Long-term Runoff Prediction and Drought Forecasting Using AI Techniques

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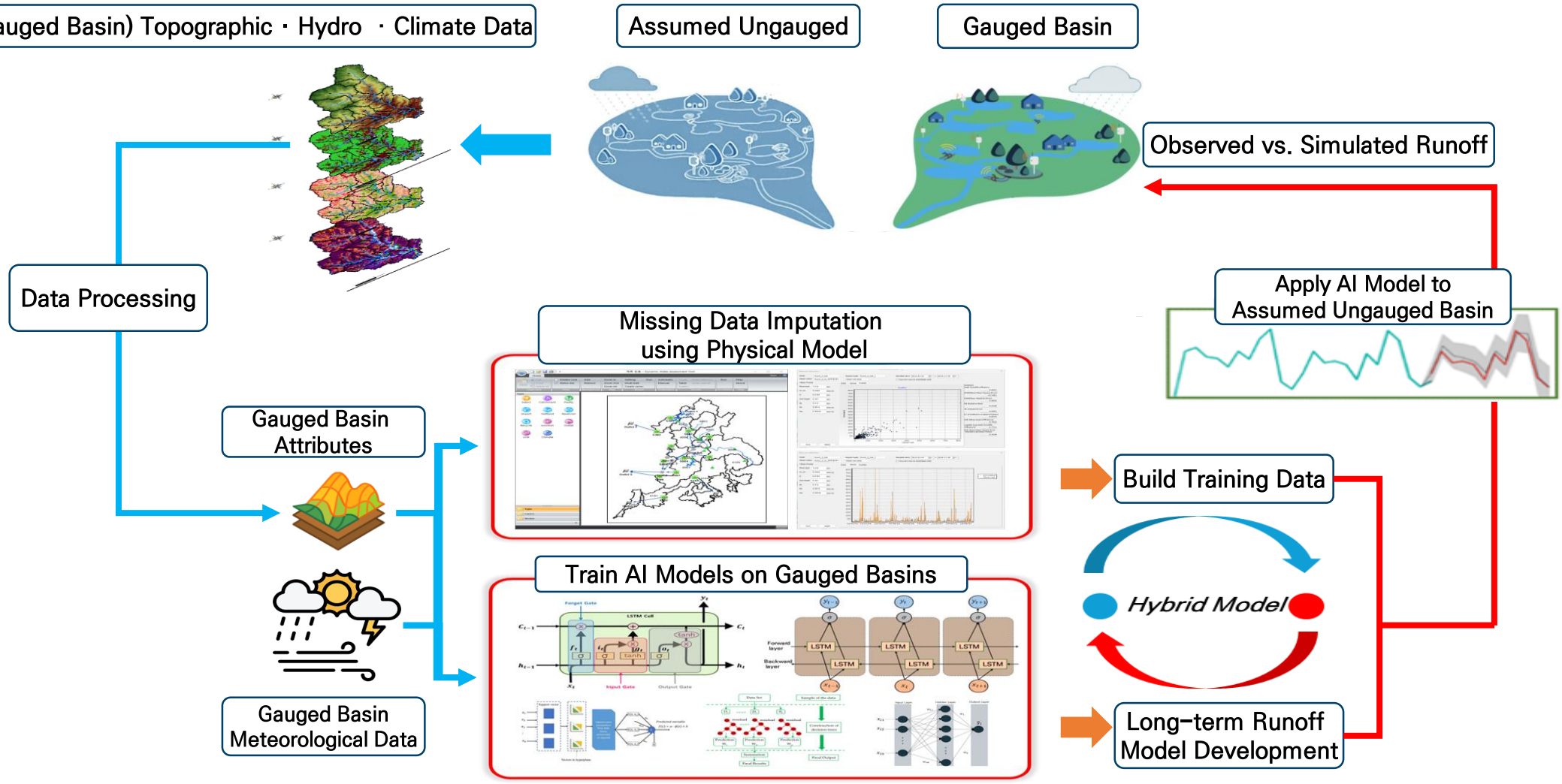
Research Overview

- **Background & Objectives**
  - In Korea, weather forecasts and rainfall-runoff models are used to predict future streamflow for drought early warning and to assess water source status for domestic and industrial water supply
  - Conceptual rainfall-runoff models (ABCD, Tank) are currently used but these are limited to fixed input variables
  - This study builds an AI-based long-term runoff system with diverse input variables to improve drought forecast accuracy
- **Research Period**
  - 2025–2027
- **Research Plan**
  - (1st Year) Review AI-based long-term runoff models & ungauged basin methodology
  - (2nd Year) Select optimal AI model for long-term runoff simulation
  - (3rd Year) Improve models & develop drought early warning integration

