# Data Assimilation in the Nextgen Framework for Improved Streamflow Predictions

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## Motivation and Objectives

- Data Assimilation can account for uncertainties in hydrological models and improve streamflow predictions.
- Reliable methods of data assimilation are being explored for the Nextgen Framework.

- **Objectives**:
  - Coupling the Conceptual Functional Equivalent (CFE) model with a state-space Muskingum-Cunge channel routing method.
  - Improving streamflow predictions from the coupled model through data assimilation (DA).

## Study Areas

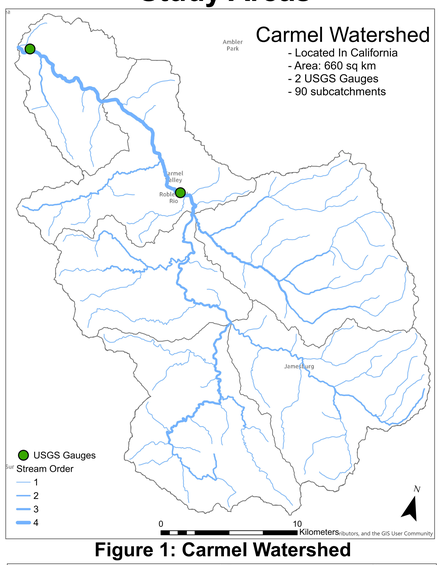



Figure 1: Carmel Watershed

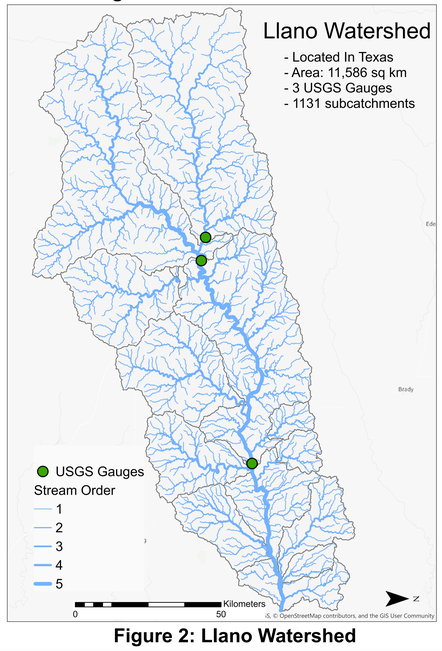
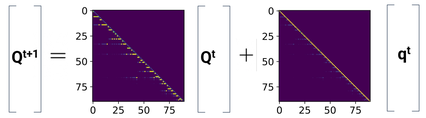



Figure 2: Llano Watershed

## Data Assimilation in the State-Space Muskingum Cunge Model

- **State Space Representation**
  - The Muskingum-Cunge (MC) equation is given by: $Q_{j+1}^{t+1} = C_1 Q_j^{t+1} + C_2 Q_j^t + C_3 Q_{j+1}^t + C_4 q$
  - The state-space representation of MC equation for watershed network can be represented as :




- **Data Assimilation** :
  - Kalman filter is applied in the state-space Muskingum Cunge model to assimilate the streamflow.
  - In Kalman Filter, data is assimilated with two main steps: Prediction, and Update.
  - Upstream gauges are used for assimilation and downstream gauge for validation.

