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Optimal Estimation of SWAT Model Parameters using Adaptive Surrogate Modelling

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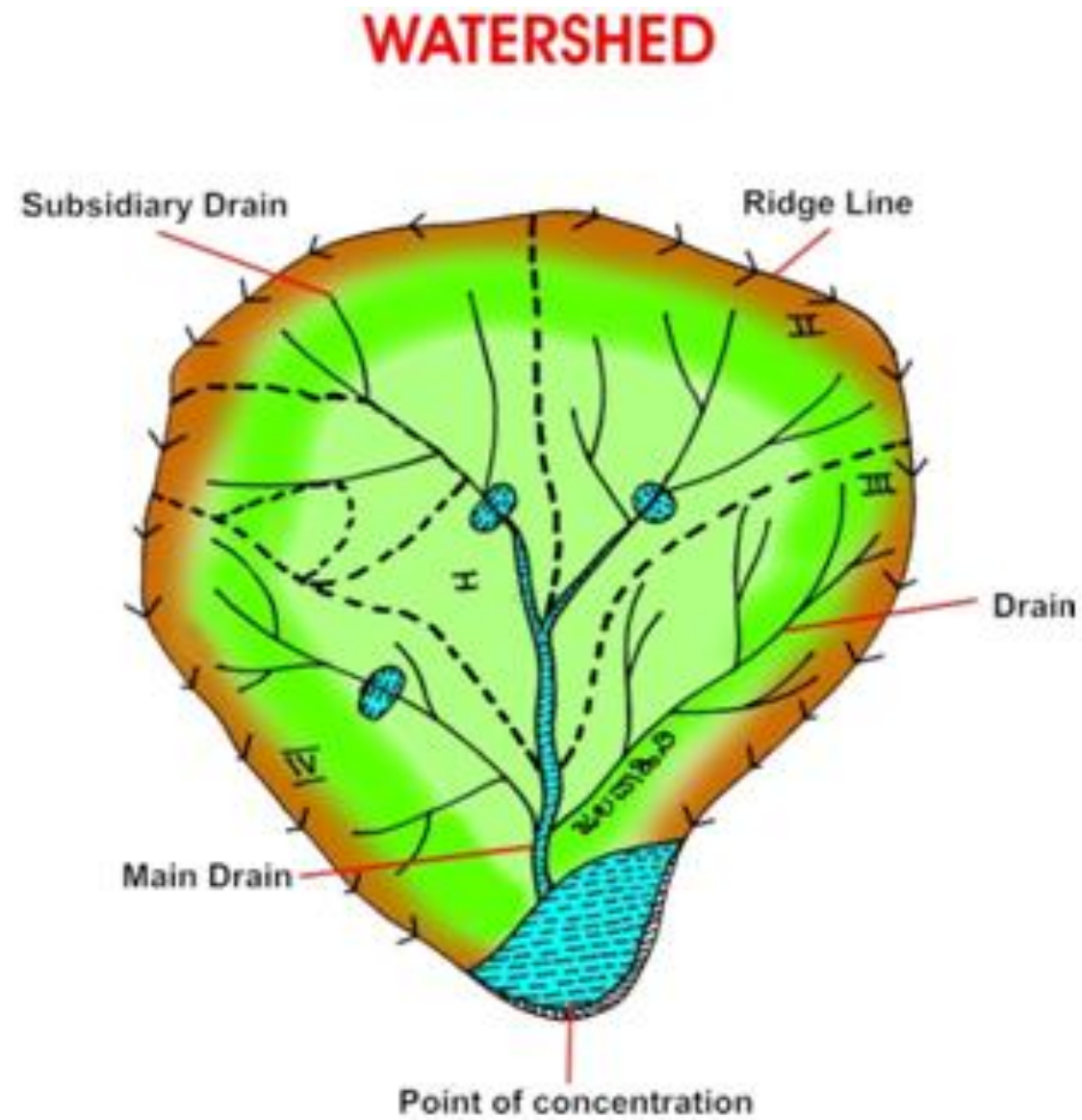
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Vellore Institute of Technology
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INTRODUCTION



INTRODUCTION

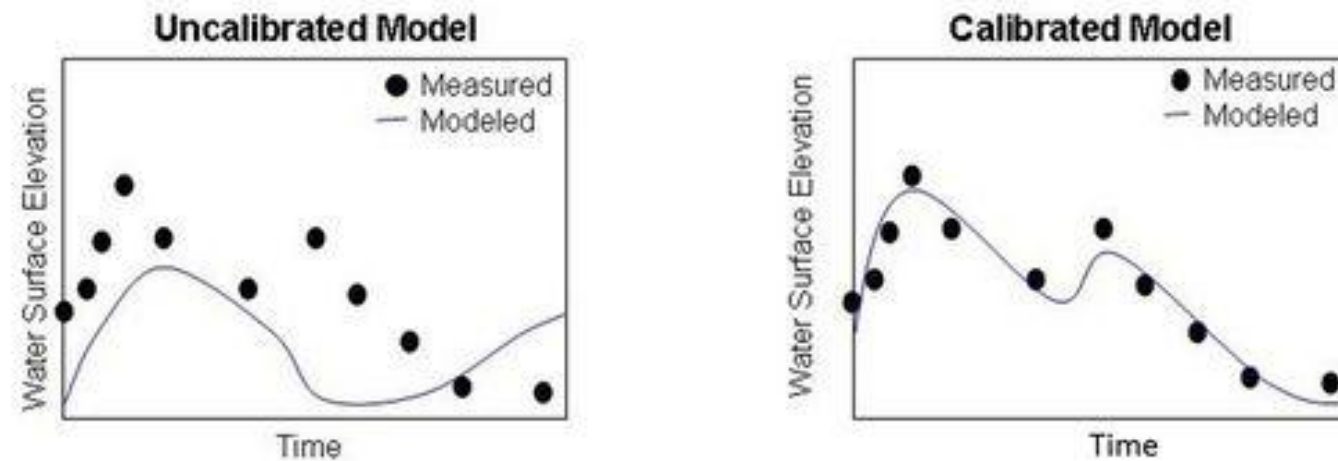
Hydrological models

- Why only SWAT model ... ?
 - Current models
 - EPIC – Field scale
 - ALMANAC – Field scale (Crop models)
 - APEX – Farm scale (not for larger watersheds)
 - SWAT – Watershed scale



INTRODUCTION

- Calibration



Source : USGS

- For global optimal solution of parameters must deal two cases like
 - Complexity (more number of parameters)
 - Computational constraint (calibration time)
- Surrogate models, Sensitivity Analysis

