FLOOD FORECASTING IN A DATA-SCARCE REGION BASED ON GRACE AND SMAP DATA

ALVEE BIN HANNAN
SIAM MAKSUD
NASREEN JAHAN
DEPARTMENT OF WATER RESOURCES ENGINEERING
BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

AGU FALL MEETING
December 17, 2021
SCIENCE is SOCIETY

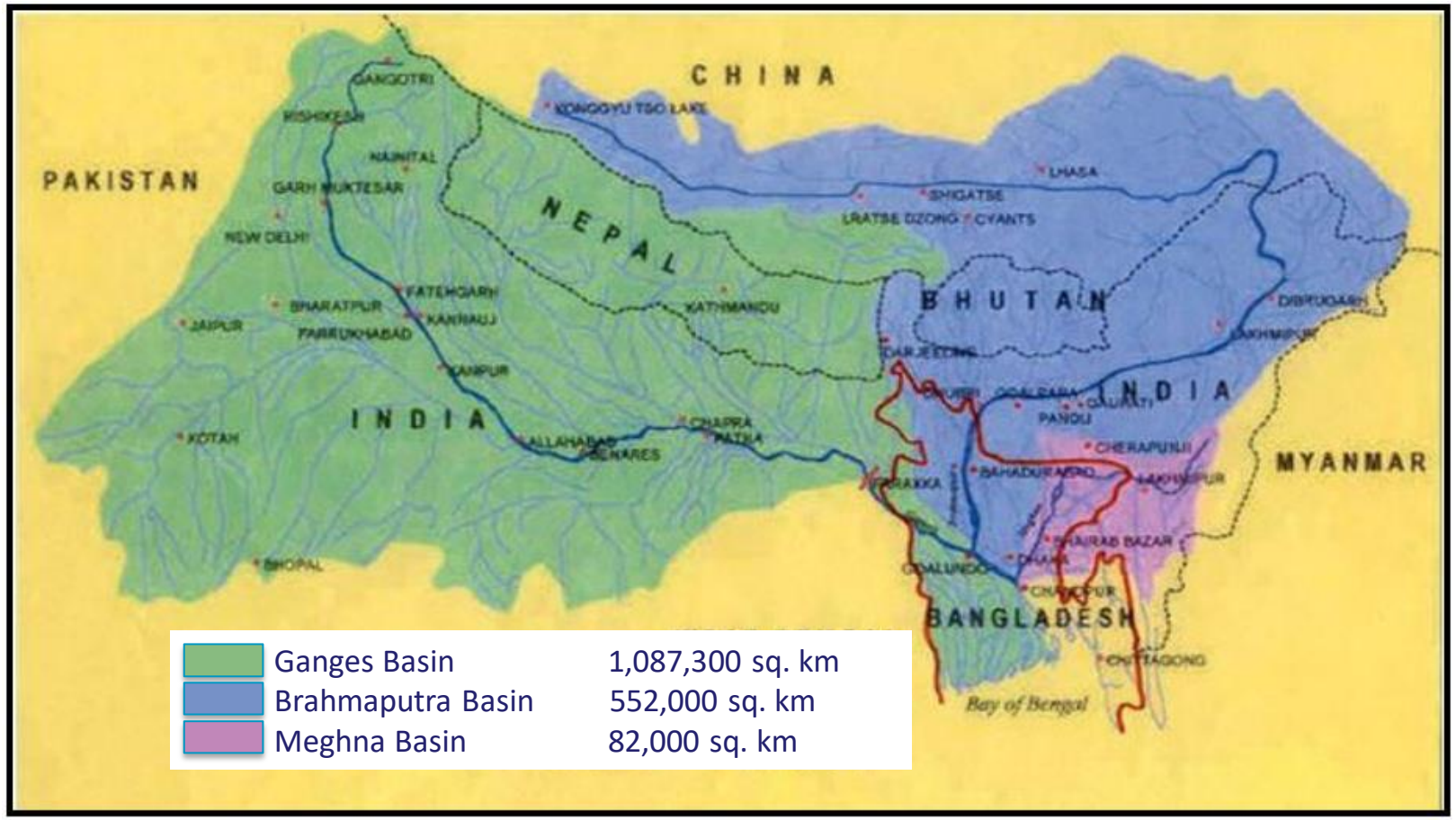
THIS PRESENTATION WILL FOCUS ON

- Necessity of Flood Forecasting in Bangladesh
- Generating Water level Forecast using ANN
- Evaluation of forecasts

WHAT CAUSES FLOOD IN BANGLADESH?

