Poster Number 3-6

Parameter Optimization of Fully Distributed Hydrological Model (SPHY) Using Remote Sensing and Inventory data
A Case Study of Astore River Basin, Northern Pakistan

Muhammad Hassan[1] , Eshrat Fatima[2], Aftab Ahmed Khan[3] , Mujtaba Hassan[4], Syeda Saleha Fatim Ali[5]

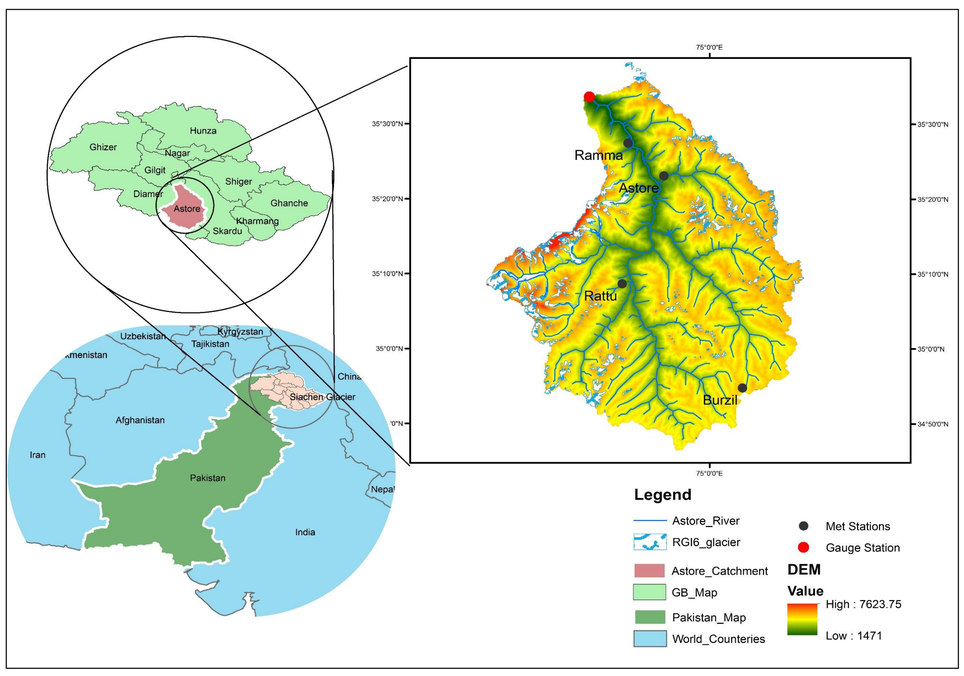
1. Abstract

The high vulnerability of Pakistan to climate change has put the water resources to risk and it is expected that the melting of glaciers in the HKH region will increase hazards like floods that will influence water availability for the future generation. This study shows the model calibration and validation of the water resources in the snow-fed and glacier-fed contributor of Indus Basin (IB), Astore catchment, Gilgit, Pakistan. A fully distributed Hydrological model SPHY has been utilized for the calibration and validation that neatly recreates the catchment's reaction. The SPHY model was successfully set up for calibration from 1999-2004, and validation from 2005-2009, respectively. Relationships among both observed and simulated values describe a high correlation which means good model performance with the R^2 of 0.71 for the calibration, and 0.72 for the validation, respectively. The sensitive analysis has been carried out for all the parameters to optimize the runoff results based on the Nash-Sutcliffe model efficiency (NSE) and (R^2). In the said analysis, Glacier melt runoff factor (GlacF), snowfall (SnowSC), and recession coefficient (Kc) values were found highly sensitive as the catchment is snow and glacier fed. Comparisons made between observed and simulated streamflow point out that the patterns of flow in the catchment can be symbolized to determine the impacts of climate change under various scenarios of climate change. The modeling results can be propagated among the public and the policy-makers which may have impacts on water asset management and water supply forecasts for natural hazards like floods.