INTRODUCTION

Surrogate models

real world

- ♦ I/O system
- ♦ stimulus / response



simulation model

- ♦ approximation
- ♦ discretization



surrogate model

- ♦ metamodel
- ♦ scalable analytical model
- ♦ *“model of model”*



Accuracy

Simulator

Surrogate model

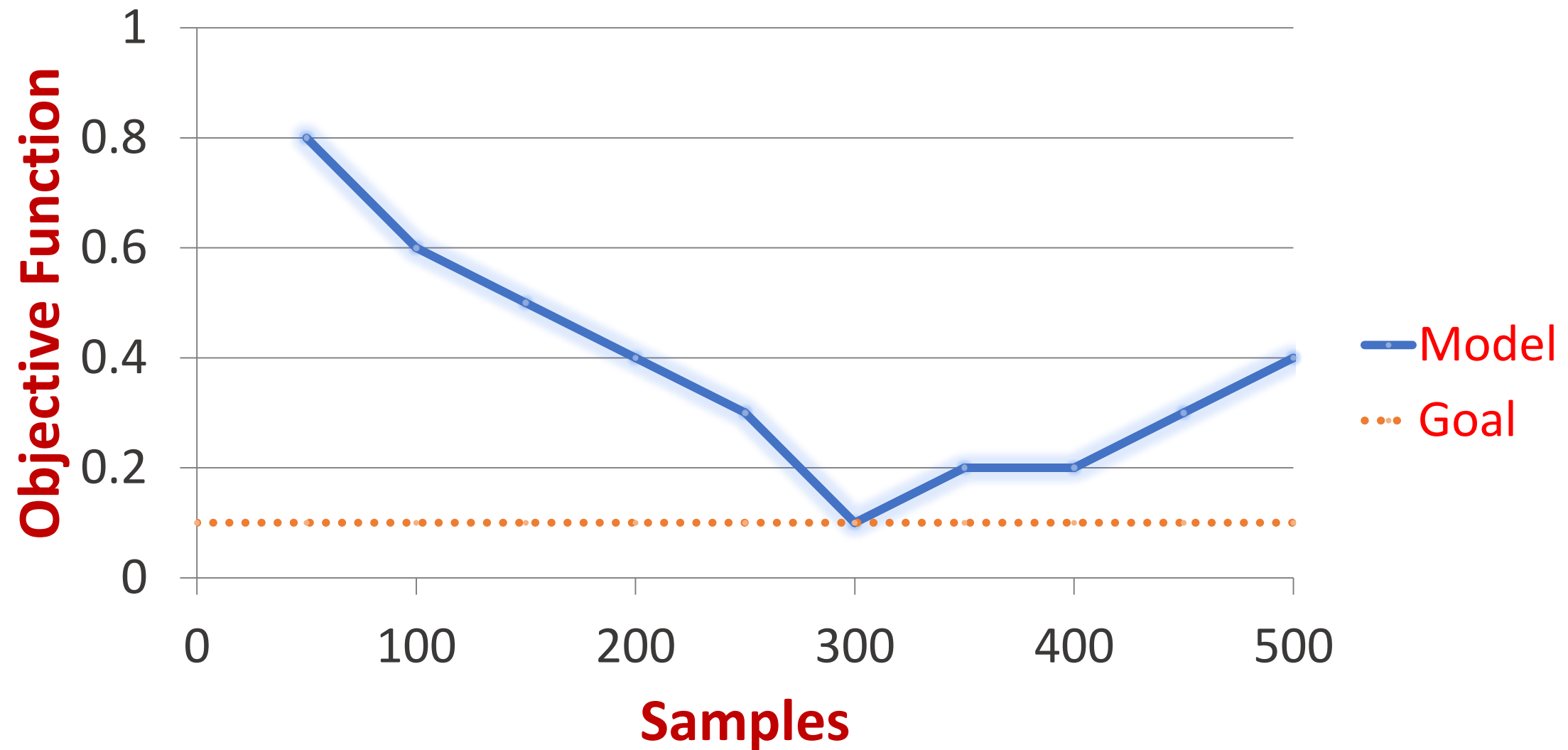
DOE

Speed

Source : Universitit Gent

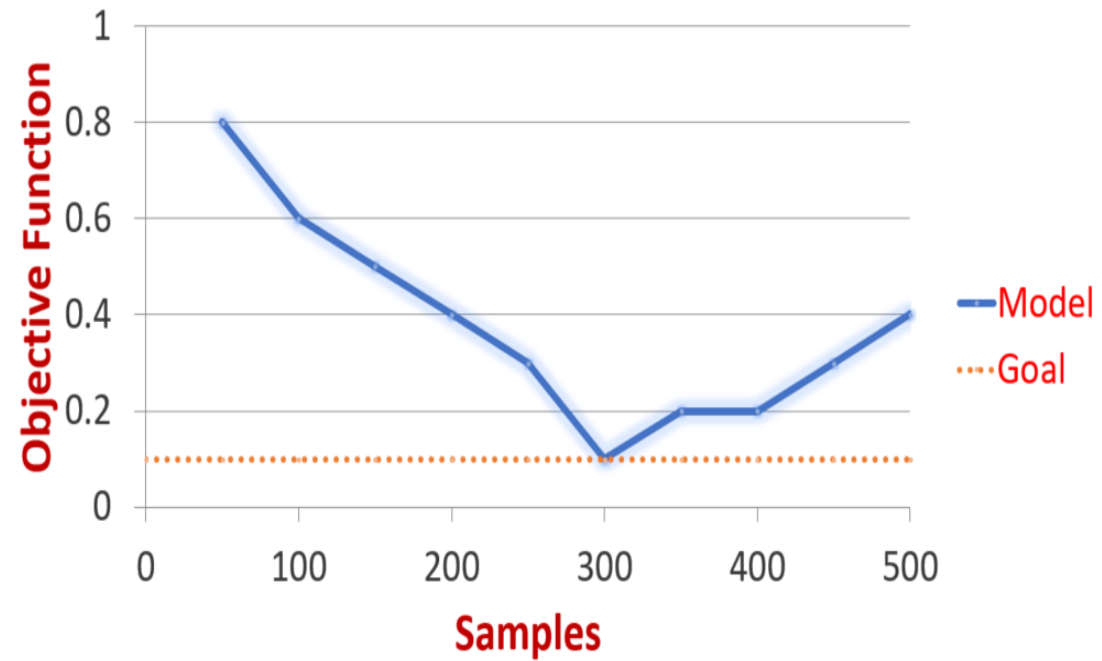
INTRODUCTION

