NANYANG TECHNOLOGICAL UNIVERSITY

# ENSEMBLE MODEL WATER LEVEL FORECASTS FOR THE LOWER MEKONG

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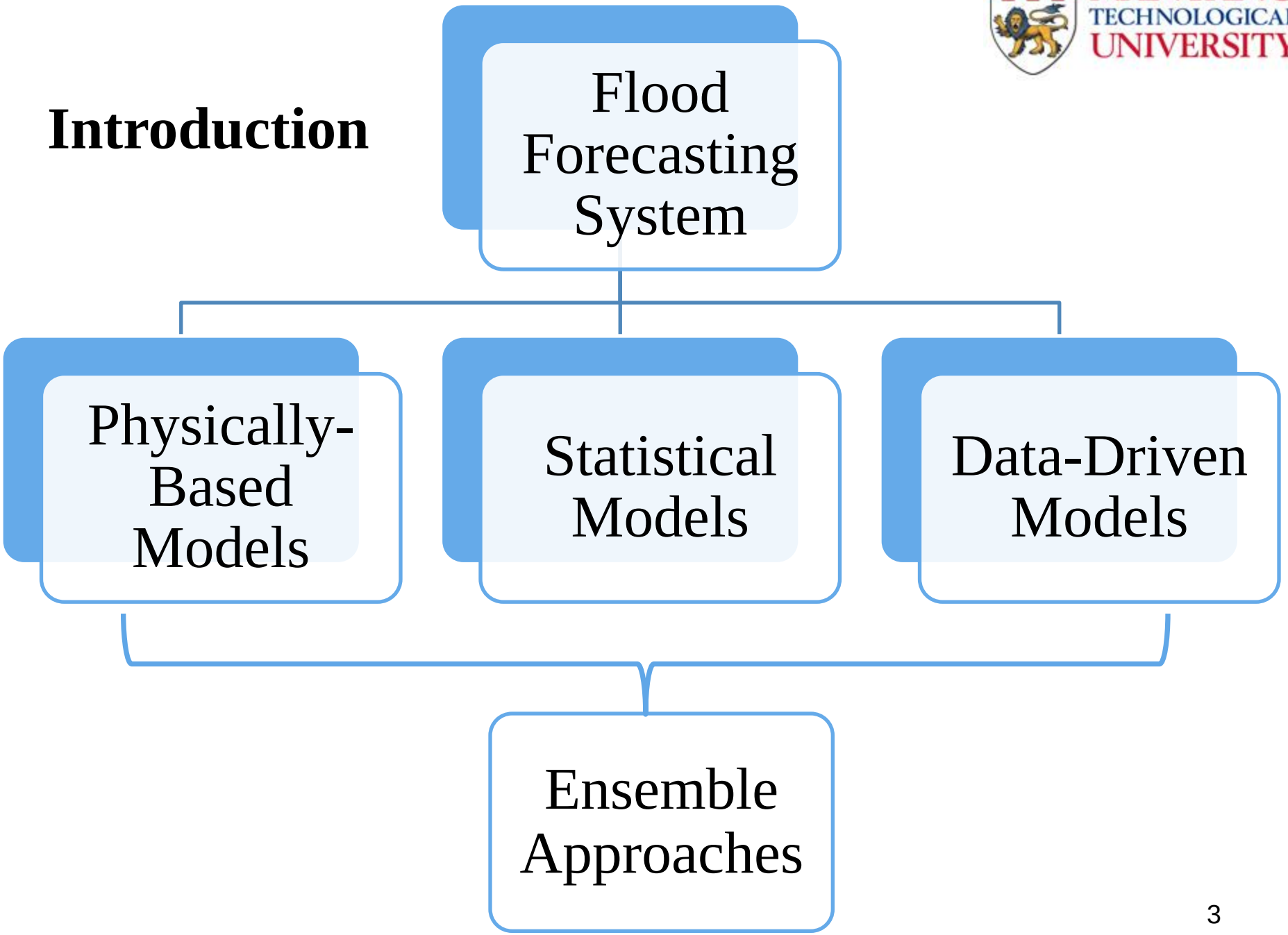
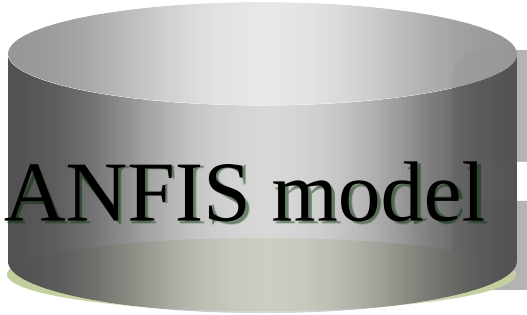
# Introduction

