

HydroNets: Leveraging River Structure for Hydrologic Modeling

Zach Moshe⁽¹⁾, Asher Metzger⁽¹⁾, Gal Elidan⁽¹⁾⁽²⁾, Frederik Kratzert⁽⁴⁾,
Sella Nevo⁽¹⁾, Ran El-Yaniv⁽¹⁾⁽³⁾

⁽¹⁾Google Research, ⁽²⁾The Hebrew University of Jerusalem, ⁽³⁾Technion - Israel Institute of Technology,

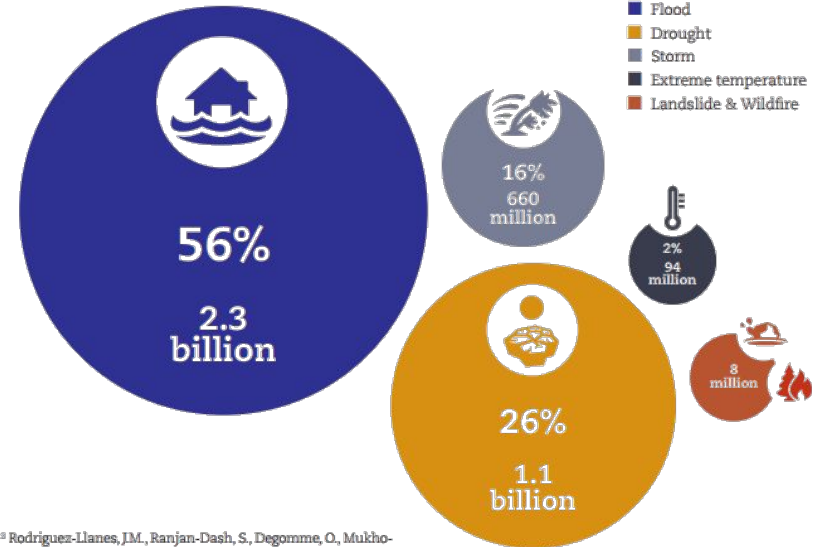
⁽⁴⁾Johannes Kepler University Linz



Flooding Impact



Numbers of people affected by weather-related disasters (1995-2015)
(NB: deaths are excluded from the total affected.)



² Rodriguez-Llanes, JM., Ranjan-Dash, S., Degomme, O., Mukhopadhyay, A., Guha-Sapir, D. (2011). "Child malnutrition and recurrent flooding in rural eastern India: a community-based survey". *BMJ Open* 2011;1: e000109.

The Google Flood Forecasting Initiative

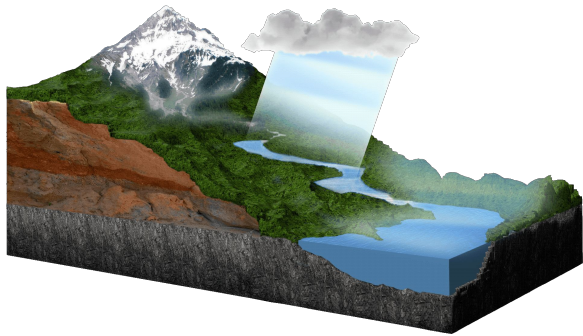


**Goal: Scalable, high-accuracy, high-resolution
flood forecasts and warnings globally**

(currently focusing on riverine floods)