Surrogate Modelling

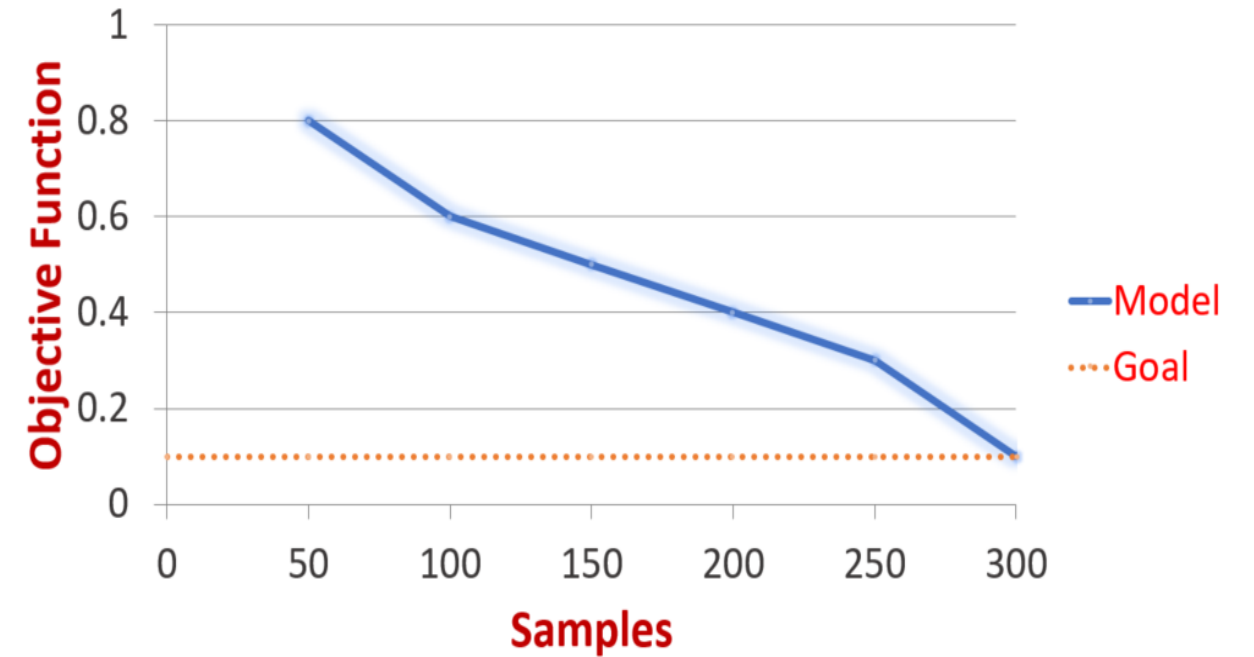


INTRODUCTION

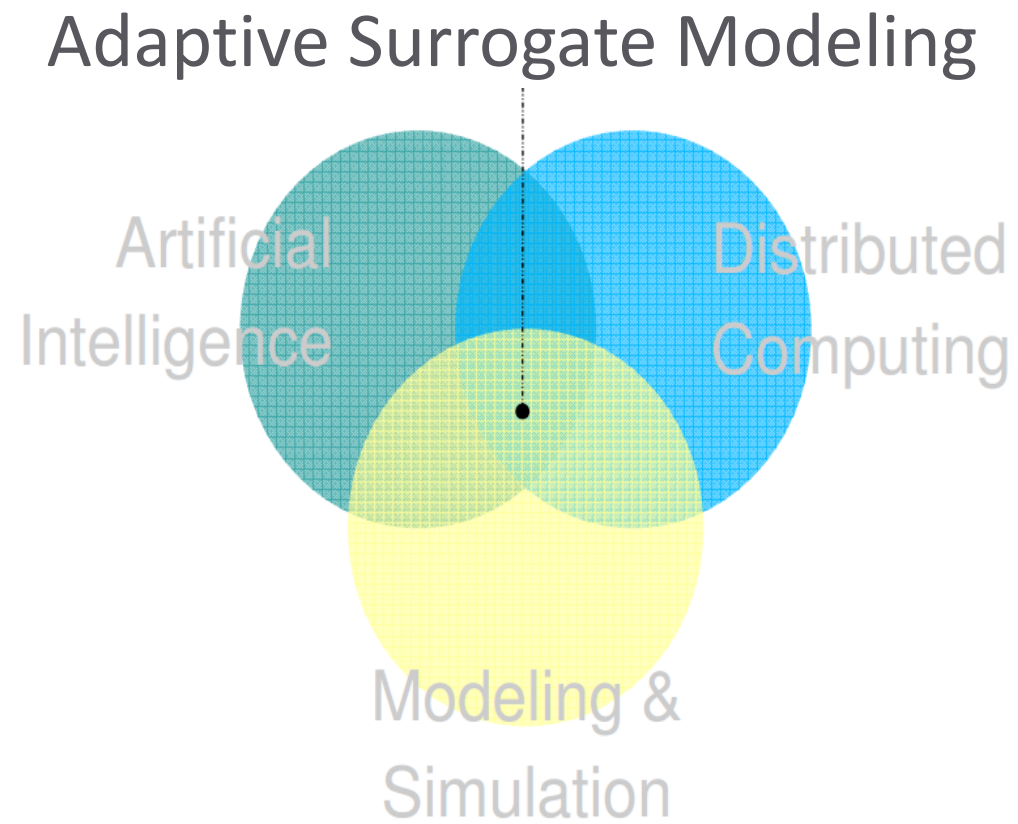
Surrogate Modelling



Adaptive Surrogate Modelling

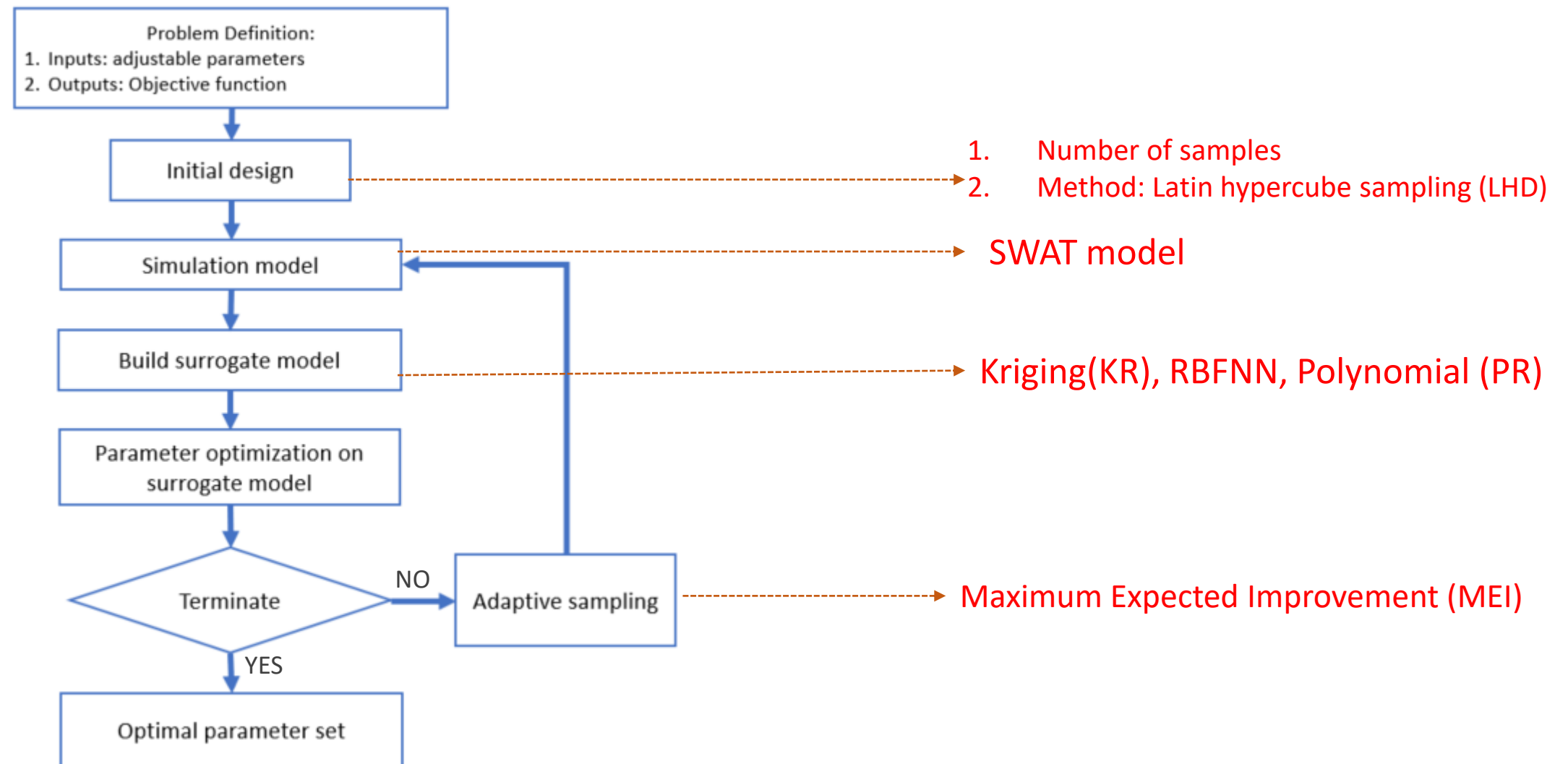


INTRODUCTION

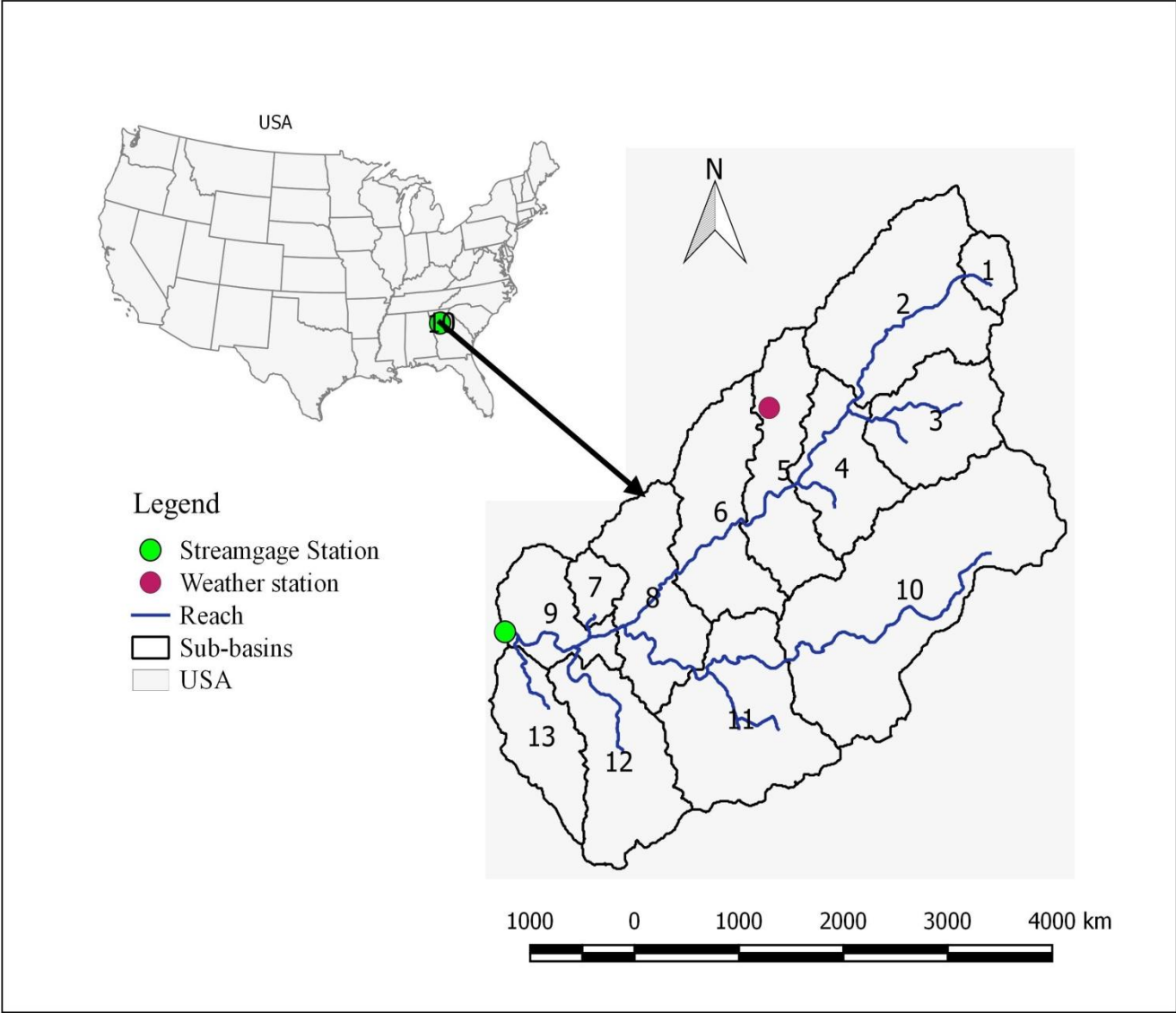


Source : Universitit Gent

METHODOLOGY



STUDY AREA

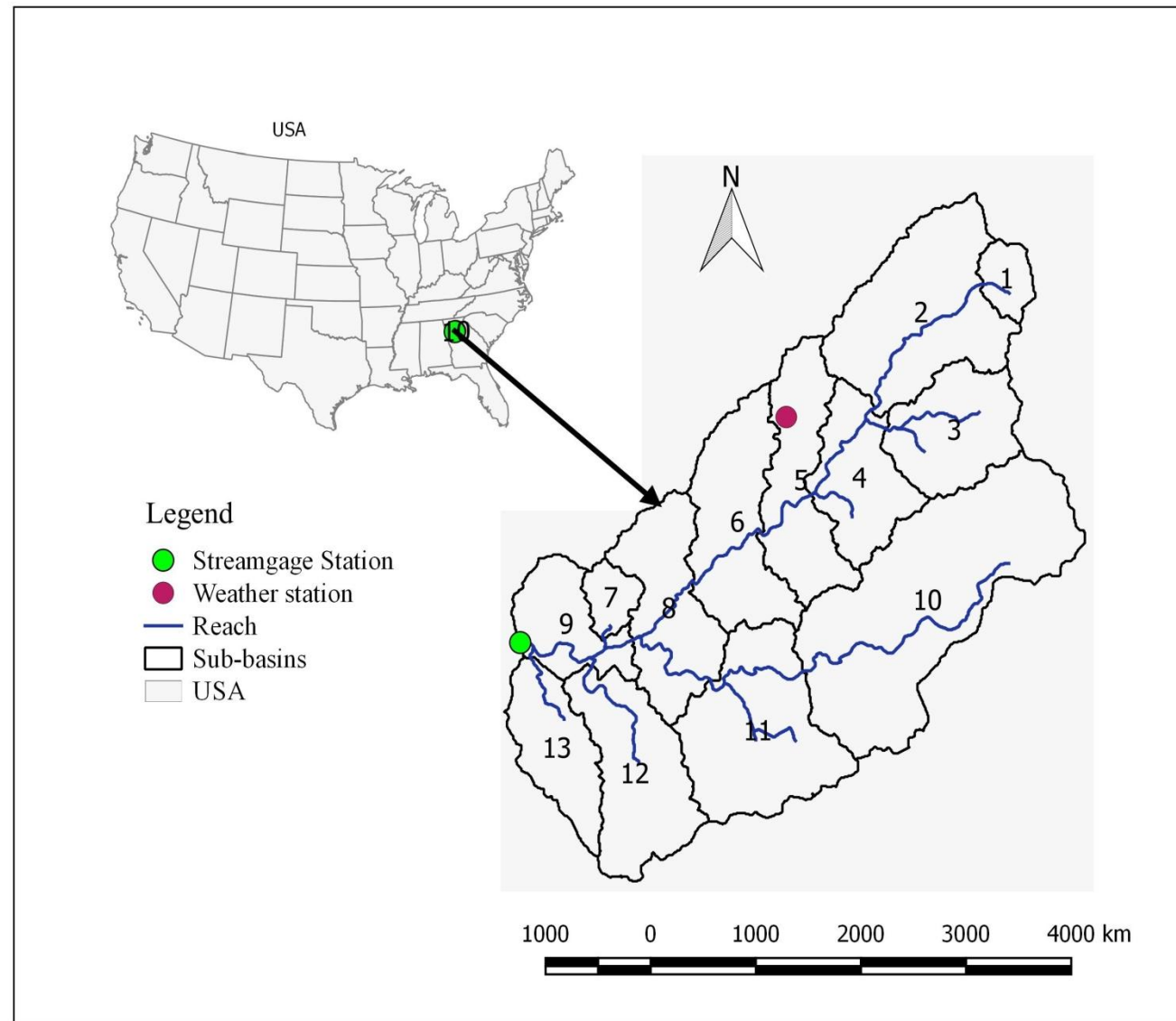


Peachtree Creek Watershed

- Time period: 2007-2013 – 7 years.

Virtual information of Peachtree Creek Watershed	
Virtual Identity	Details
Location	Atlanta, USA
Name of the watershed	Peachtree watershed
Area of the Watershed	216.2 km ²
Elevation range	232.43 m to 342.67 m, based on DEM (NHD-PLUS, 2006)
Dominant Landuse	Urban landcover (NLCD, 2011)
Soil Properties	Clayey and rocky soils of Georgia's Piedmont region (U.S. Geological Survey, 1995)