2. Research Aims and Objectives

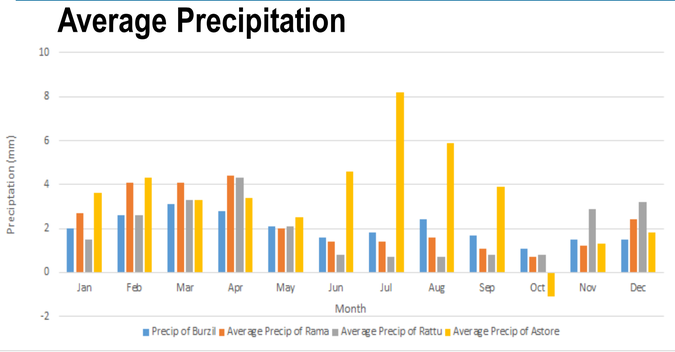
- Calibration and validation of the hydrological model SPHY for Astore catchment using remote sensing and inventory data for the period between 1999-2009
- To point out the sensitive parameters which play an important role in the calibration of the model for the catchment.

3. Study Area

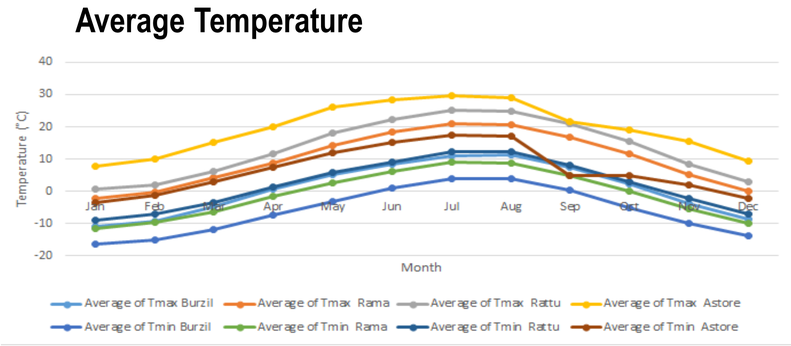


4. Materials and Method

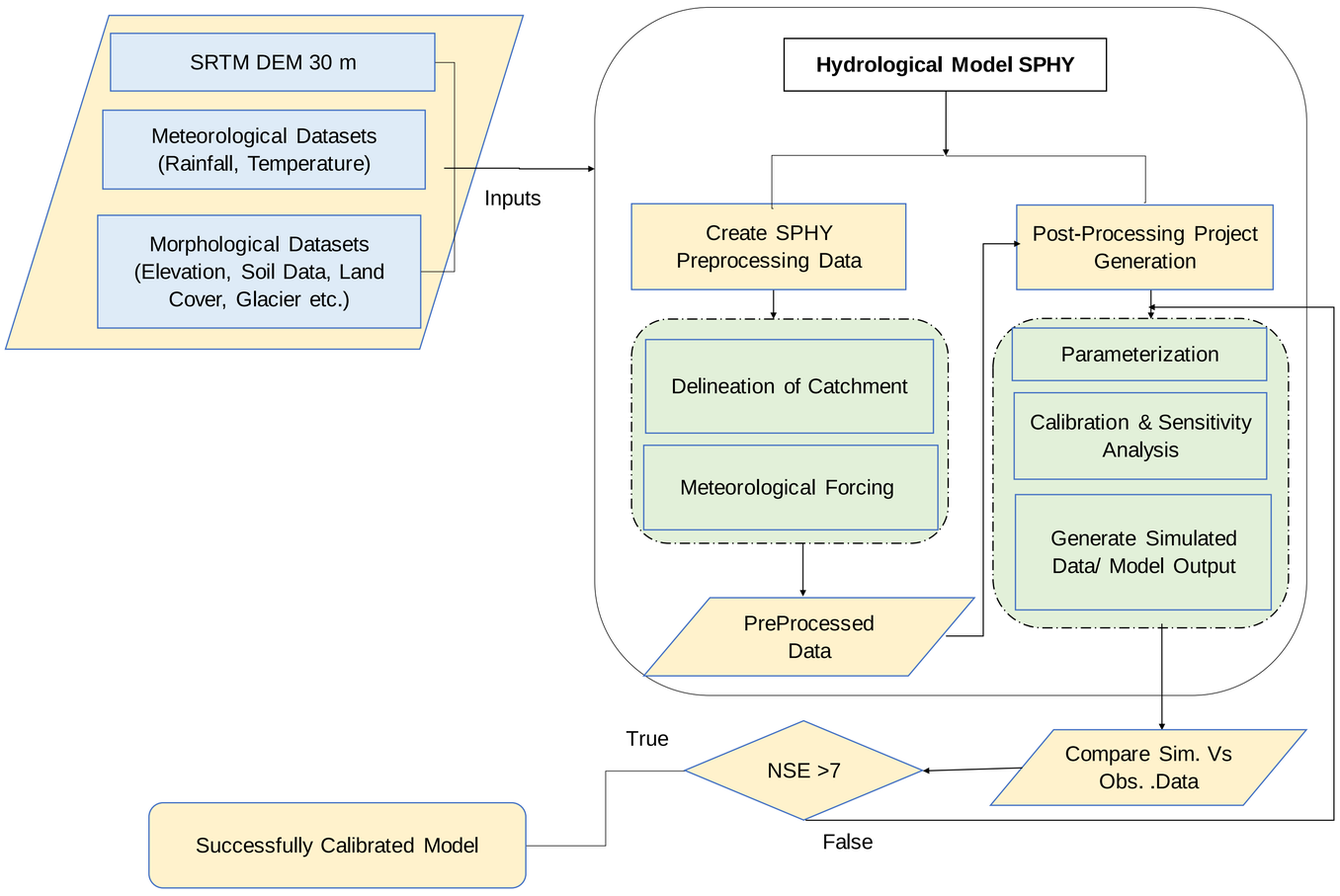
Average Precipitation



Average Temperature

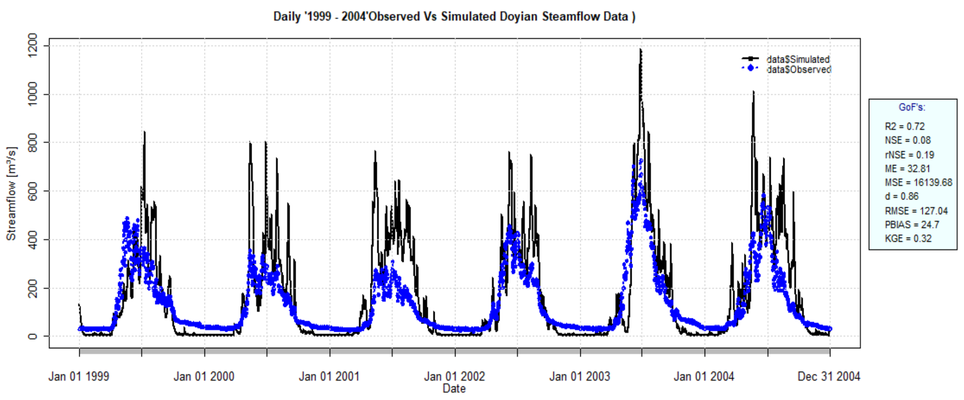


Working Methodology

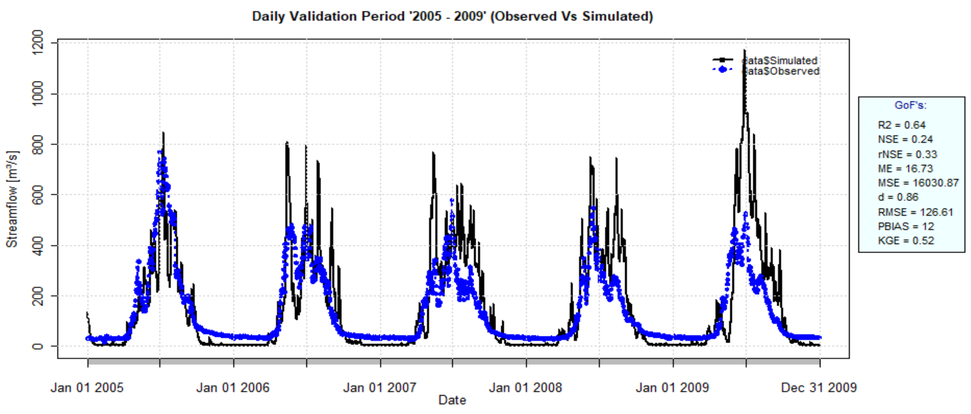


5. Results

Calibration (1999-2004)



Validation (2005-2009)



Critical Model Parameters

Parameter Acronym	Description	Units	Calibration Range	Calibrated Value
Glacier				
DDFG	Degree day factor debris-free glaciers	mm ºC day-1	3-9	9.00
DDFDG	Degree day factor debris-covered glaciers	mm ºC day-1	1-7	7.00
Snow				
Tcrit	Critical temperature	˚C	-3-3	2.00
SnowSC	Water storage capacity of snow pack	mm mm-1	0-1	0.7
DDFs	Degree day factor snow	mm ºC day-1	3-9	5.00
Rainfall-Runoff				