1.72 million sq. km of the Ganges, Brahmaputra and the Meghna basin drains out through Bangladesh

Precipitation in this large GBM basin causes extreme flood in Bangladesh



Md. Monowar Hossain et. al., Climate change impact on the discharge of Ganges-Brahmaputra-Meghna (GBM) basin and Bangladesh , 2015

WHY FLOOD FORECASTING IS IMPORTANT

Frequent floods in north-eastern region of Bangladesh causes damages to lives and property

A reliable forecast with a significant lead time can help minimize these losses

SCIENCE is SOCIETY

https://www.tribuneindia.com/news/world/over-700-000-marooned-as-flash-floods-wreak-havoc-in-bangladesh-112858

https:// www.dhakatribune.com/bangladesh/nation/2017/08/28/rice-production-fall-floods-deluge-farmland

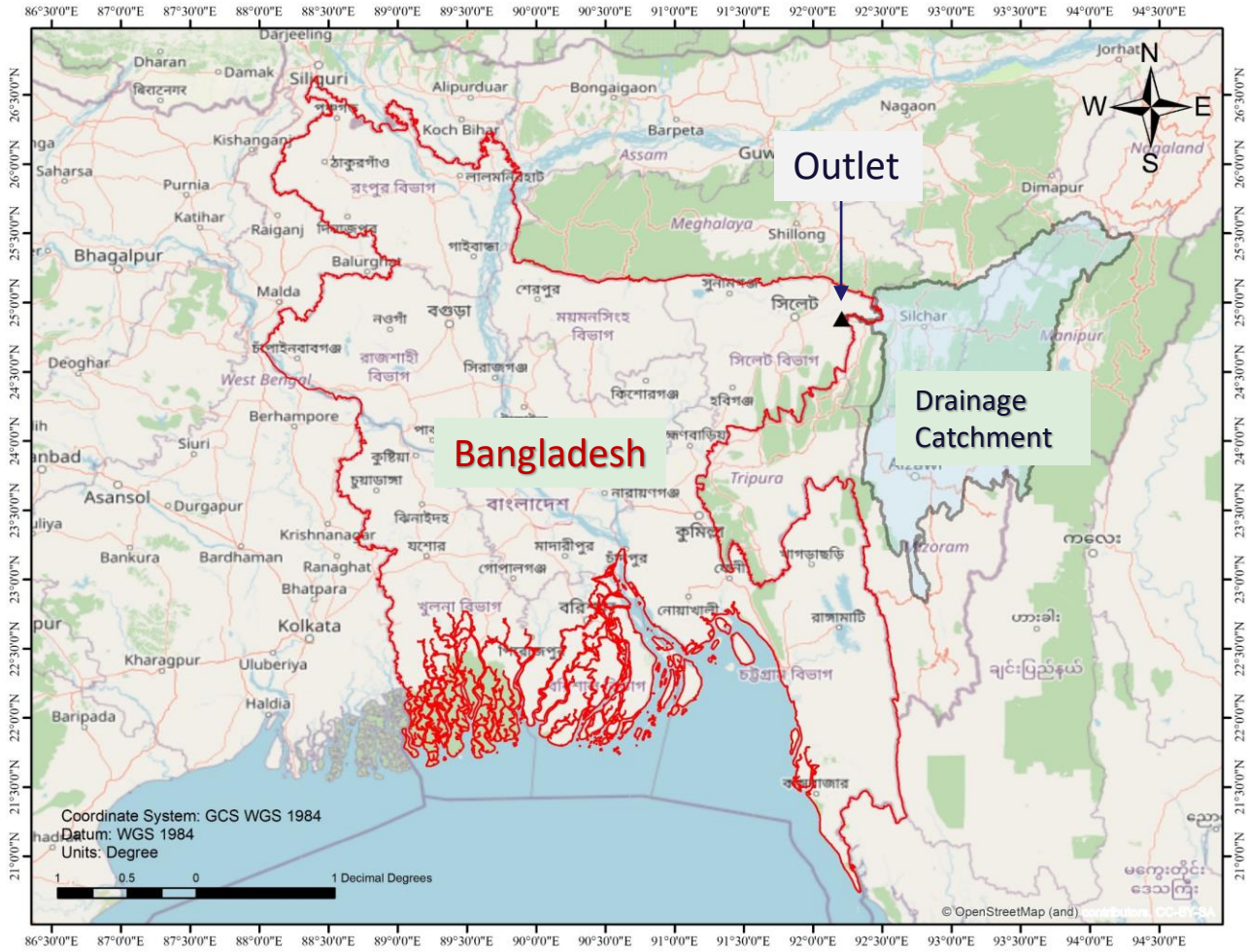
In 2020 alone, Floods caused a damage worth around 155 million USD in crops, destroying crops in 392,440 acres of land