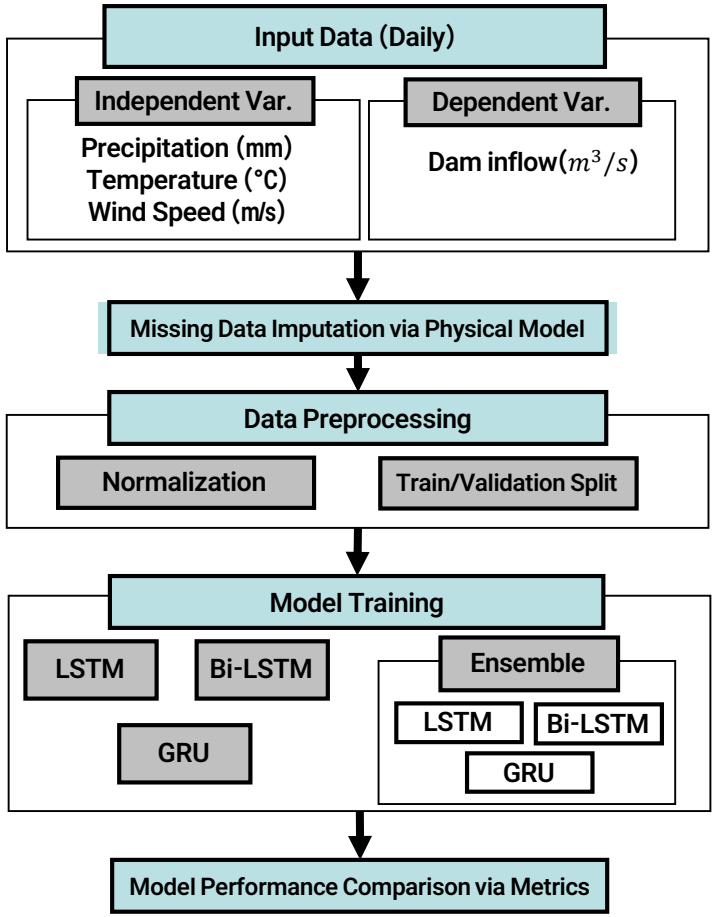
Ungauged Basin Long-term Runoff Simulation Methodology

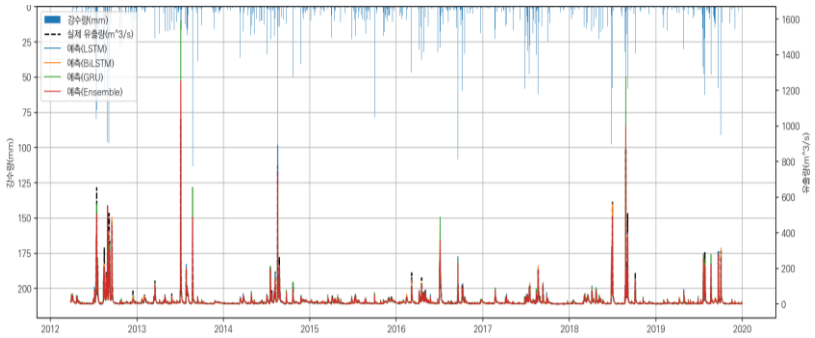
- Gauged basins are treated as ungauged to evaluate performance by comparing simulated vs. observed runoff



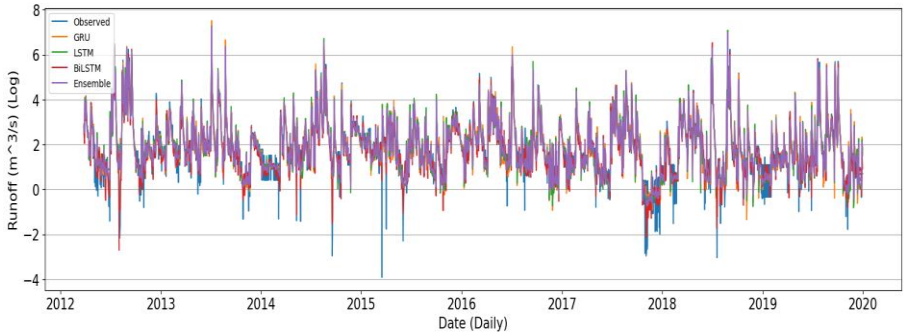
AI Model Review for Long-term Runoff Simulation