STUDY AREA



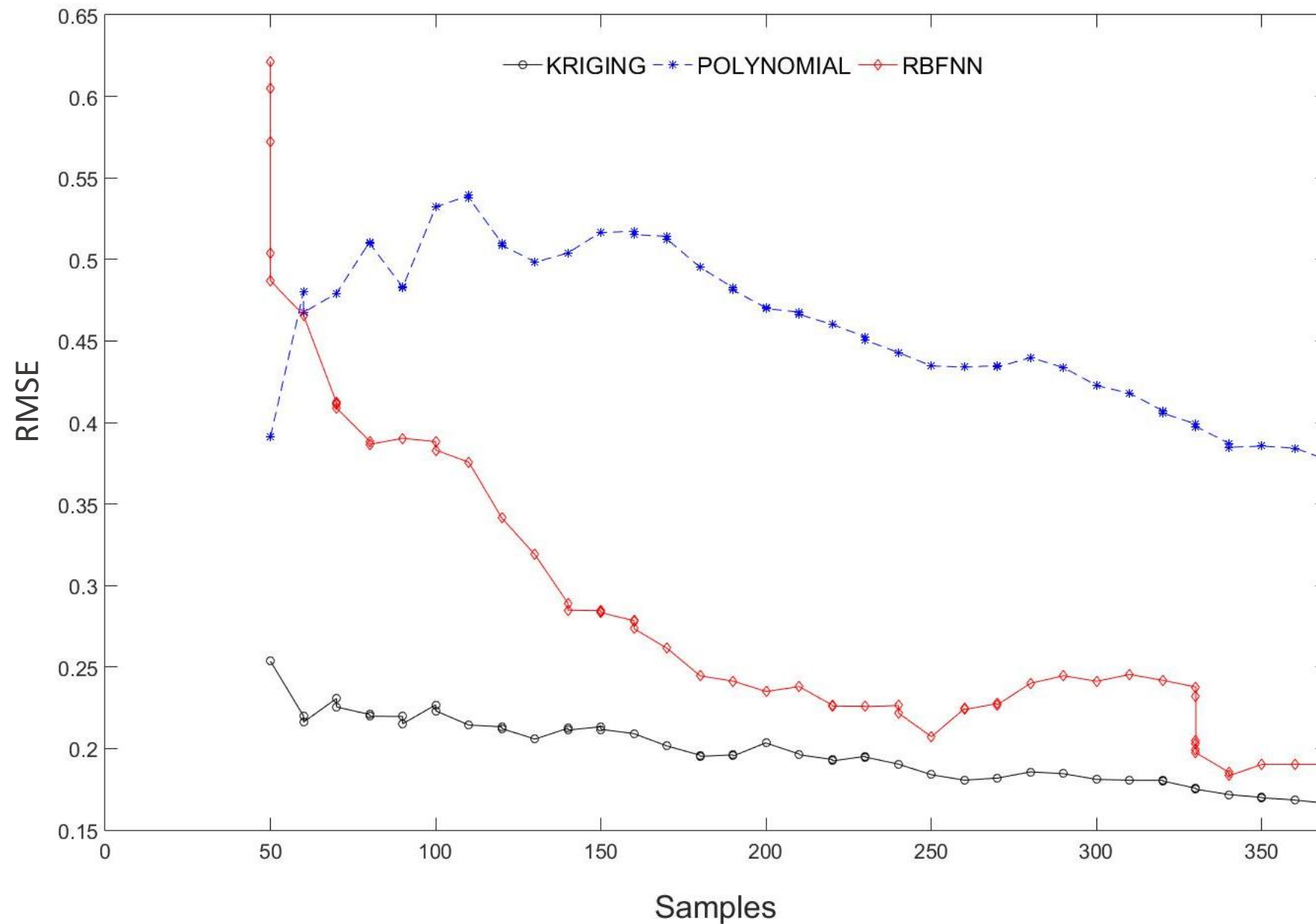
SELECTED SWAT PARAMETERS

- 16 parameters selected (Zhang et.al., 2009), (Confesor et.al., 2007), (Noori et.al., 2016)

Sl.No.	Parameter
1	CN2
2	ESCO
3	SOL_AWC
4	GW_REVAP
5	REVAPMN
6	GWQMN
7	GW_DELAY
8	ALPHA_BF
9	RCHRG_DP
10	CH_K2
11	SFTMP
12	SMTMP
13	SMFMX
14	SMFMN
15	TIMP
16	SURLAG