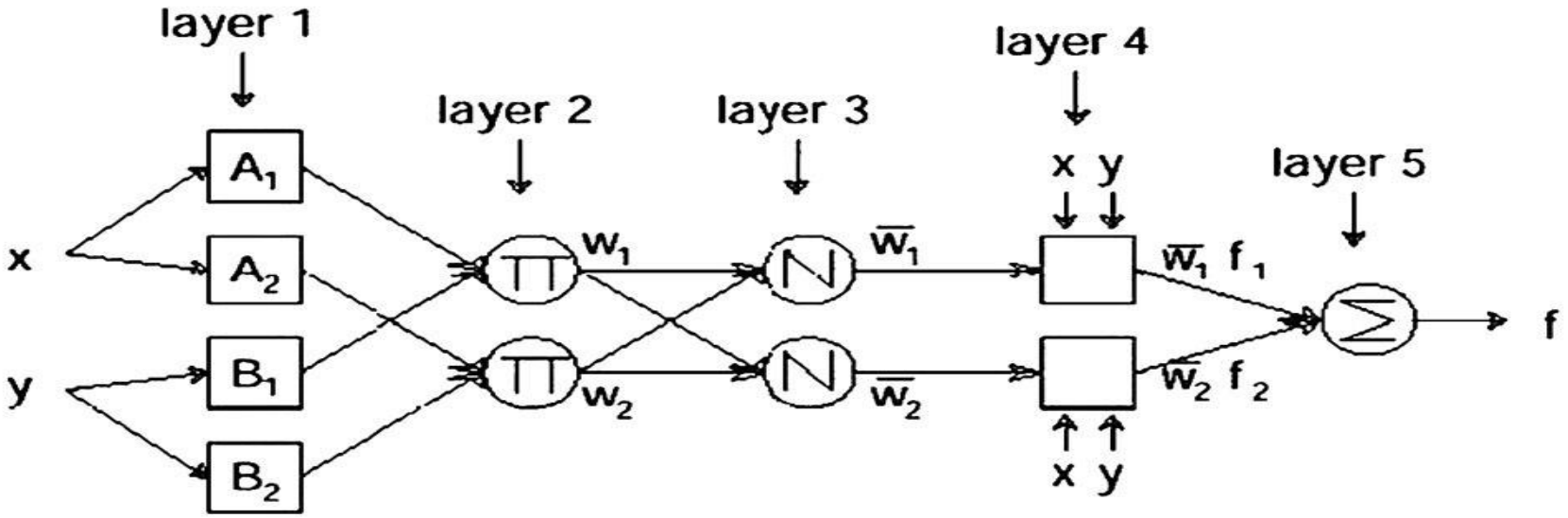


# Methodology

models to be combined




- Adaptive-network-based fuzzy inference system
- Combining the IF–THEN rule reasoning and computational power