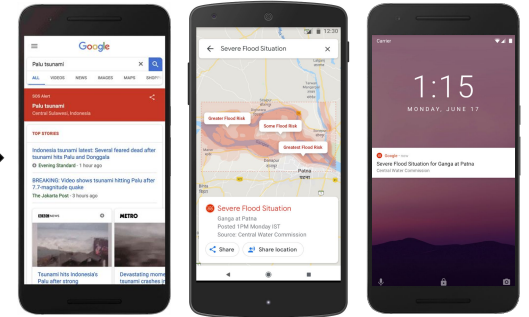
Flood Forecasting in a nutshell



Hydrologic
Model



Hydraulic
Model



Warning
Distribution

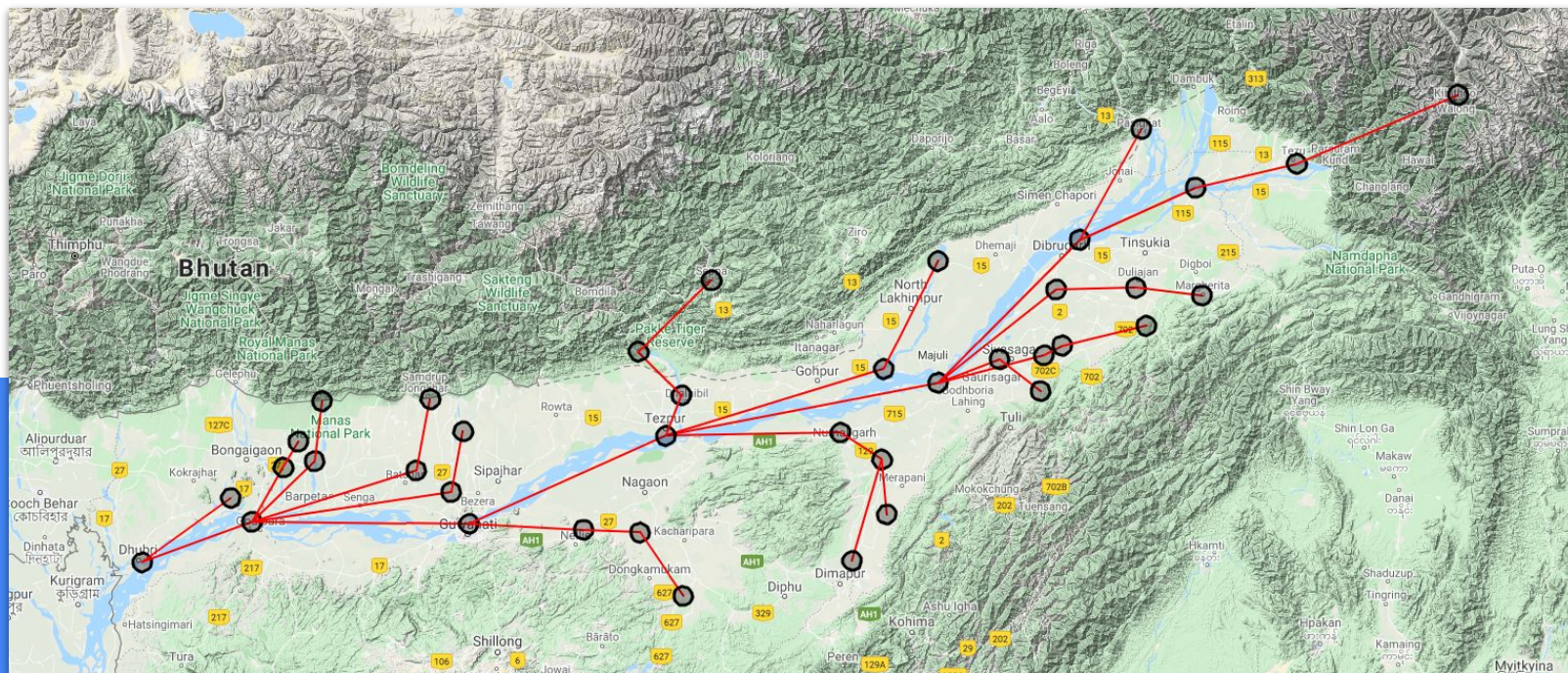
The Data

- **Water height** - Measured by every gauged station on an hourly basis.
Provided by the Indian Central Water Commission
- **Precipitation** - GSMaP
Based on JAXA's GPM satellite mission