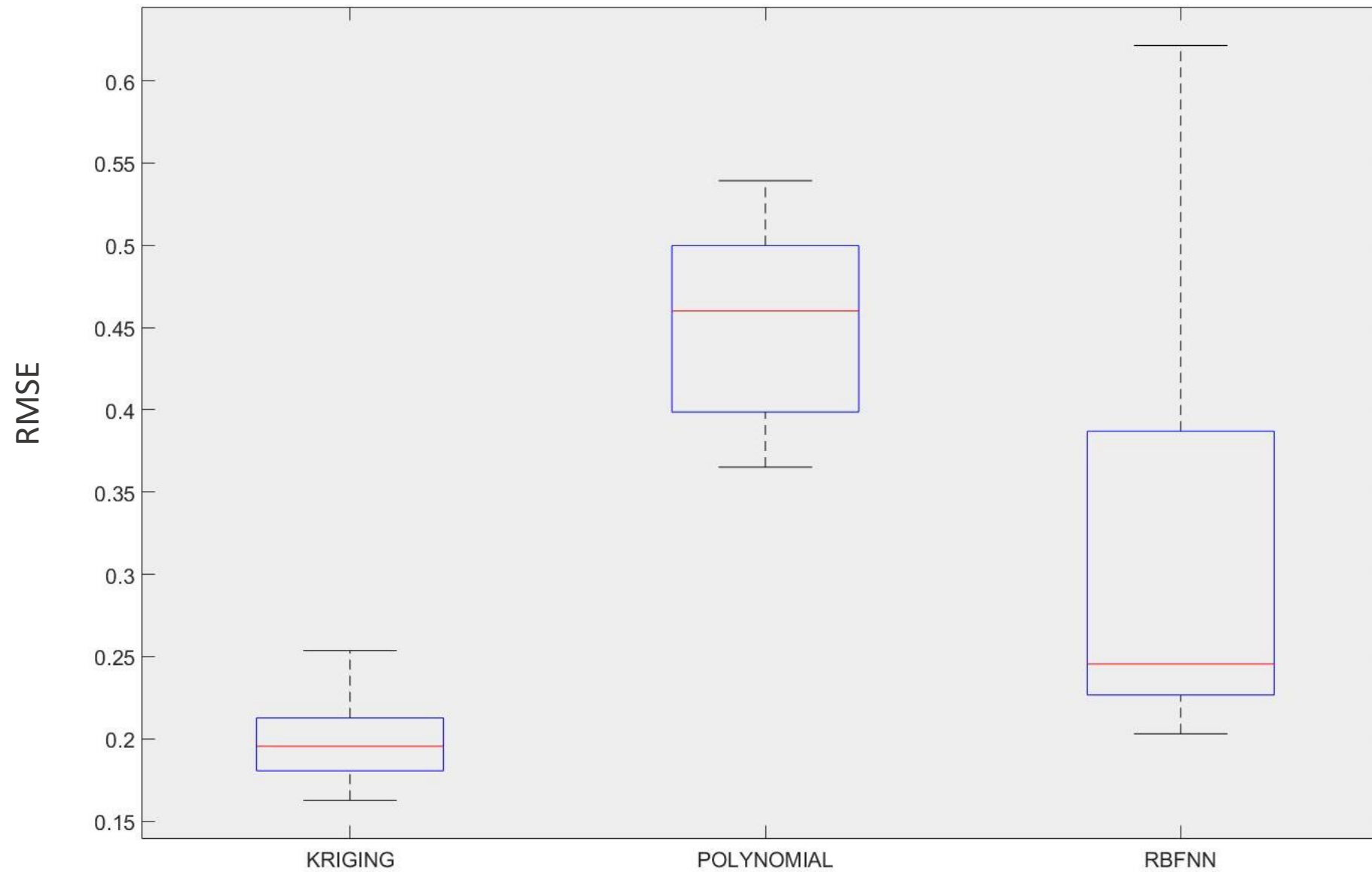
RESULTS

Model Accuracy Analysis



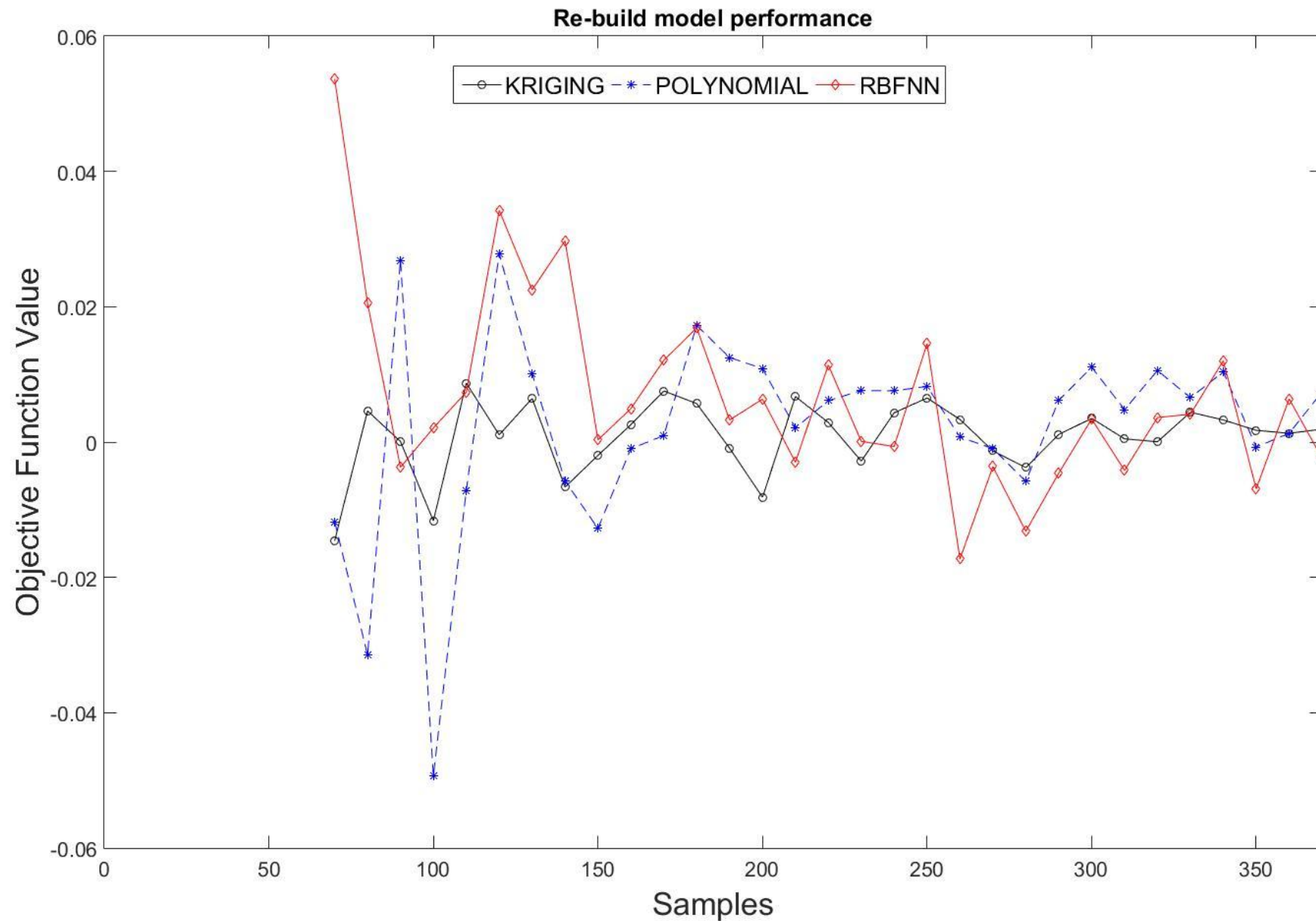
RESULTS

Model Accuracy Analysis



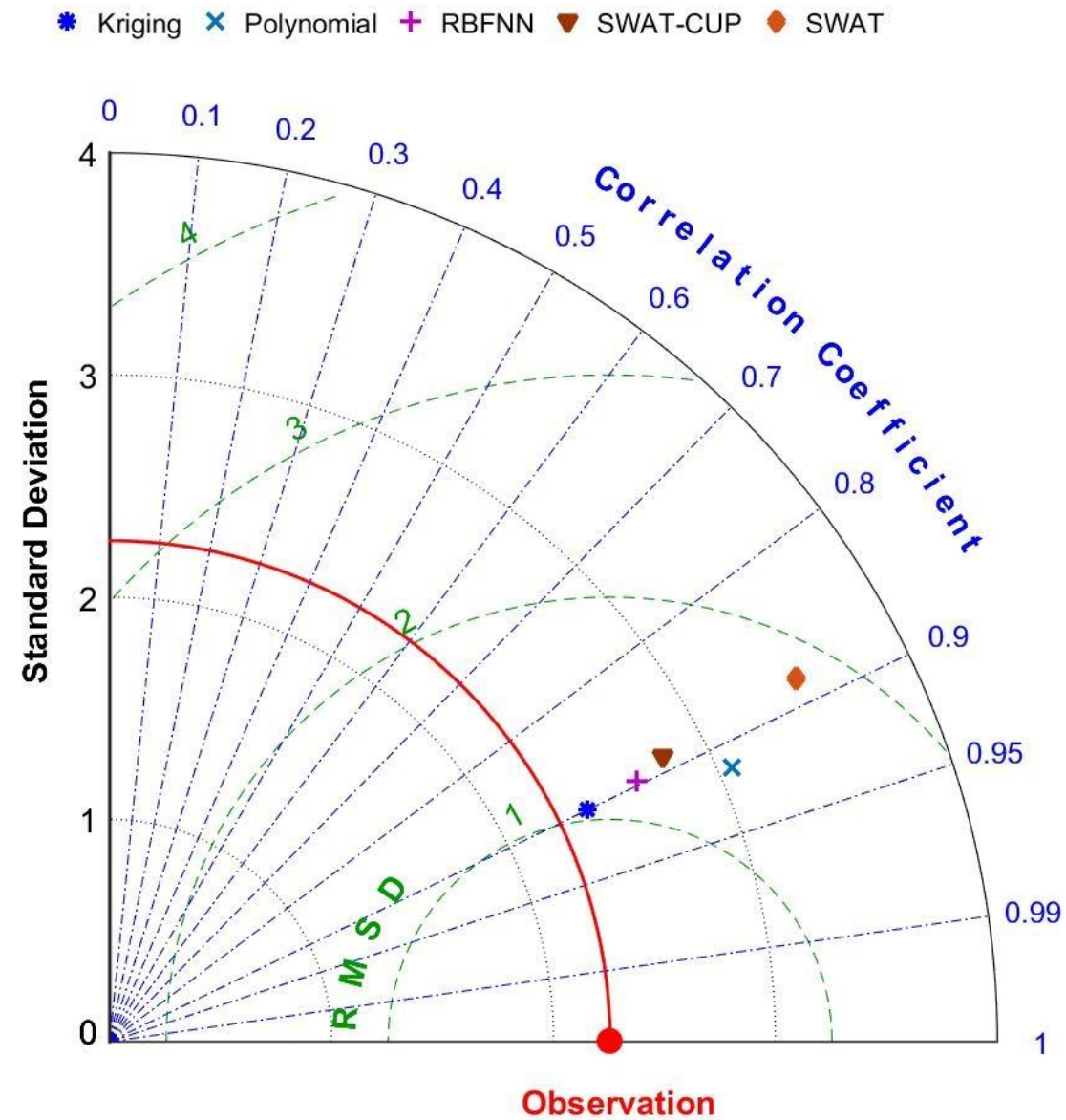