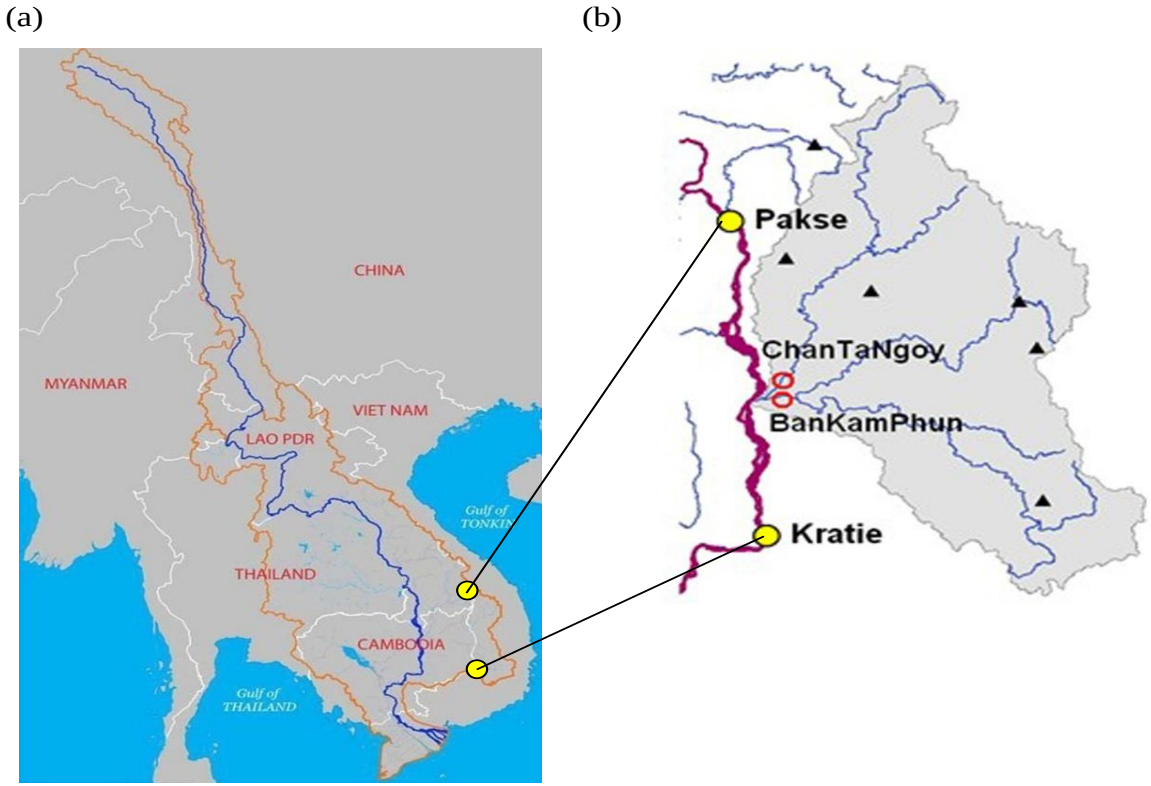



ANFIS or Type-3 ANFIS (Jang, 1993)

URBS model

- Unified River Basin Simulator (lumped parameter model)
- Temporal and spatial variation of rainfall.

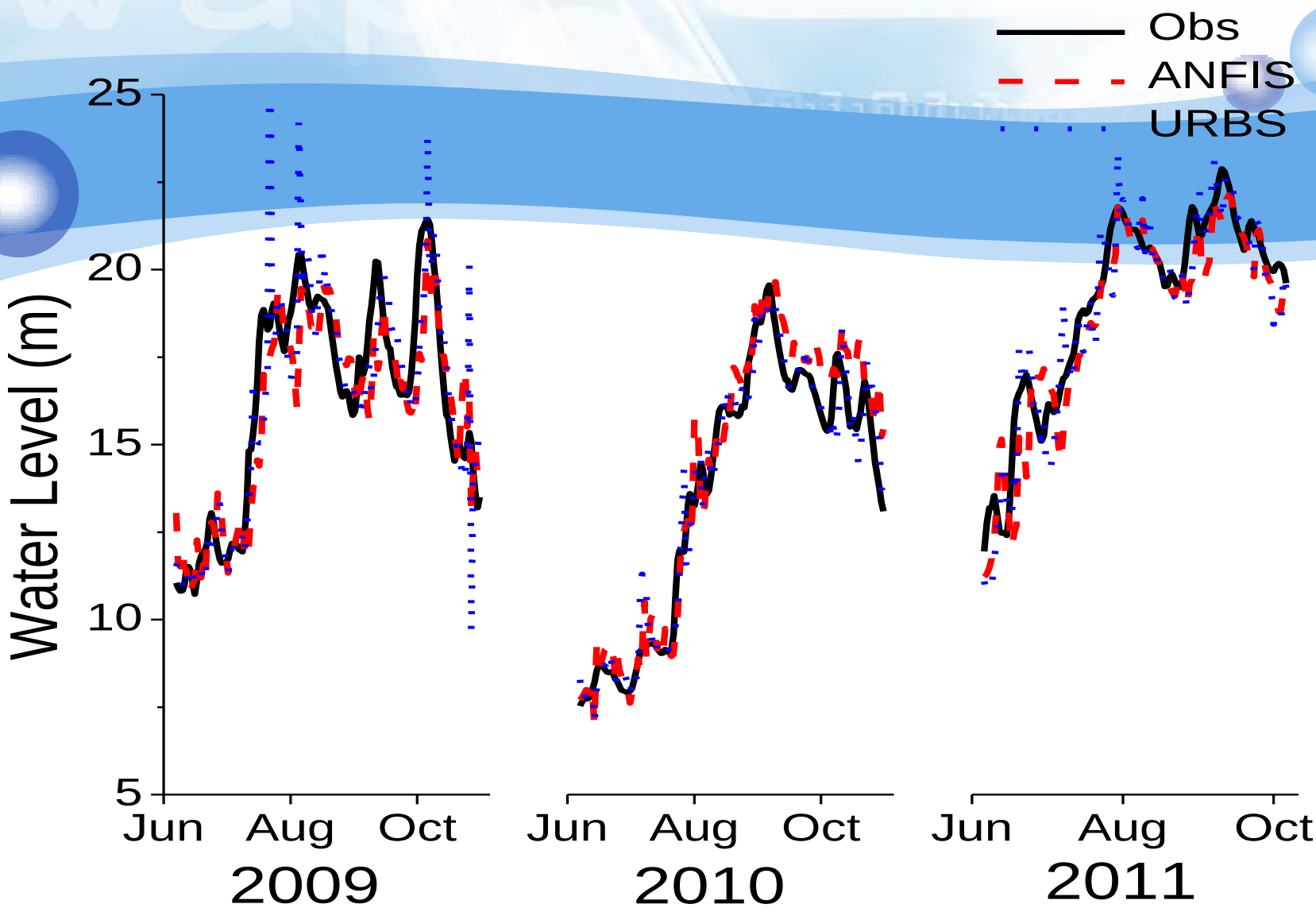
## Study Area and Data Used （URBS, ANFIS)