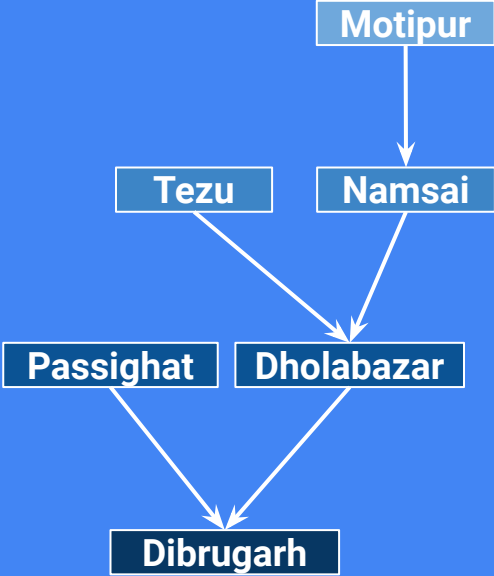
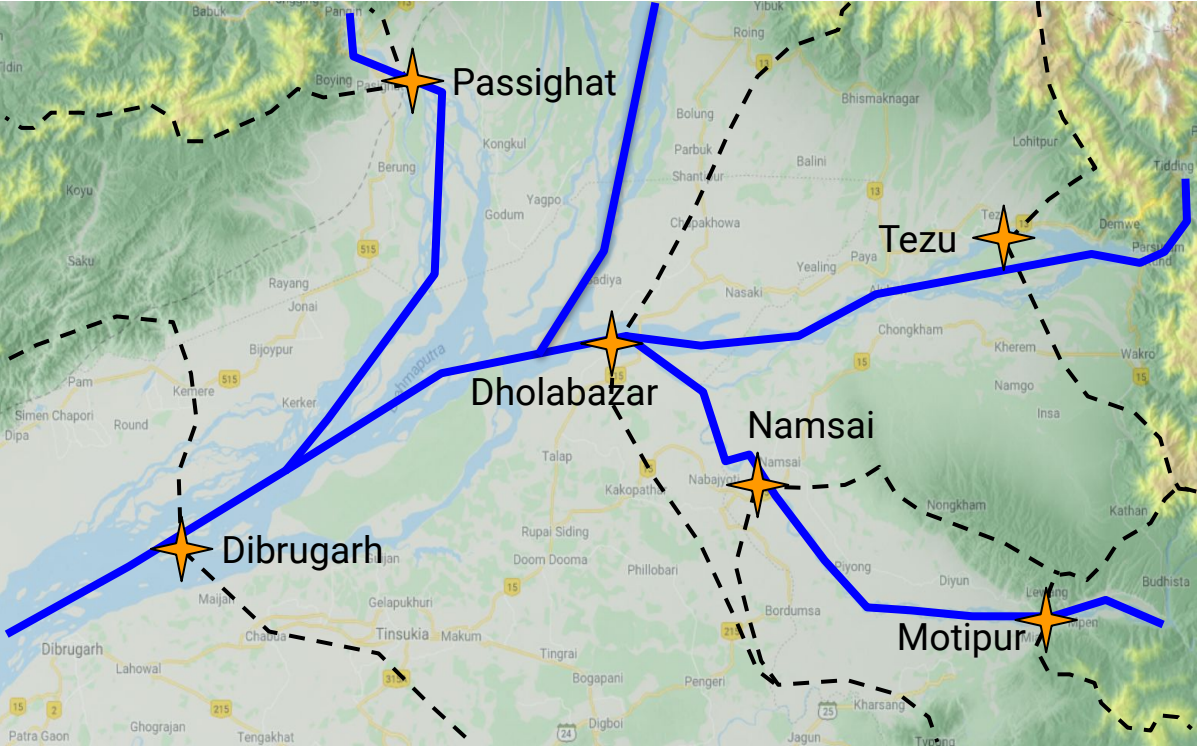
Also exists:

- Temperature, Radiation level, Soil moisture, etc..
- Static catchment features

Leveraging river structure as a prior knowledge

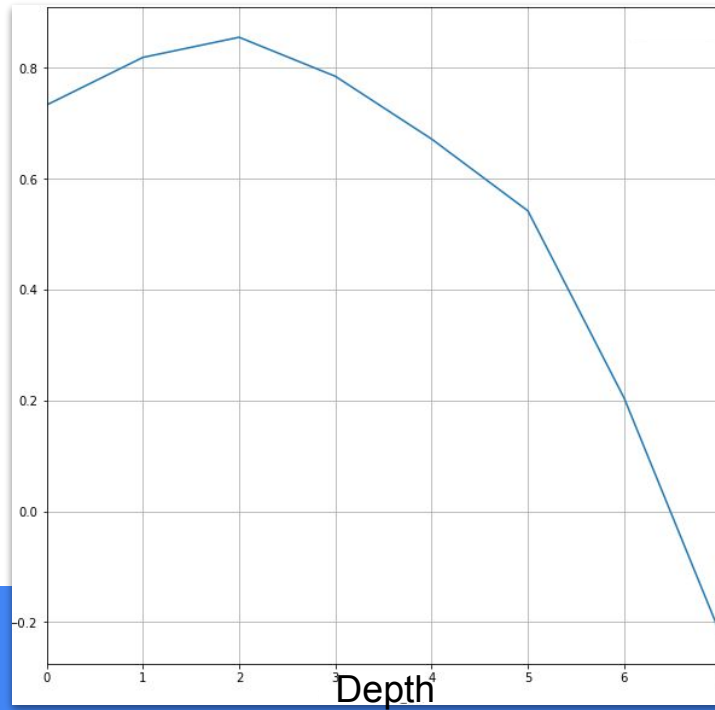


Defining the graph



The Value of Depth

R²
Persist

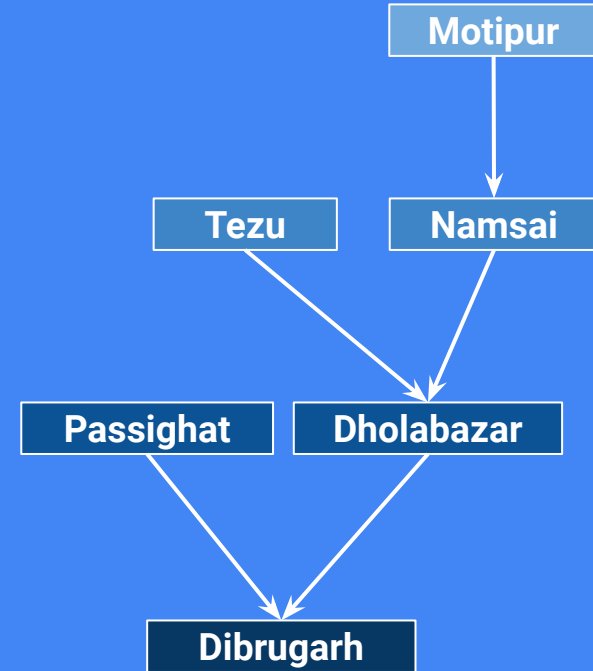


