

Background

Long Short Term Memory (LSTM) neural networks trained on regional hydrology datasets produce better predictions at previously unseen basins than commonly used hydrology models individually calibrated at the same basins^{1,2}. Previous experiments have focused on unmodified or “natural” river basins. In this research, we evaluate the performance of LSTMs in predicting streamflow modified by dams and agriculture.

An LSTM neural network trained on a regional hydrology dataset can predict streamflow accurately at human modified river basins.

Methods and Data

We train an LSTM on 481 natural river basins from the CAMELS dataset.³

Using remote sensing inputs, we capture real time changes in land surface characteristics such as snow and vegetation.

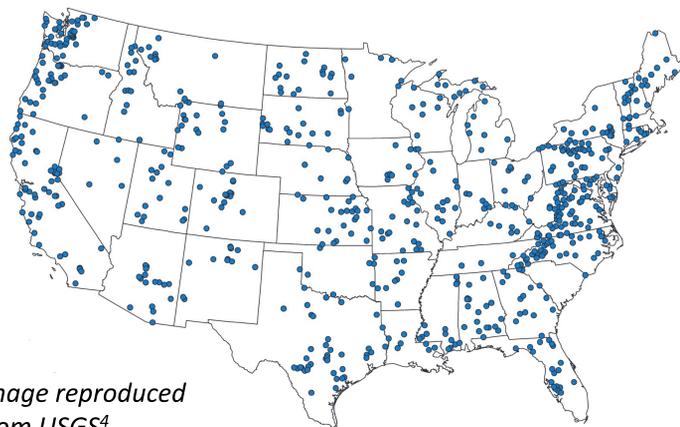
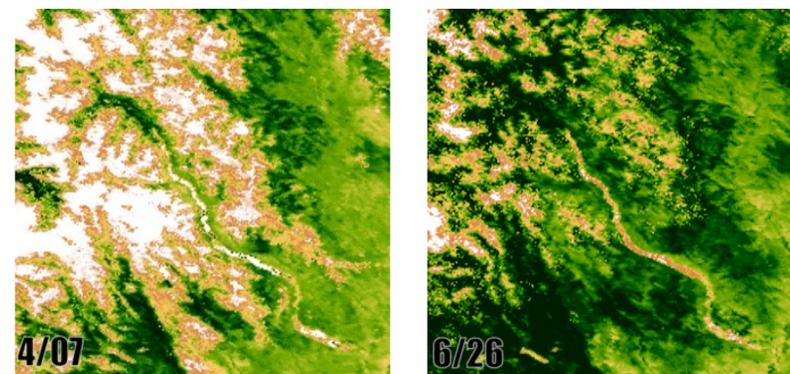


Image reproduced from USGS⁴



Satellite imagery above and graphic below produced at Upstream Tech

Model predictions are evaluated on human modified basins both before the model has seen the basins, and after the model is tuned on previous years' data from the same basins.

Inputs

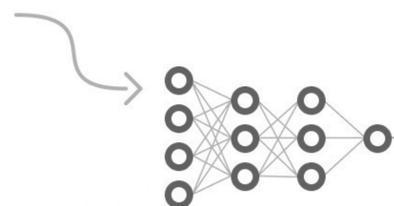
Meteorological
Temperature, Precipitation, Wind, Solar Radiation, etc

Land Surface
Vegetation, Snow

Basin Features
Basin area, Mean Precipitation, Mean Vegetation

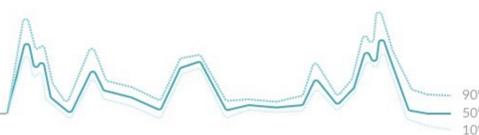
Model

Long Short Term Memory Neural Network



Output

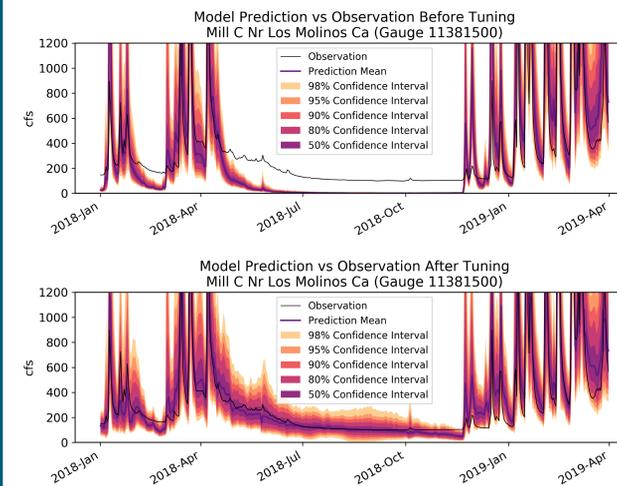
Seasonal flow forecast with confidence range



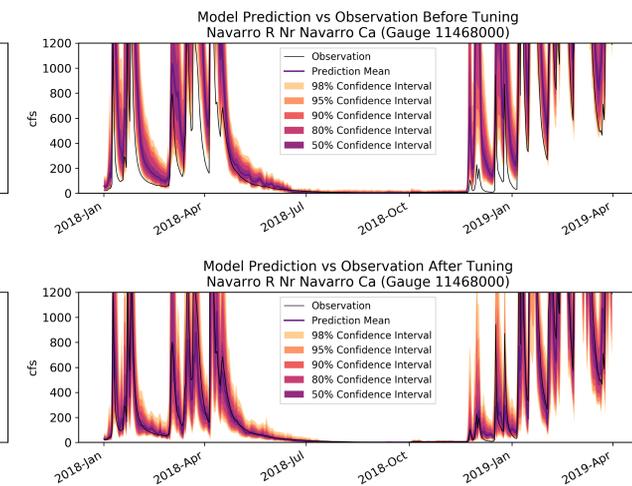
Results

Mill Creek (Sacramento River Tributary) is regulated to maintain a minimum flow.

Agricultural diversions reduce water in the Navarro River.



R²: 0.83

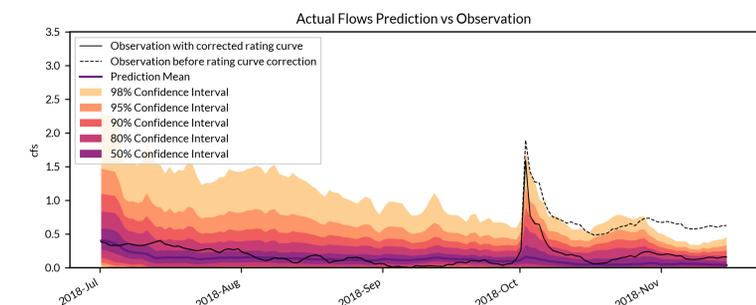


R²: 0.83

During unseen predictions, the model produces hydrographs representative of unmodified rivers. Upon tuning with previous years data, we can produce reasonable streamflow predictions of the human modified streamflow.

Highlight

Model results at the gauge on the right indicated that an early season storm flood changed the rating curve. The subsequent rating curve correction shows us that the model actually performed better than the initial gauge measurement.



Future work will explore how we can use integrate these models into conservation and management operations.

References

1. Kratzert, F. Benchmarking a Catchment-Aware Long Short-Term Memory Network (LSTM) for Large-Scale Hydrological Modeling. (2019).
2. Kratzert, F. Prediction in Ungauged Basins with Long Short-Term Memory Networks. (2019).
3. Newman, A. A large-sample watershed-scale hydrometeorological dataset for the contiguous USA. (2014).
4. Lins, H.F. USGS Hydro-Climatic Data Network 2009 (2012)

Acknowledgements

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