Inputs:
Water levels and rainfall

Outputs:
5 days ahead predictions

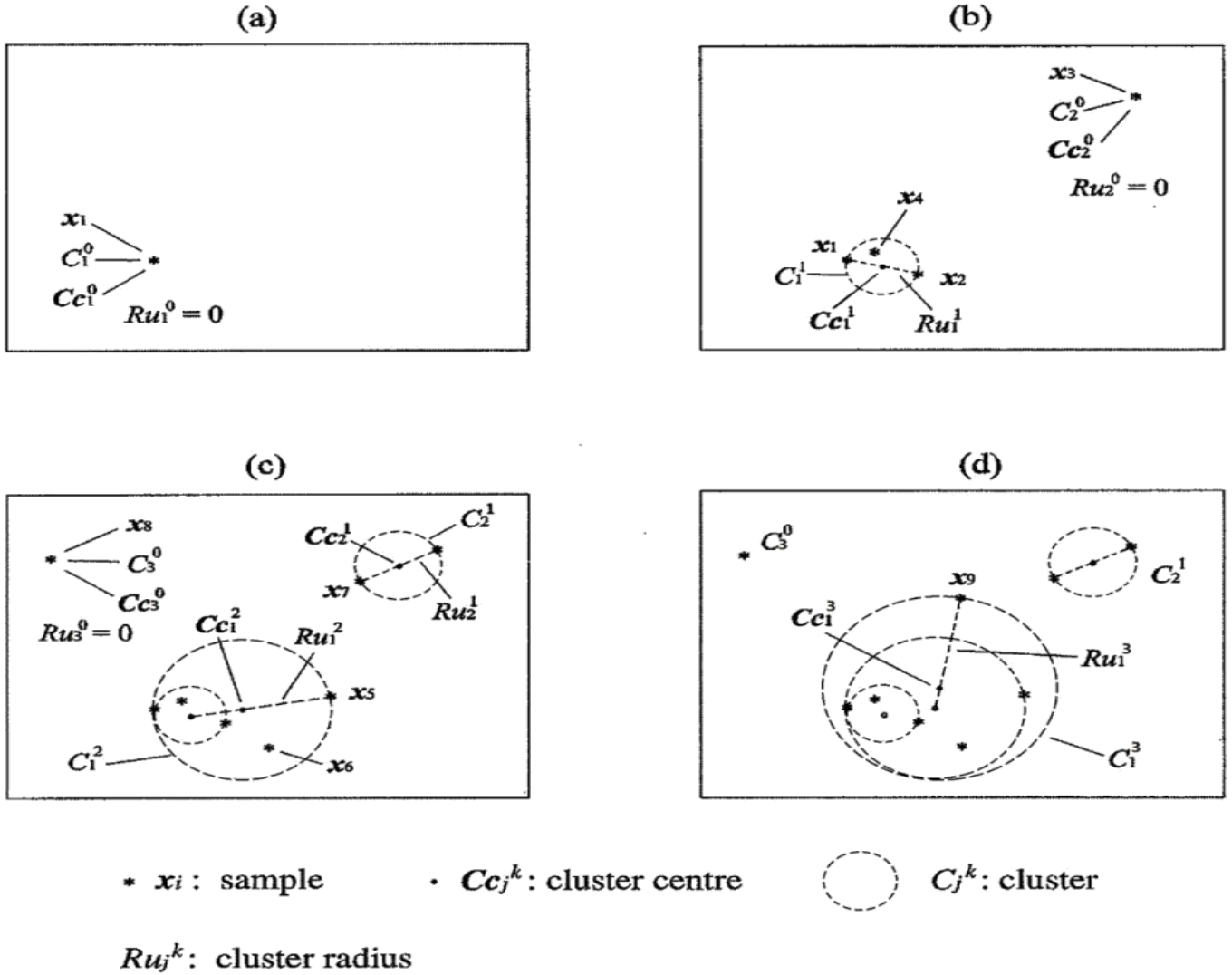
(a) Location map for the Mekong Basin; (b) Sub-basin with gauging station Kratie: 28,815 ($km^2$). Source: (MRC, 2005, 2007)