In 2020, flood affected around 4 million people

https://give2asia.org/2020-bangladesh-flood-response/

OUR STUDY AREA

We want to forecast the water levels at an outlet for the Kushiyara River located in the North-East region of Bangladesh



LIMITATION OF EXISTING FLOOD FORECAST SYSTEM

Lack of Rainfall Data

Long Term data unavailable for suited Hydrologic model

Use of Inaccurate forecast data

SO HOW DID WE MANAGE TO GET DATA?

5th Generation ECMWF Reanalysis (ERA5) → Precipitation

Global Land Data Assimilation System with the Gravity Recovery and Climate Experiment Data Assimilation (GRACE-DA) → Terrestrial Water Storage (tws)

Soil Moisture Active Passive (SMAP) → Surface Soil Moisture

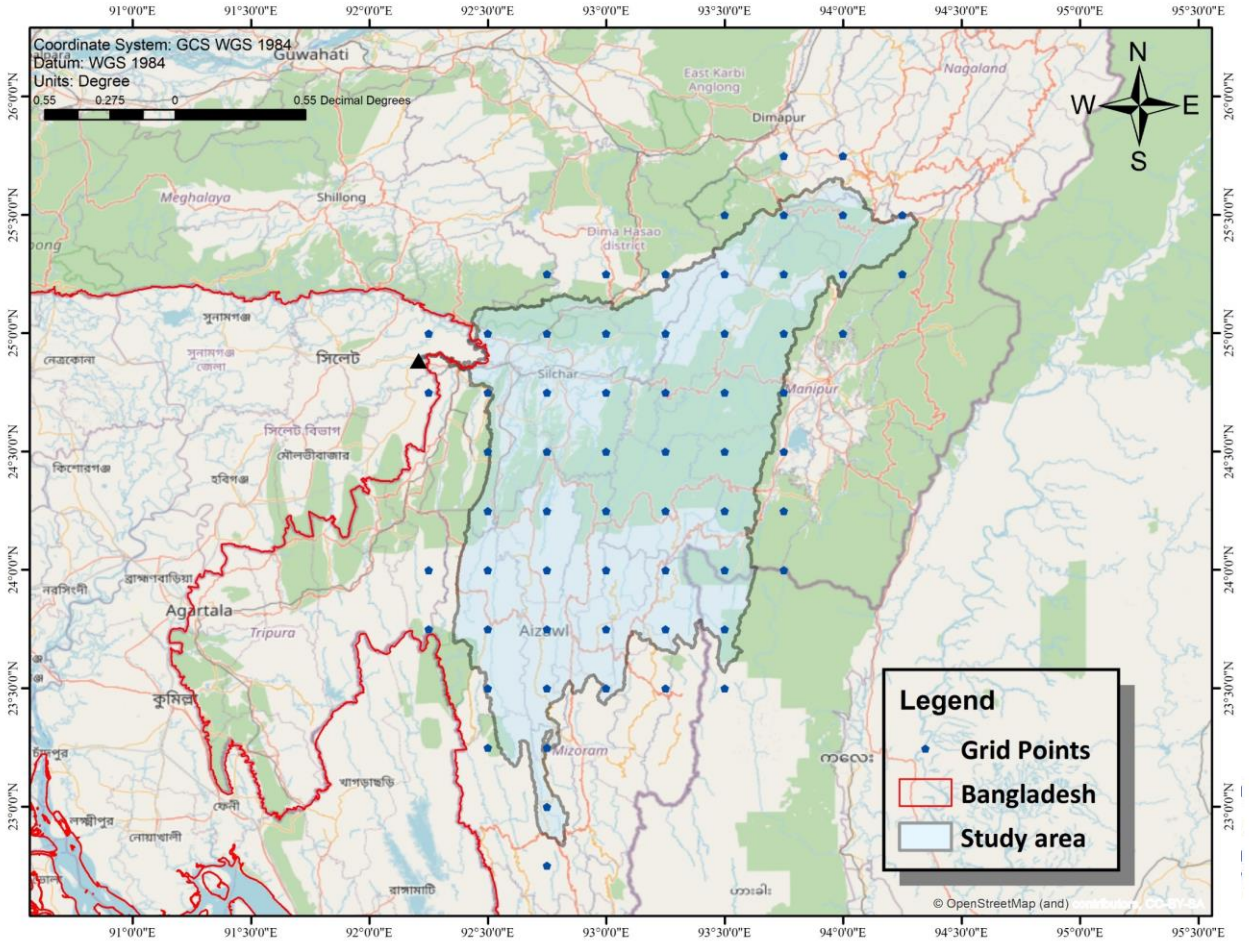
Bangladesh Water Development Board (BWDB) → Water Level and Discharge

