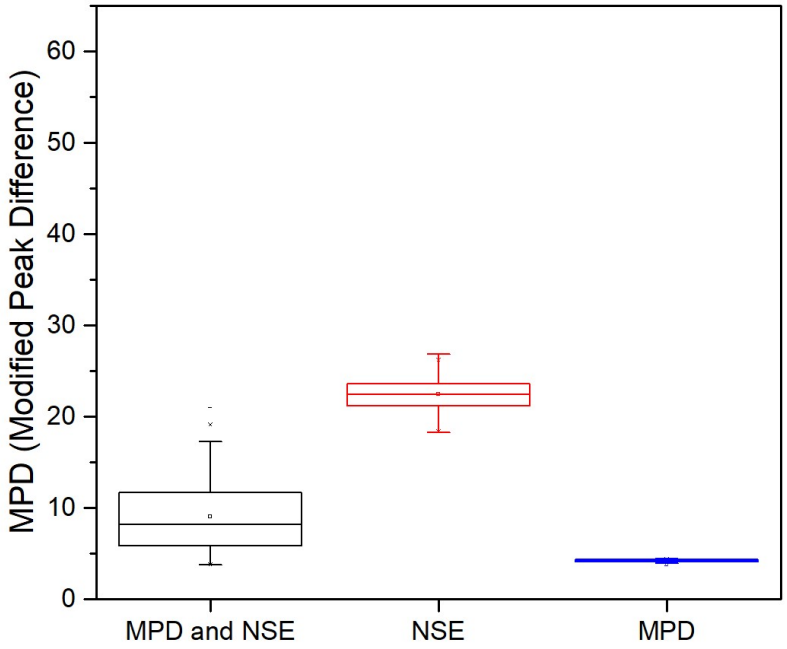
Results Contd:-

Objective function used	Calibration					Validation				
	NSE	ET_p (time step)	P_{diff} (%)	MSE (m^3/s)	RVE (m^3)	NSE	ET_p (time step)	P_{diff} (%)	MSE (m^3/s)	RVE (m^3)
NSE	0.88	6.25	23.03	0.17	0.22	0.86	1.33	41.64	0.09	0.10
MPD	0.34	1.27	14.75	0.94	1.27	0.08	1.33	23.72	0.64	1.26
NSE and MPD	0.87	6.00	10.45	0.18	0.17	0.92	0.67	14.19	0.05	0.09

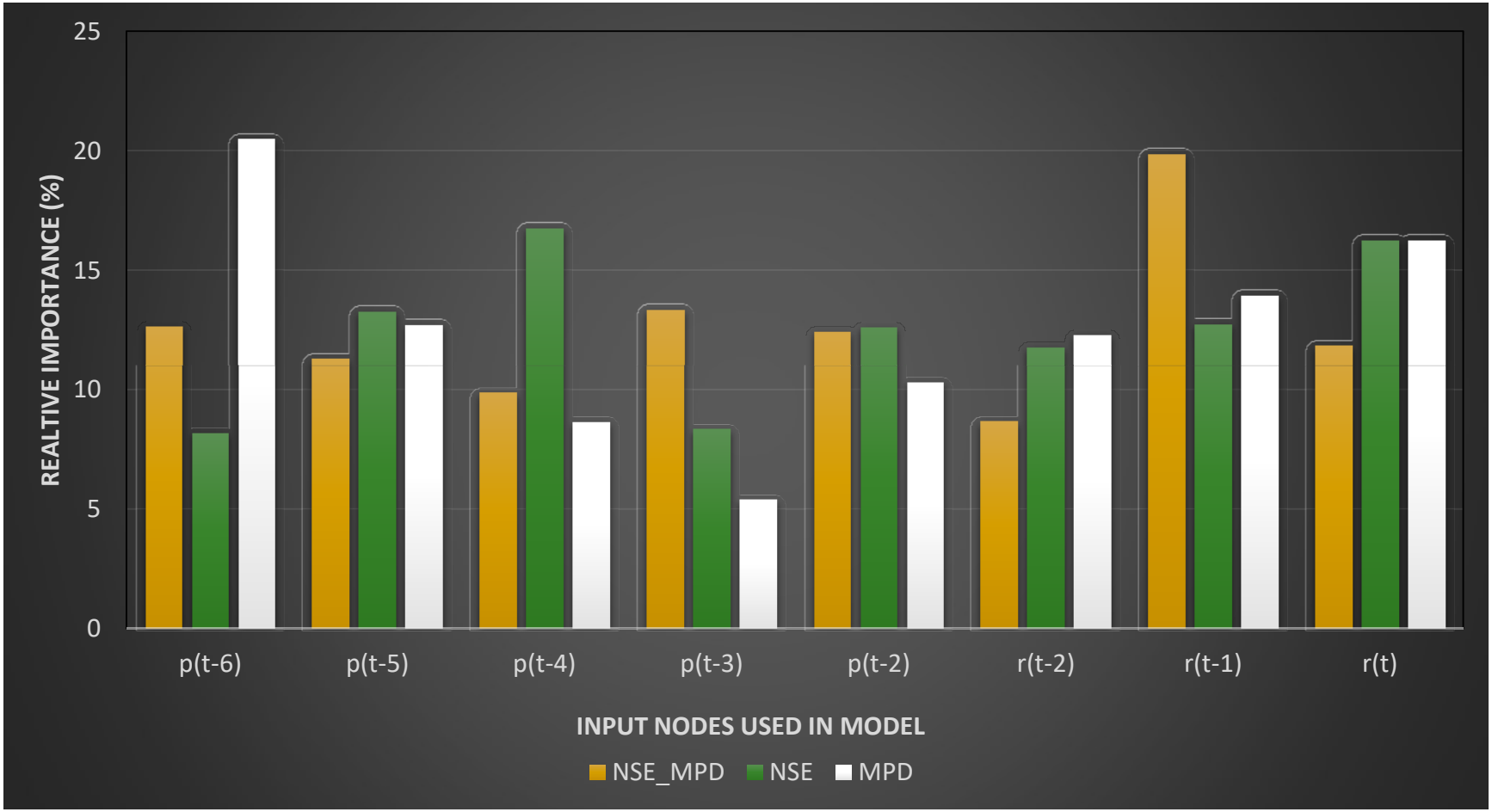
Effect of Objective Function on Model Performance

- Evaluated the model performance across the calibrated models using NSE and MPD





Effect of objective function on Inputs to ANN model



Summary and Conclusions

- Studied the effect of objective functions on calibration of a flood forecasting model and different combinations of objective functions were employed for the analysis
- results showed that multi objective calibration improves the model performance compared to single objective calibration method
- Each of the objective functions brings up a different characteristic of the hydrograph, therefore, Selection of the objective function should be done based on the application of the model
- Further studies are required to extensively study the impact of objective functions and to come up with a guideline for the selection of objective function based on the model application.