The HydroNets Architecture

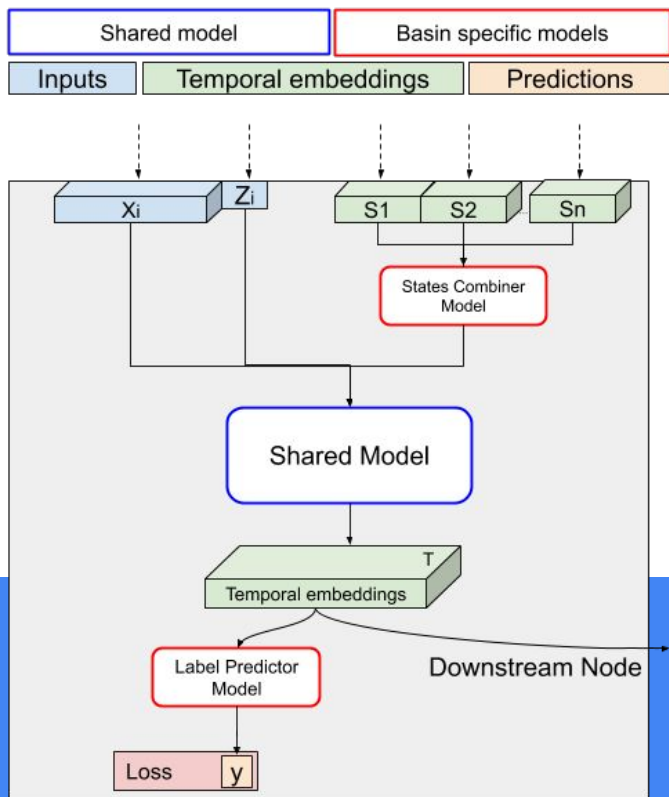


Architecture guiding principles

- Causality between basins
- General modeling vs. basin specific
- Data flow should reflect the water flow

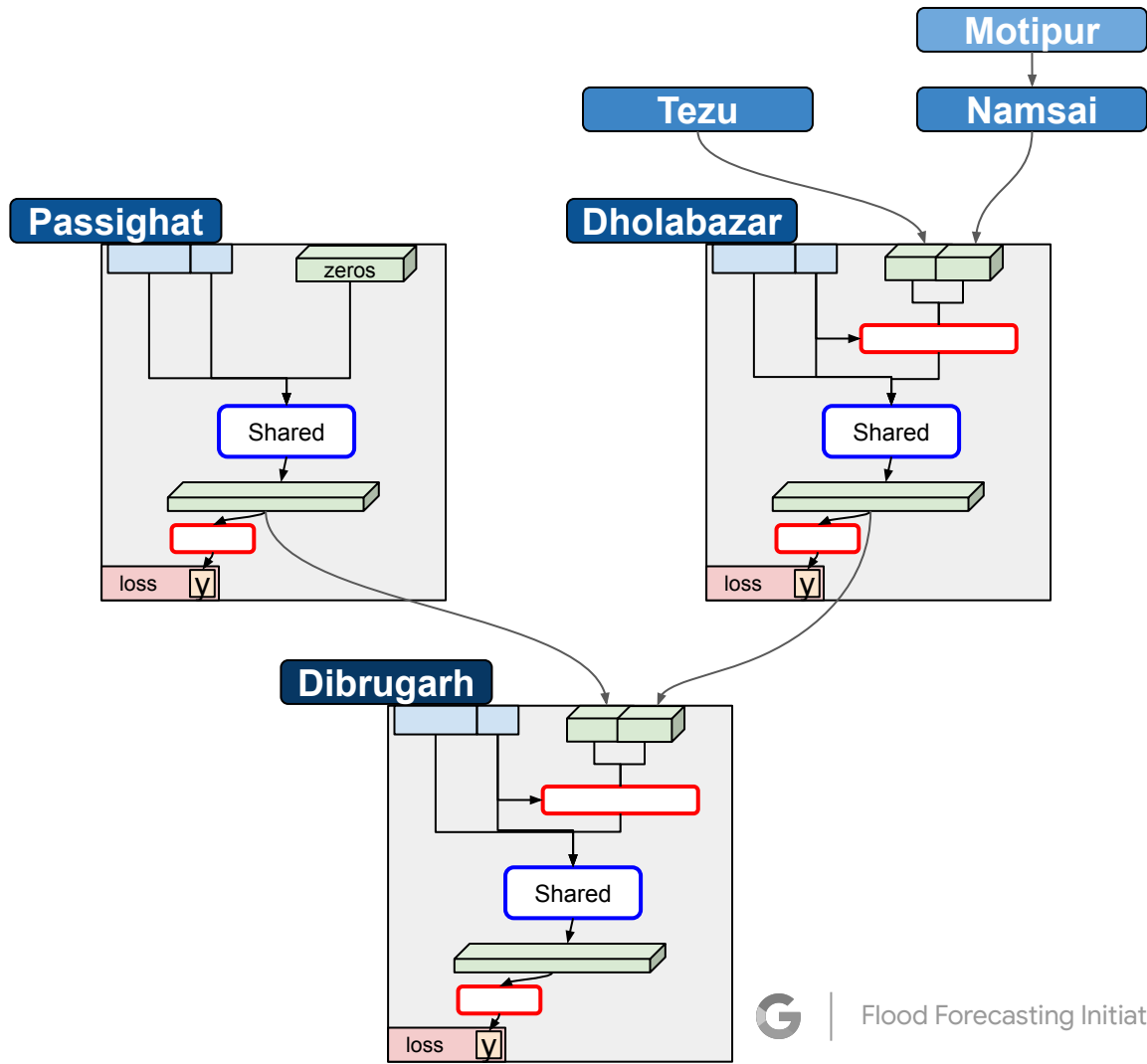
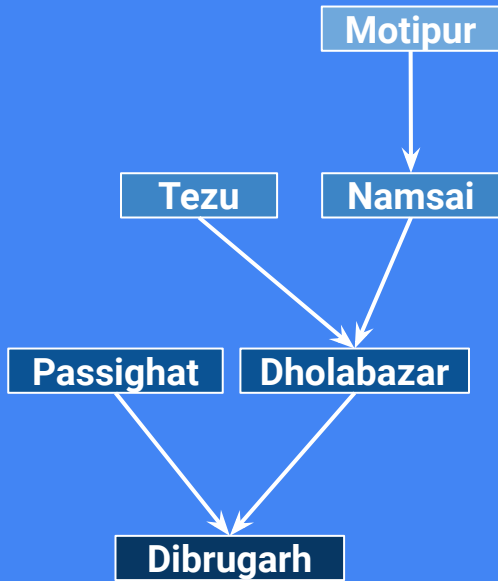