RESULTS

Re-build Model Performance



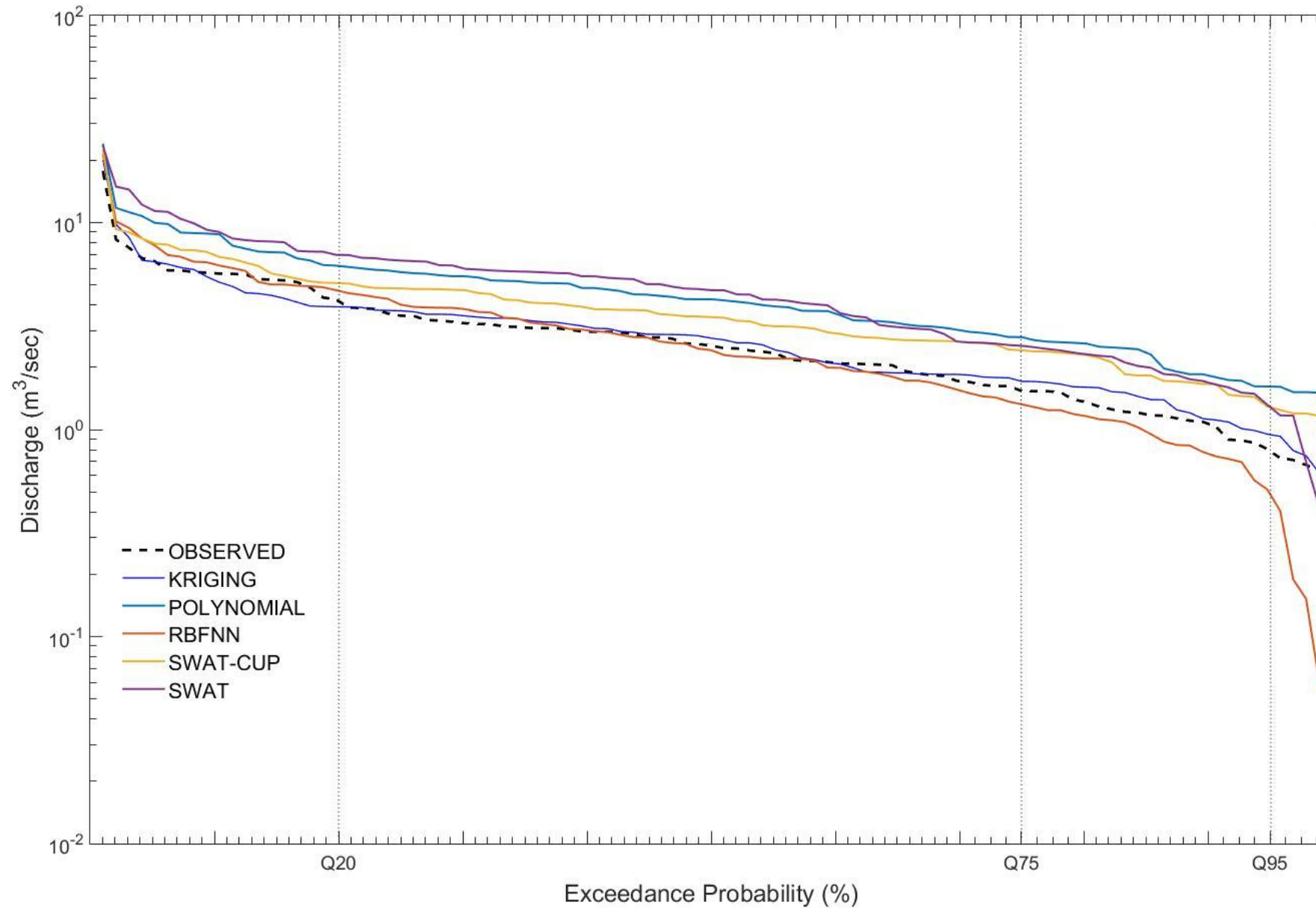
RESULTS

Comparison of models

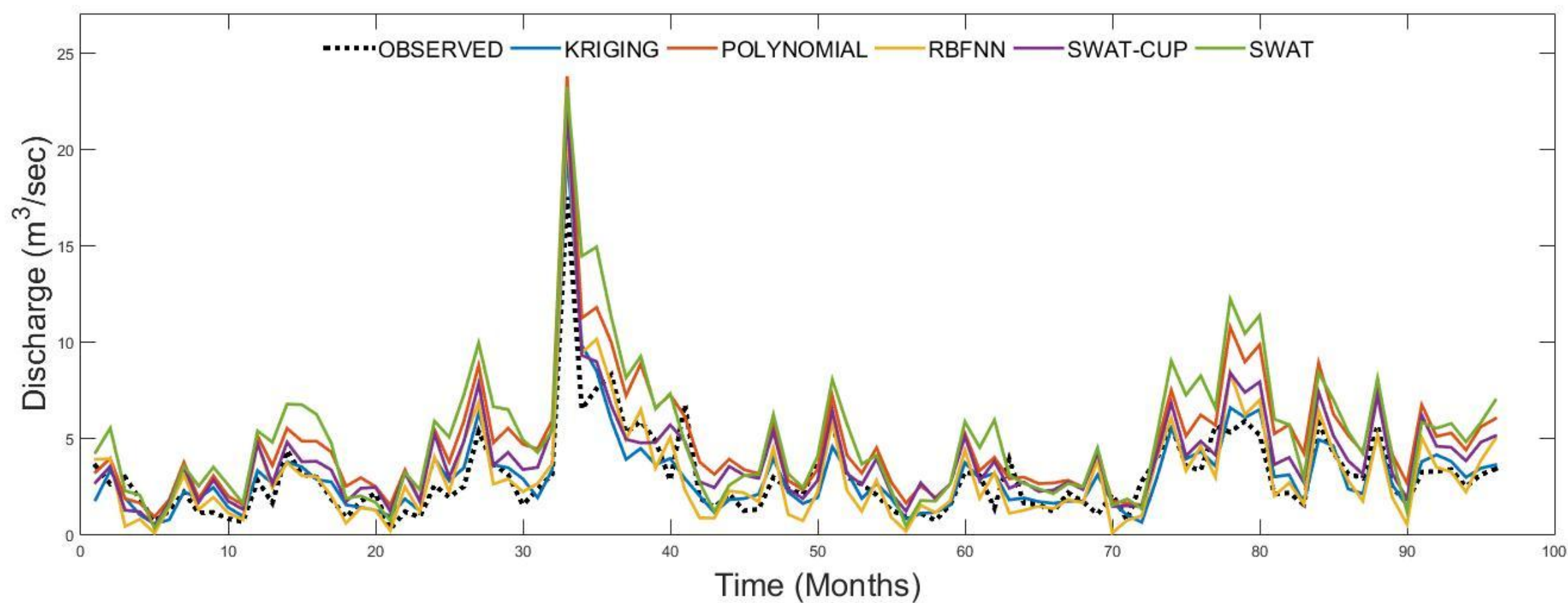


RESULTS

Flow Duration Curves (FDC)