alphaGw	Baseflow recession coefficient	-	0.001-0.2	0.2
deltaGw	Groundwater recharge delay time	day	1–180	1
GlacF	Glacier melt runoff factor	-	0–1	0.8
Rootdepth	The thickness of the root zone	mm	50–1000	800
Subdepth	Thickness of subsoil	mm	300–3000	2500
Kc	Routing recession coefficient	-	0.5±0.99	0.85

6. Conclusion and Recommendation

- SPHY model's calibration and validation gives good results for Astore River catchment and can be efficiently used for catchment management, climate change impacts, and flood analysis
- Different satellite data products can be compared for even better outputs.
- Model parameterization carry an important role to satisfy the results for specific basin, we find Routing recession coefficient, kc table and Snow parameter a sensitive parameter for Astore Basin using SPHY Model.

7. Reference

- Fatima, E., Hassan, M., Hasson, S. U., Ahmad, B., & Ali, S. S. F. (2020). Future water availability from the western Karakoram under representative concentration pathways as simulated by CORDEX South Asia. Theoretical and Applied Climatology, 141, 1093-1108.
- Ali, S. S. F., Mehmood, S. A., Hassan, M., & Latif, A. (2019, November). River Runoff Modelling Through Geospatial Techniques-A Case Study of Snow and Glacier Fed Astore River Basin, Northern Pakistan. In 2019 Sixth International Conference on Aerospace Science and Engineering (ICASE) (pp. 1-12). IEEE.
- Latif, Y., Ma, Y., Ma, W., Muhammad, S., Adnan, M., Yaseen, M., & Fealy, R. (2020). Differentiating Snow and Glacier Melt Contribution to Runoff in the Gilgit River Basin via Degree-Day Modelling Approach. Atmosphere, 11(10), 1023.
- Tahir, A. A., Chevallier, P., Arnaud, Y., Ashraf, M., & Bhatti, M. T. (2015). Snow cover trend and hydrological characteristics of the Astore River basin (Western Himalayas) and its comparison to the Hunza basin (Karakoram region). Science of the total environment, 505, 748-761
- Lutz, A. F., Immerzeel, W. W., Kraaijenbrink, P. D., Shrestha, A. B., & Bierkens, M. F. (2016). Climate change impacts on the upper Indus hydrology: sources, shifts and extremes. PloS one, 11(11), e0165630.

The authors acknowledge Pakistan Meteorological Department (PMS) and Water and Sanitation Agency (WASA, Pakistan for providing the data.