Water level predictions from ANFIS model and URBS model

# Ensemble Approach

## Dynamic Evolving Neural-Fuzzy Inference System (DENFIS)




Clustering process using Evolving Clustering Method (ECM) in 2-D space (Kasabov and Qun, 2002)

DENFIS

- Online mode (ECM)
- Offline mode (ECMc) optimized clusters

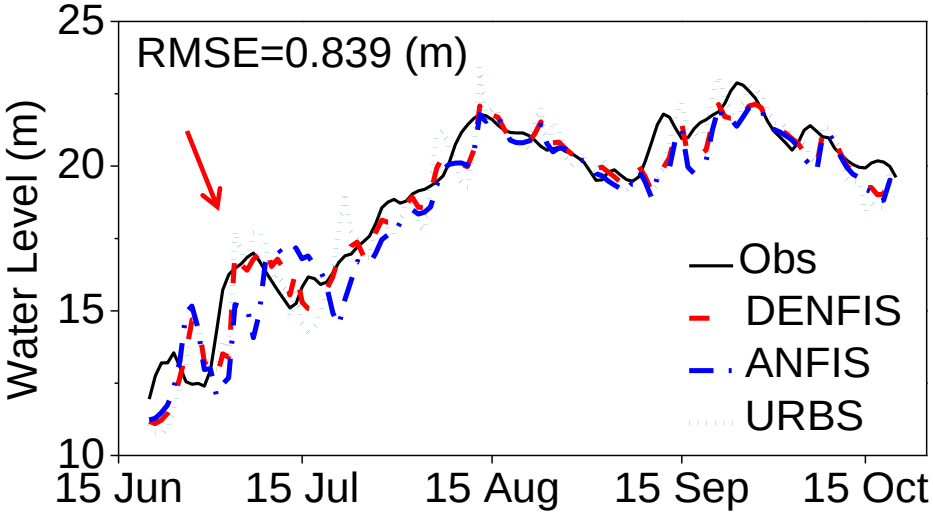
DENFIS

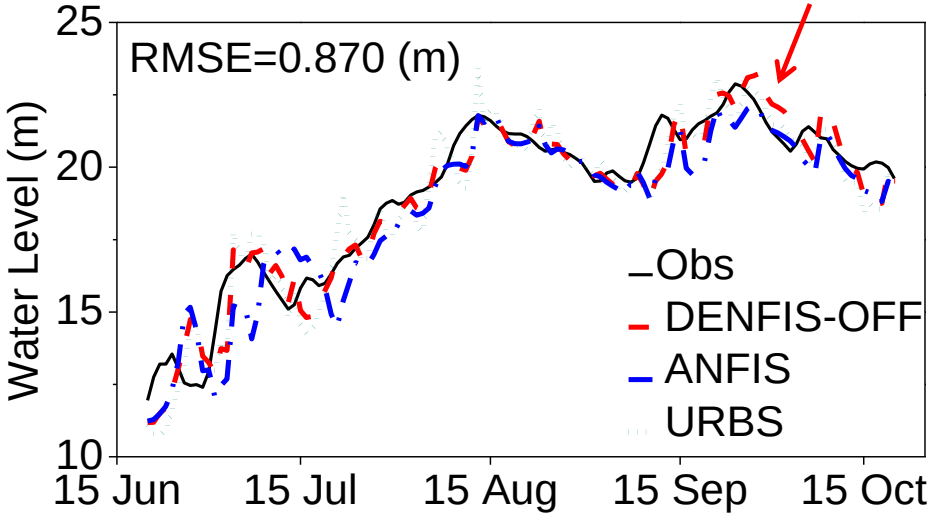
Training: Wet seasons in 2009 and 2010 ; Testing: Wet season in 2011
$D_{thr}$ is set as 0.19 → 3 clusters.

