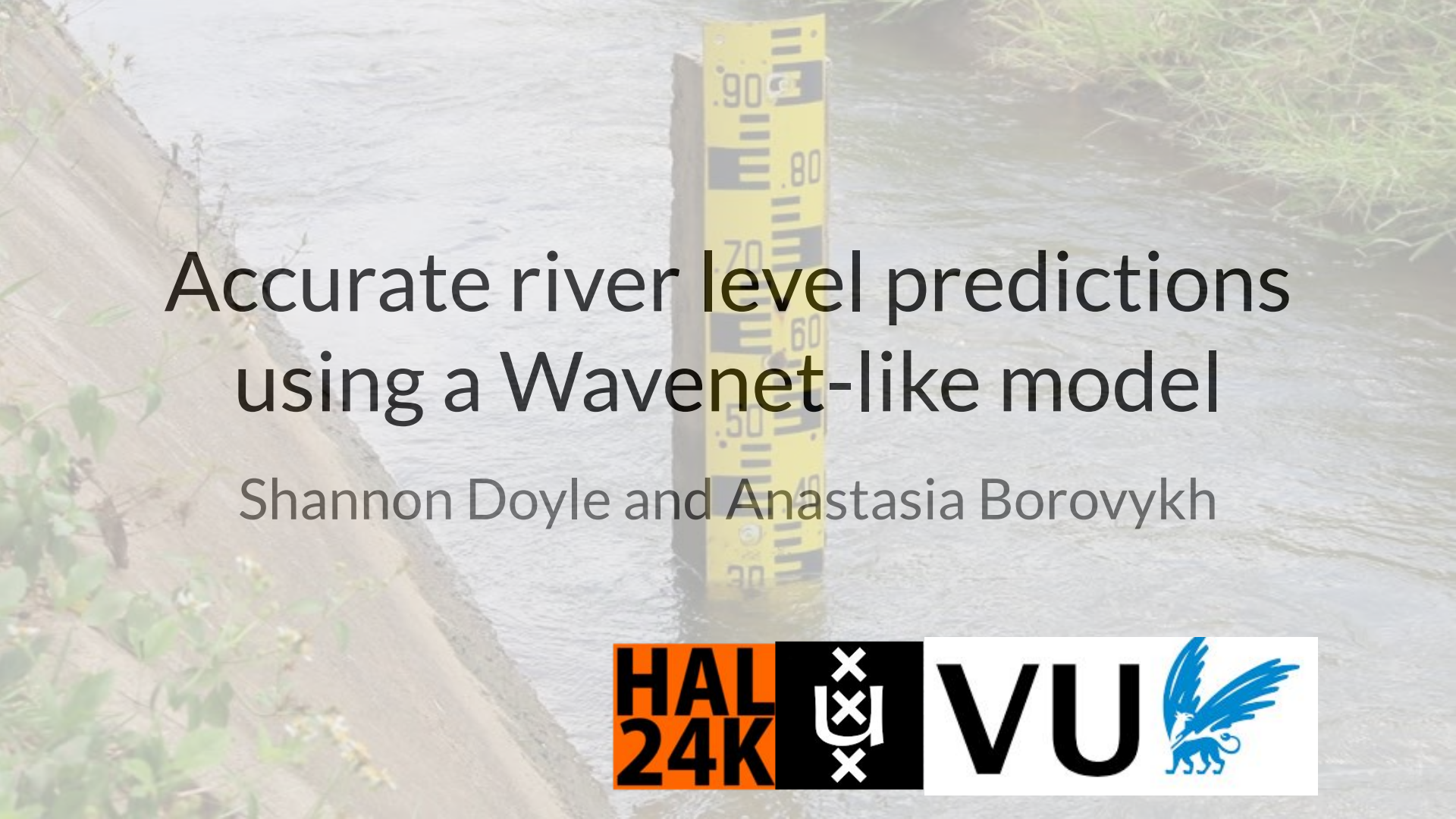


Accurate river level predictions using a Wavenet-like model

Shannon Doyle and Anastasia Borovykh

Relevance

River Level forecasts are important for:

- Flood management
- Inland Shipping
- City planning
- Infrastructure planning
- Water management
- Environmental planning

Data and Study Area - River Trent

Daily Average values of:

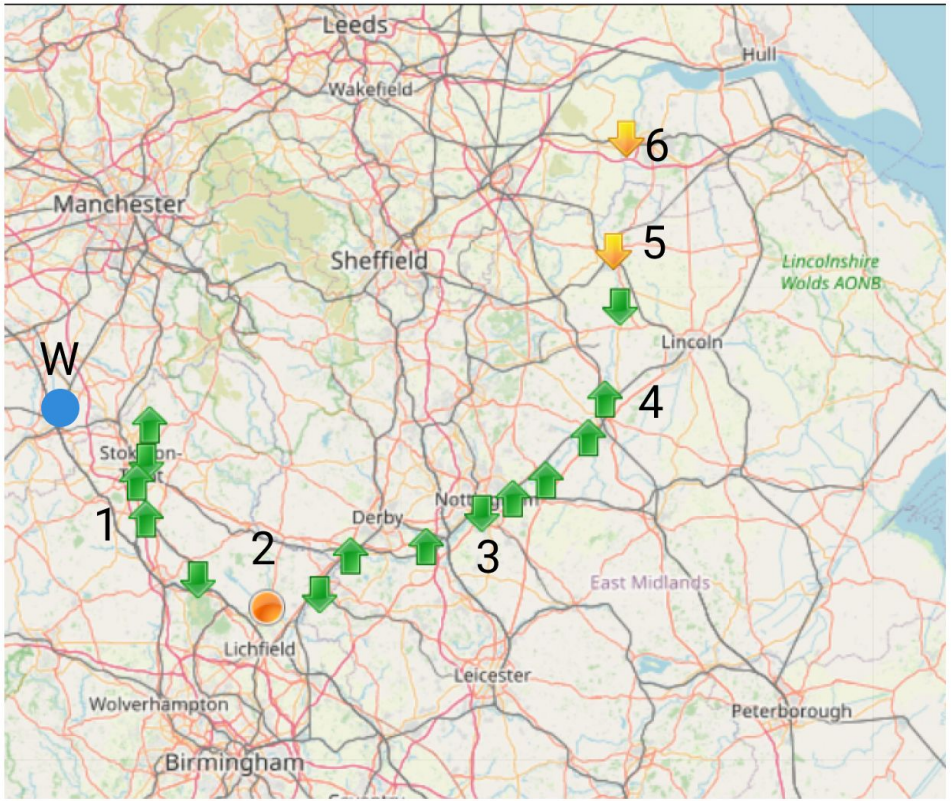
- River Levels UK:

  River Stage 2012-2020

- NRFA:

  Rainfall and river flow

  1982-2018



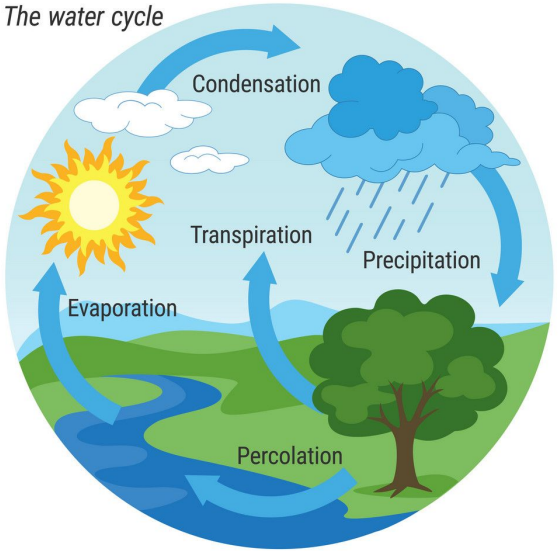
Station Location

1: Darlaston
2: Kings Bromley
3: Colwick
4: North Muskham
5: Gainsbury
6: Keadby

W: Shrewsbury

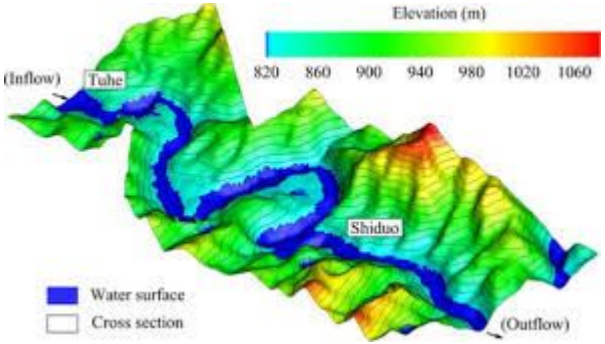
River Level Formation

- Short-term dependencies with hydrological variables
- Seasonality
- Yearly trends and climate change
- River levels display non-linearity and noise