The HydroNets Architecture



The three sub-models:

- **Combiner:** Accounts for the relative importance of sources to their drain.
- **Shared:** Classical rainfall-runoff hydrological modeling.
- **Predictor:** Accounts for basin-specific properties.



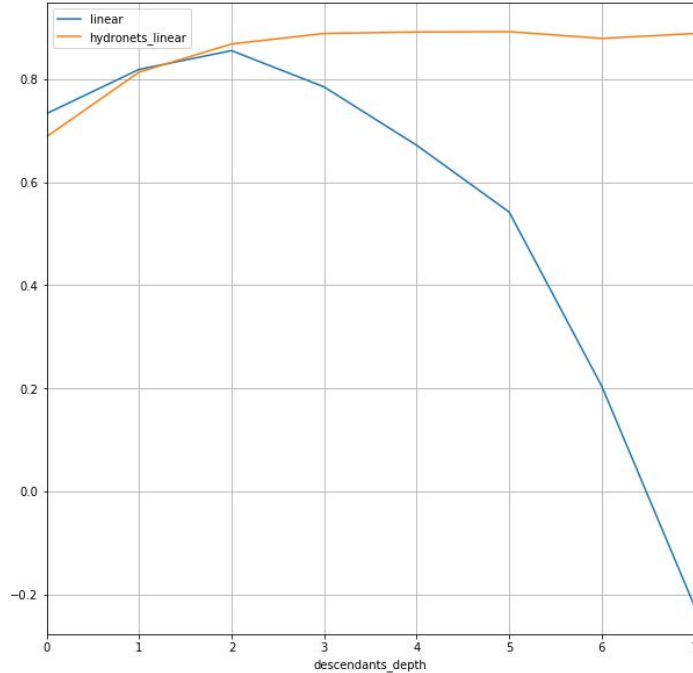
Addressing Overfitting (“Linear HydroNets”)