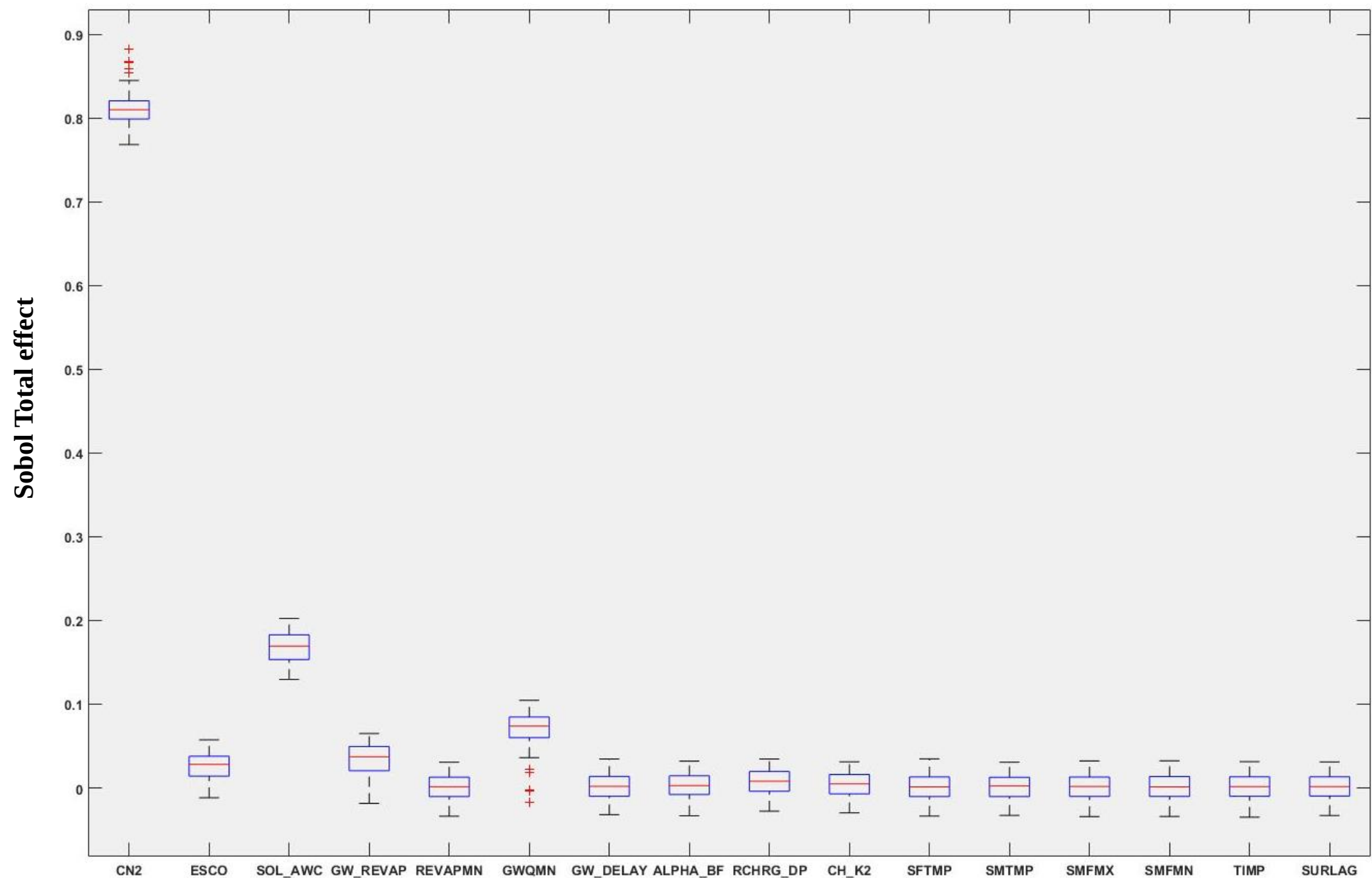
RESULTS



	NSE	Samples
Optimized Model	0.85	370

RESULTS

Sensitivity Analysis



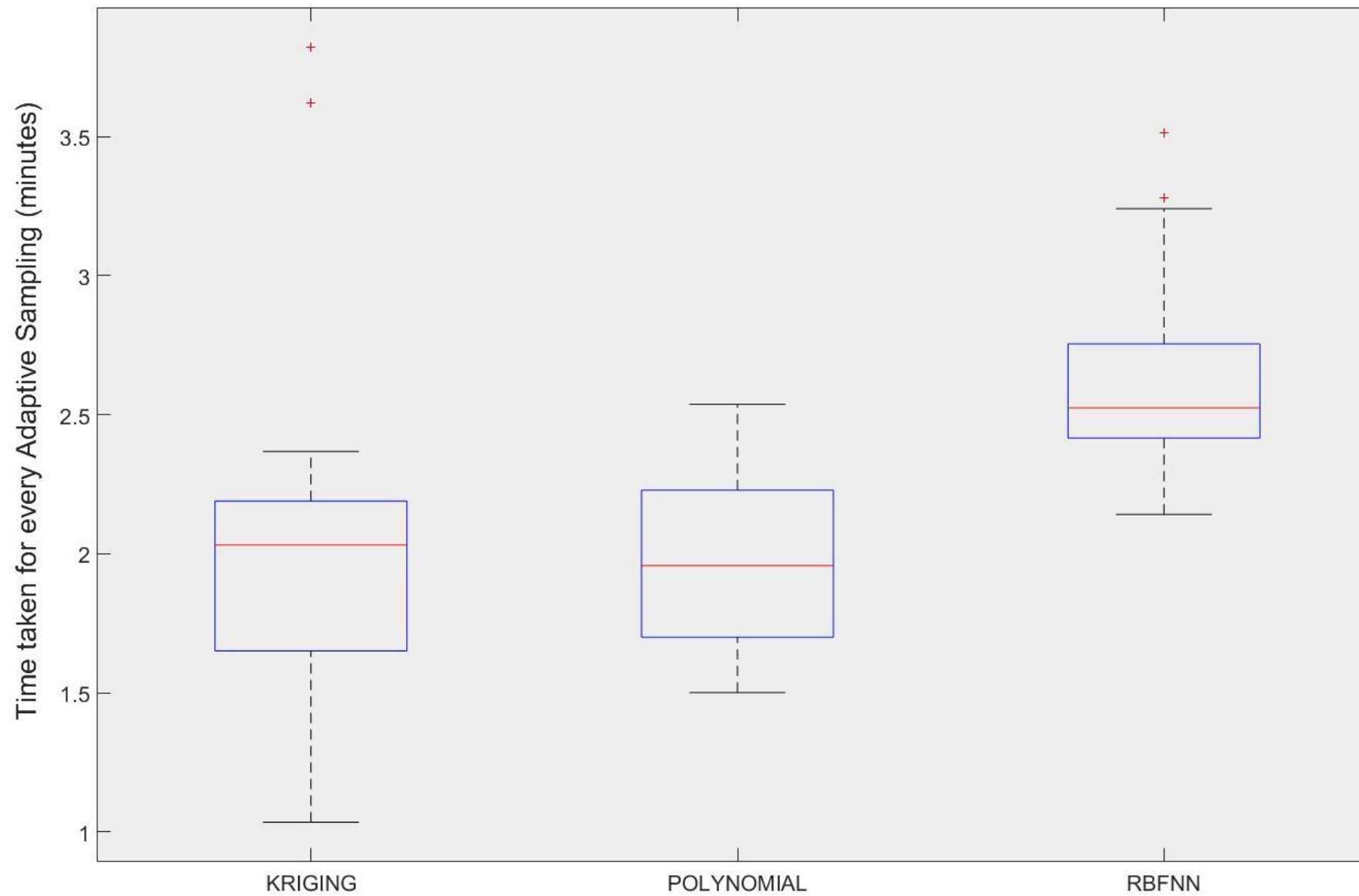
RESULTS

Parameter Ranges

Sl.No.	Parameter	Min	Max	Final values
1	CN2	-0.1	0.1	0.056921
2	ESCO	0	1	0.981186
3	SOL_AWC	-0.5	0.5	-0.23194
4	GW_REVAP	0.02	0.2	0.18101
5	REVAPMN	0	500	380.1984
6	GWQMN	0	5000	4903.937
7	GW_DELAY	0	50	33.60853
8	ALPHA_BF	0	1	0.140485
9	RCHRG_DP	0	1	0.007826
10	CH_K2	-0.01	150	116.1692
11	SFTMP	0	5	4.094897
12	SMTMP	0	5	0.129684
13	SMFMX	0	10	6.86628
14	SMFMN	0	10	5.110134
15	TIMP	0	1	0.088095
16	SURLAG	0	10	7.476304

RESULTS

Computational Time



CONCLUSIONS

- **Kriging** surrogate model had better approximation accuracy comparing with remaining models.
- **Adaptive sampling** requires less samples (**370 samples**).
- **Reduction** in computational time.
- No need to fix the SWAT **parameter ranges** unlike SWAT-CUP.
- It is observed that **CN2** is most sensitive parameter.

REFERENCES

- [Wang et al., 2014](#). An evaluation of adaptive surrogate modeling based optimization with two benchmark problems.
- [Gong et al., 2015](#). Multi-objective parameter optimization of common land model using adaptive surrogate modelling.
- [Zhang et al., 2009](#). Approximating swat model using artificial neural networks and support vector machine.
- [Sudheer et al., 2011](#). Application of a pseudo simulator to evaluate the sensitivity of parameters in complex watershed models.

PUBLICATIONS

International Journals:

1. **Venkatesh B**, Roshan Srivastav. **ADAPTIVE SURROGATE MODELLING FRAMEWORK FOR ESTIMATION OF SWAT PARAMETERS** (Submitted to Journal of Hydrology).
2. **Venkatesh B**, Roshan Srivastav. **QUANTIFICATION OF UNCERTAINTIES IN MULTI-SCALE SIMULATIONS THROUGH ADAPTIVE SURROGATE** (Under Preparation).

Questions & Suggestions

Thank you!