- Time-series AI models (LSTM, Bi-LSTM, GRU) were applied to Seomjingang Dam watershed in South Korea.
- Input meteorological variables from prior studies: **daily precipitation, daily temperature (mean/max/min), and daily mean wind speed.**

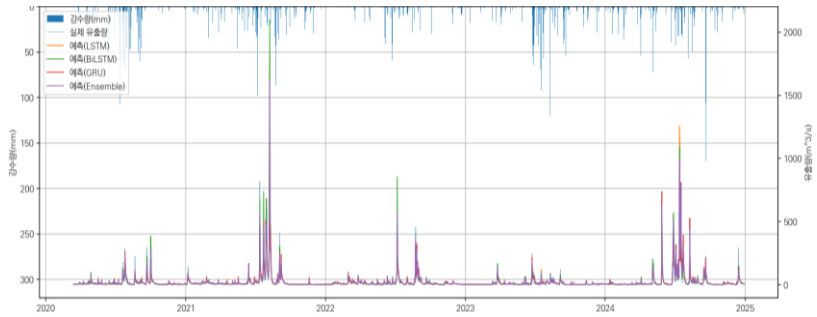




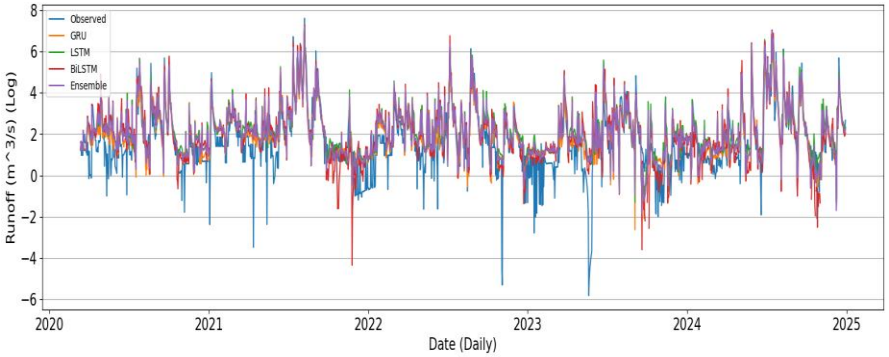
〈 Train Simulation Results 〉



〈 Train Simulation Results (Log Scale) 〉



〈 Validation Simulation Results 〉



〈 Validation Simulation Results (Log Scale) 〉

Results of AI Long-term Runoff Simulation

- (Training period) **Bi-LSTM**; (Validation period) **Ensemble**
- Seasonal (flood and dry) evaluation results:
  - ➢ (Training period) **Bi-LSTM**; (Validation period) **Ensemble**

Metric	Train (2012.01.01. ~ 2019.12.31.)				Validation (2020.01.01. ~ 2024.12.31.)			
	LSTM	Bi-LSTM	GRU	Ensemble	LSTM	Bi-LSTM	GRU	Ensemble
MAE	4.80	2.80	5.87	4.13	9.82	10.33	10.82	9.50
MSE	201.58	70.87	471.41	160.60	813.17	934.76	1438.97	686.57
RMSE	14.19	8.41	21.71	12.67	28.51	30.57	37.93	26.20
R^2	0.91	0.96	0.79	0.93	0.87	0.85	0.77	0.89

Metric	Train (Flood Season)				Validation (Flood Season)			
	LSTM	Bi-LSTM	GRU	Ensemble	LSTM	Bi-LSTM	GRU	Ensemble
MAE	10.50	5.46	13.14	8.70	22.70	23.89	22.94	21.39
MSE	955.95	270.07	2170.31	701.17	3353.59	3551.97	4073.16	2948.82
RMSE	30.91	16.43	46.58	26.47	57.91	59.59	63.82	54.30
R^2	0.87	0.96	0.72	0.91	0.84	0.83	0.81	0.86

Metric	Train (Dry Season)				Validation (Dry Season)			
	LSTM	Bi-LSTM	GRU	Ensemble	LSTM	Bi-LSTM	GRU	Ensemble
MAE	3.27	1.78	3.55	2.67	6.16	6.07	4.98	5.48
MSE	61.62	15.00	69.93	39.02	216.00	271.40	195.50	192.54
RMSE	7.84	3.87	8.36	6.24	14.69	16.47	13.98	13.87
R^2	0.75	0.93	0.71	0.84	0.50	0.37	0.54	0.56

※ Flood Season : Jun 21 – Sep 20, Dry Season : outside flood season

Thank you for listening