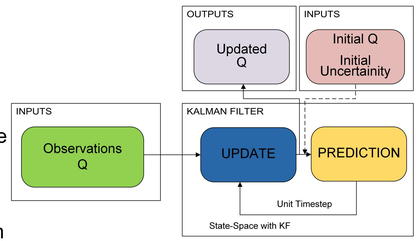



Figure 3: Kalman Filter Process

## Spatial Influence of Data Assimilation

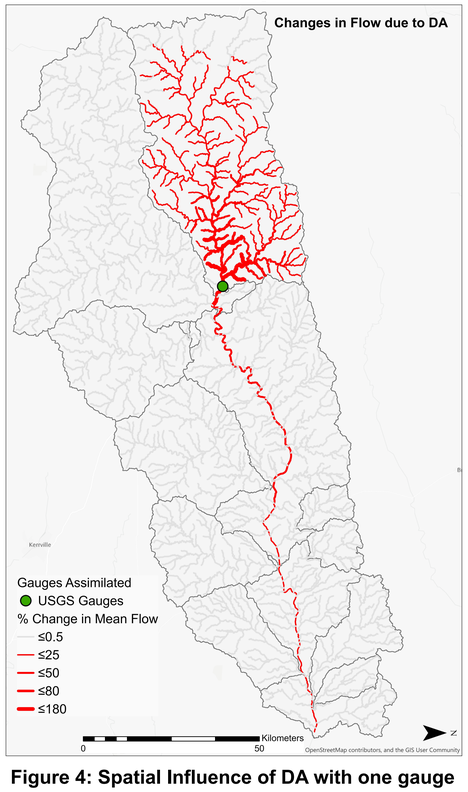



Figure 4: Spatial Influence of DA with one gauge

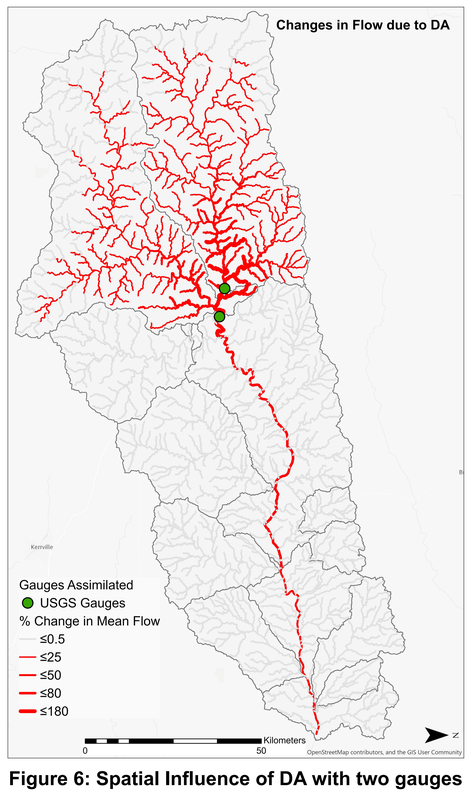



Figure 6: Spatial Influence of DA with two gauges

- Streamflow in both upstream and downstream channels are updated.
- Spatial influence of DA increases with the number of assimilated gauges.

## Streamflow Prediction in Carmel Watershed

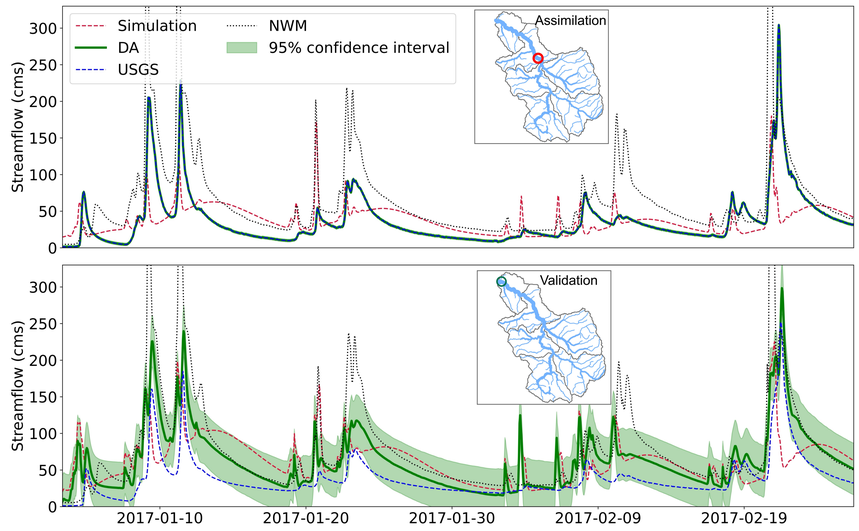



Figure 7: Streamflow Predictions after DA in Carmel Watershed

## Streamflow Prediction in Llano Watershed

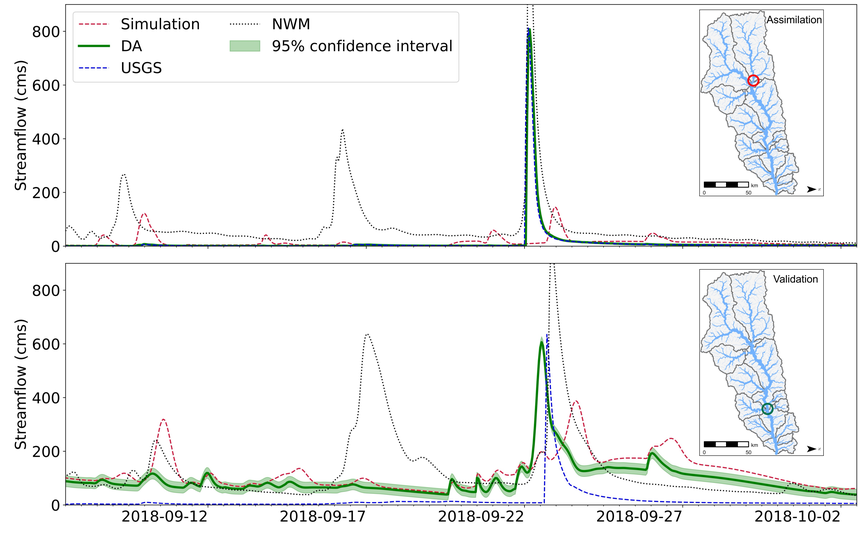



Figure 8: Streamflow Predictions after DA in Llano Watershed

- After DA, the predicted streamflow matches the peak during storm period and also reduces false alarms during non-storm period.
- DA improves streamflow predictions in the validation locations in both watersheds, irrespective of their geographical conditions.

## Conclusion and Future Works

- State-Space Muskingum Cunge model with Kalman Filter can be used for DA in Nextgen Framework.
- Spatial influence of DA depends on the number of gauges assimilated.
- DA improves streamflow predictions from the CFE model.
- Future work will focus on the expansion of this work on larger watersheds.

## Questions/Comments?

Contact us at *sujanatimilsina@utexas.edu*

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## References

[1] R. E. Kalman, “A New Approach to Linear Filtering and Prediction Problems,” Journal of Basic Engineering, vol. 82, no. 1, pp. 35–45, Mar. 1960, doi: 10.1115/1.3662552.
[2] U.S. Geological Survey, 2016, National Water Information System data available on the World Wide Web (USGS Water Data for the Nation) at URL [http://waterdata.usgs.gov/nwis/].