Legend

— Linear baseline

— HydroNets structure

R²_persist per descendants depth



Improved accuracy

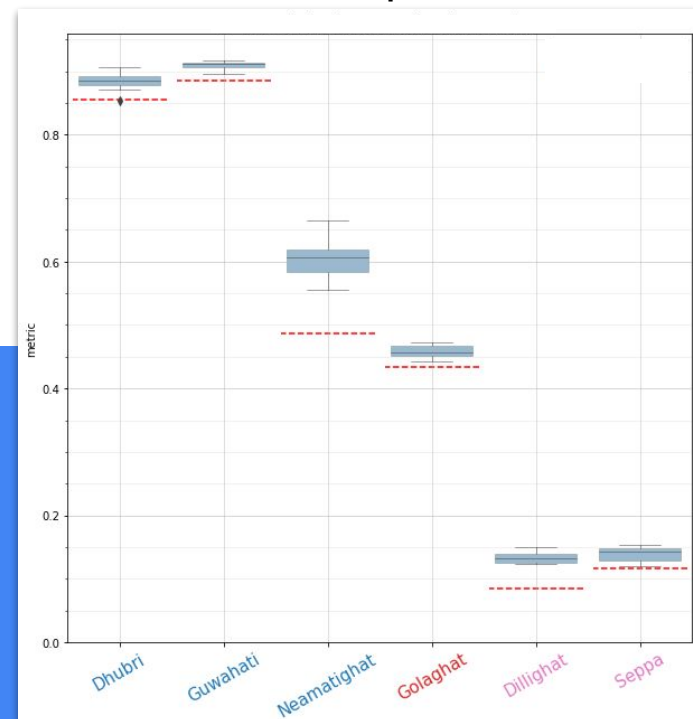
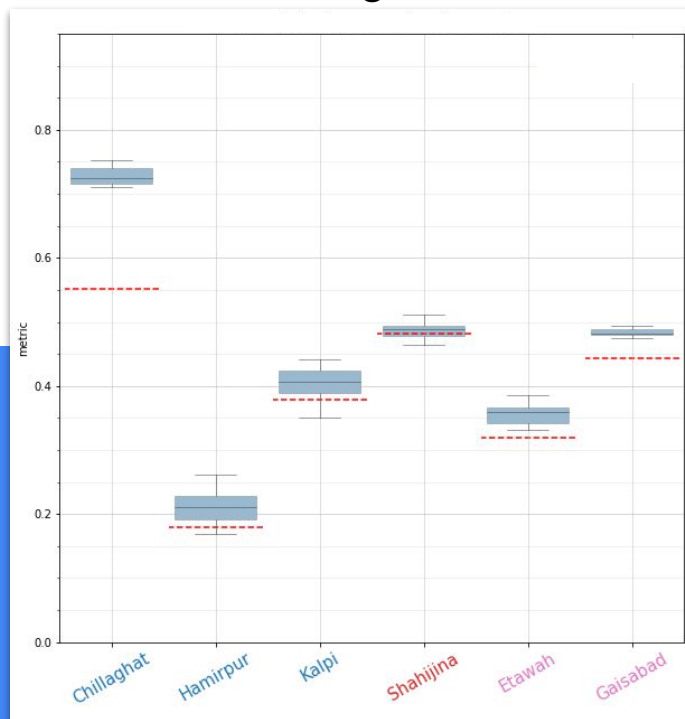
Ganges

Brahmaputra

Legend

--- Linear baseline

HydroNets



Future Work

- Non-linear sub-models
- Transfer learning for stations with less data
- Adding static basin-features



Questions?

zmoshe@google.com

ashermetzger@google.com