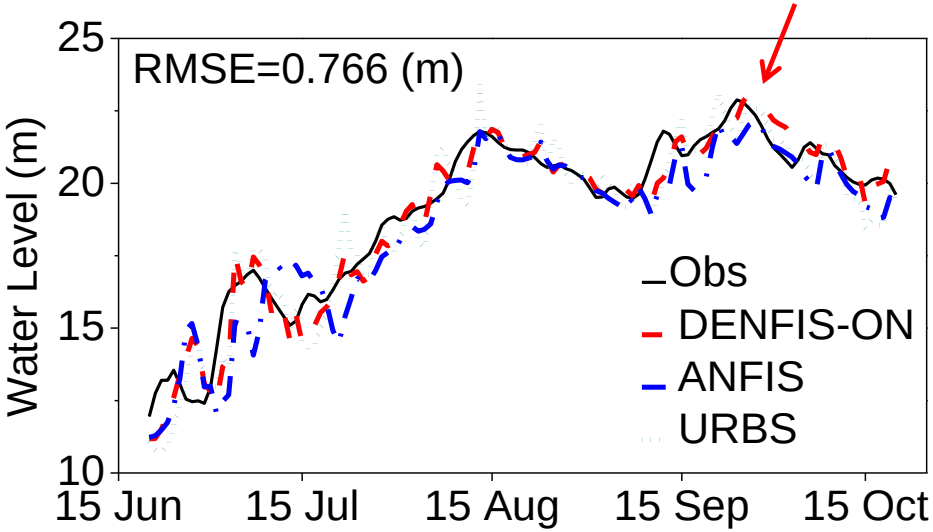
Real time application

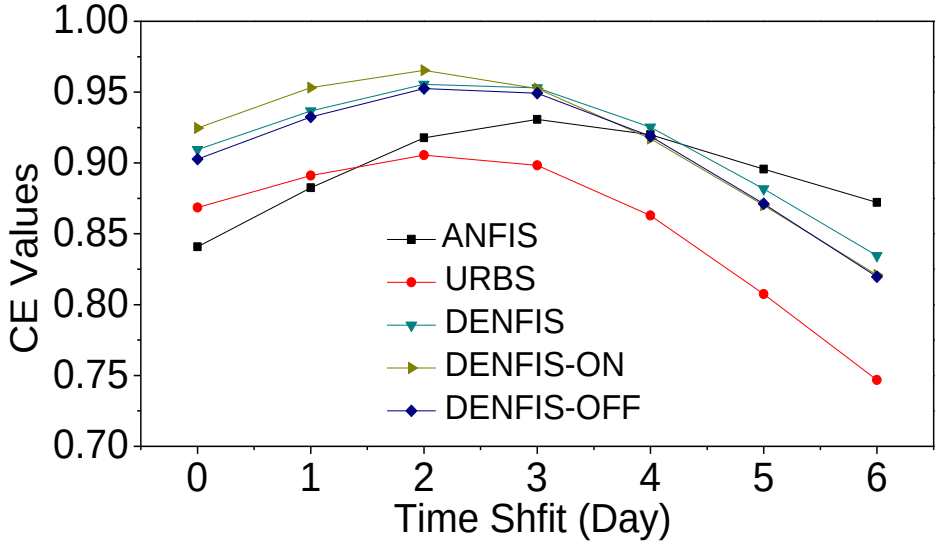
- update the model parameters with latest observed water levels

DENFIS-ON
DENFIS-OFF




# Ensemble Forecasts Comparisons and Time Shift Analysis

Comparisons of the ensemble models and the combined models

| Models | *RMSE* (m) | *CE* | *MAE* (m) |
|---|---|---|---|
| ANFIS | 1.113 | 0.841 | 0.827 |
| URBS | 1.012 | 0.869 | 0.780 |
| DENFIS | 0.839 | 0.910 | 0.612 |
| DENFIS-ON | 0.766 | 0.925 | 0.572 |
| DENFIS-OFF | 0.870 | 0.903 | 0.663 |

# Conclusions

- The online mode of DENFIS model with real time updating produced the greatest improvements
- Time-shift errors and spikes were decreased


## Acknowledgements

The measured data and the results of the URBS model were generously provided by the Mekong River Commission.

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# Thank You!