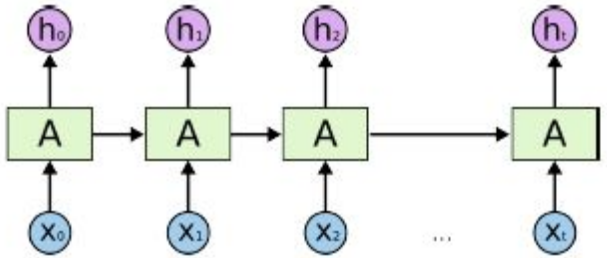
River Level forecasting

- Physically-based hydrodynamic models



- Autoregressive models, FFC neural networks

- New gold standard: LSTM



WaveNet model

- CNN adapted to temporal data
- Can make use of short-term and long-term dependencies in the data
- Can use conditional input
- Shown to work on regression-type problems

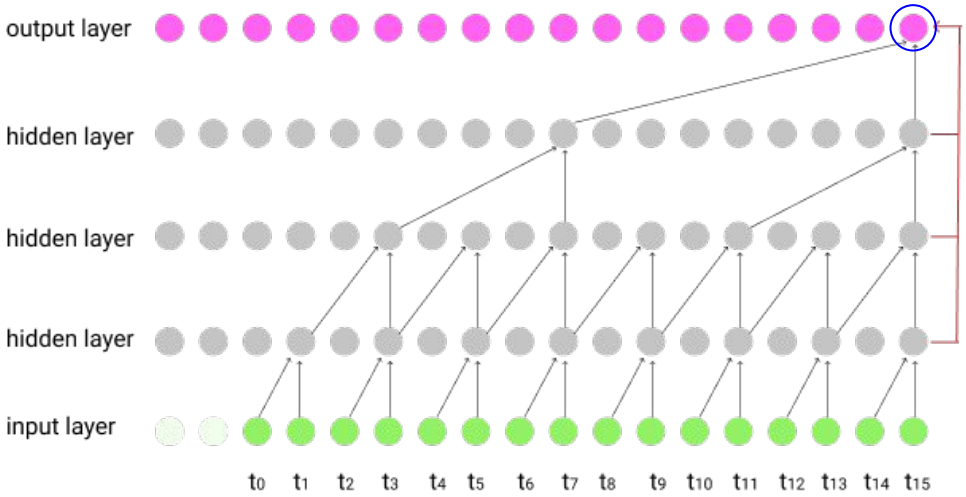
Project Aim

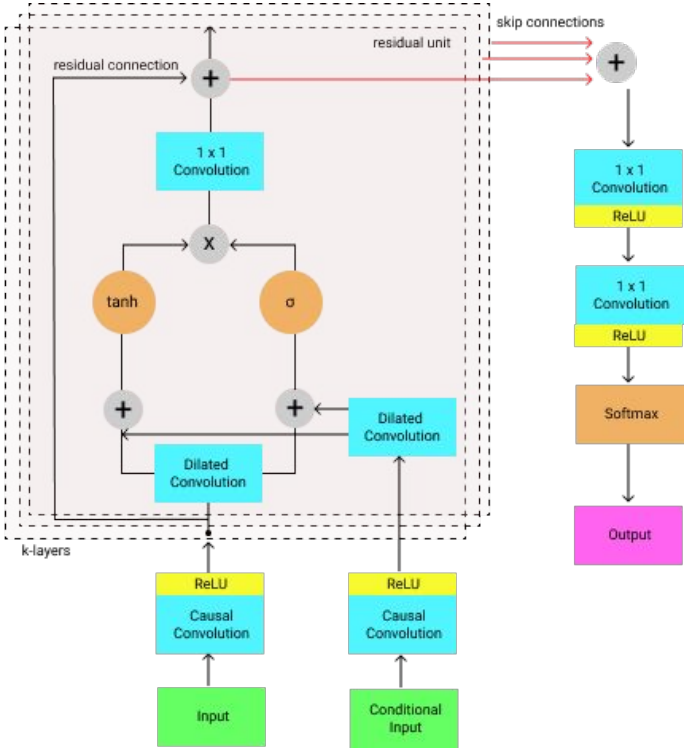
Compare the performance of WaveNet model and LSTM model (baseline) for one-day ahead river level forecasts.

- Primary input: River flow/stage
- Conditional input: Rainfall, river stage/flow

WaveNet Model

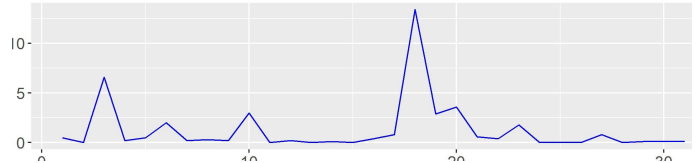
CNN with dilated causal convolutions dilations and specialised residual unit



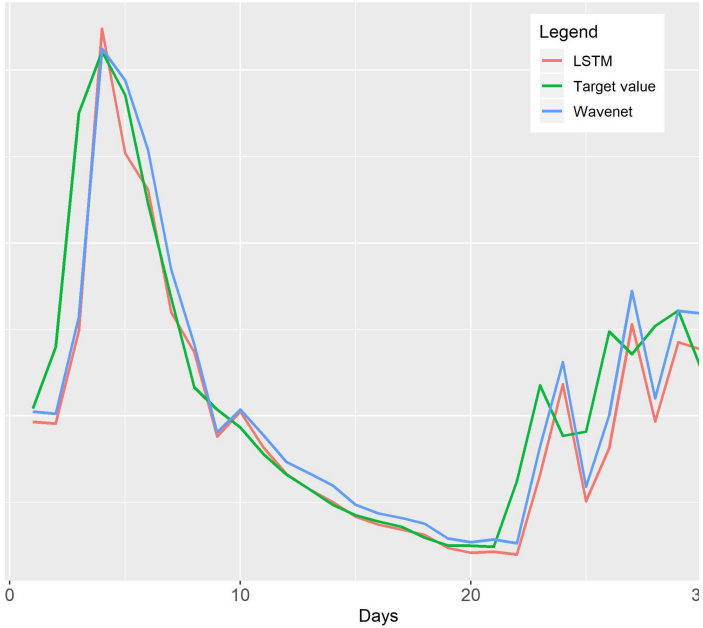


Unconditional vs. Conditional Model Predictions

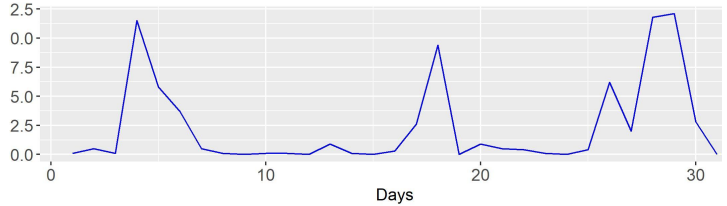
Rain



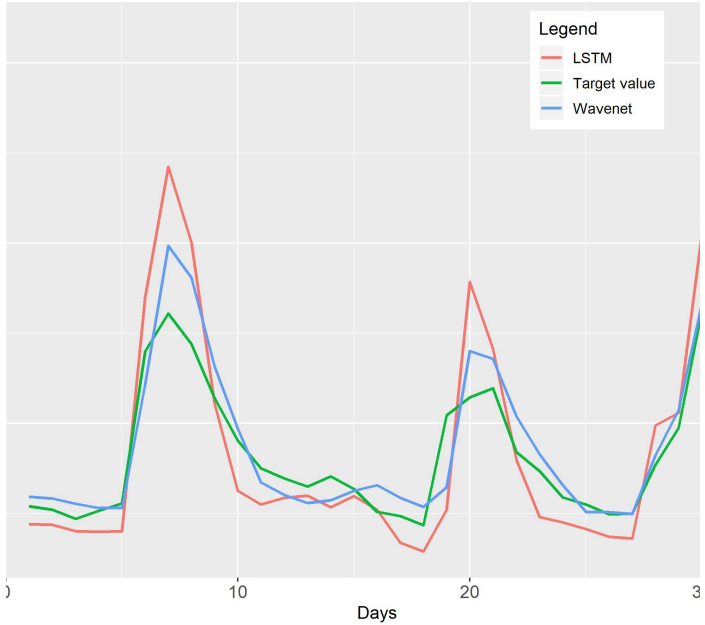
Stage Level



Rain



Flow Level



Results

Model	Cond. Input	Input Size	U2 mean	U2 Std	E Mean	E Std
River Variable Stage						
WaveNet	-	16	0.921	0.004	**0.936**	7e-04
LSTM	-	150	**0.888**	0.027	0.932	0.005
WaveNet	Rain, Flow	16	**0.525**	0.001	**0.967**	1e-04
LSTM	Rain, Flow	28	0.596	0.022	0.962	0.003
River Variable Flow						
WaveNet	-	128	**0.918**	0.002	**0.930**	0
LSTM	-	56	1.084	0.225	0.928	0.007
WaveNet	Rain, Stage	16	**0.524**	0.006	**0.967**	0.001
LSTM	Rain, Stage	160	0.693	0.052	0.960	0.004

Conclusion and Future Outlook

- WaveNet model can replace LSTM as gold standard for river level forecasting
- Performance improvements through additional conditioning series and long-term dependencies
- Further validate model and extend prediction horizon