SCIENCE is SOCIETY

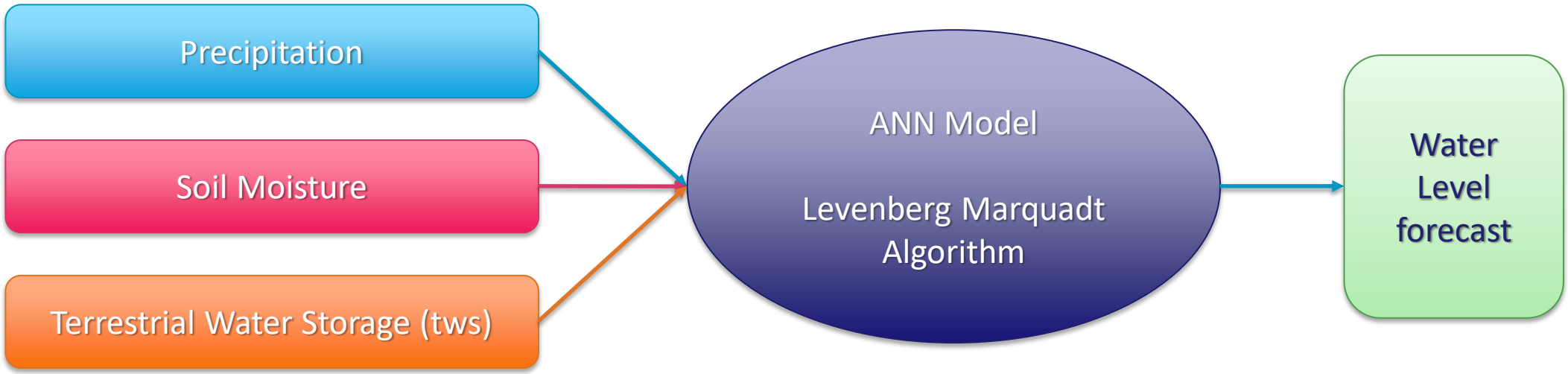
MORE INFORMATION ON OUR DATA

Spatial resolution 0.25^0

March 2015 – June 2017

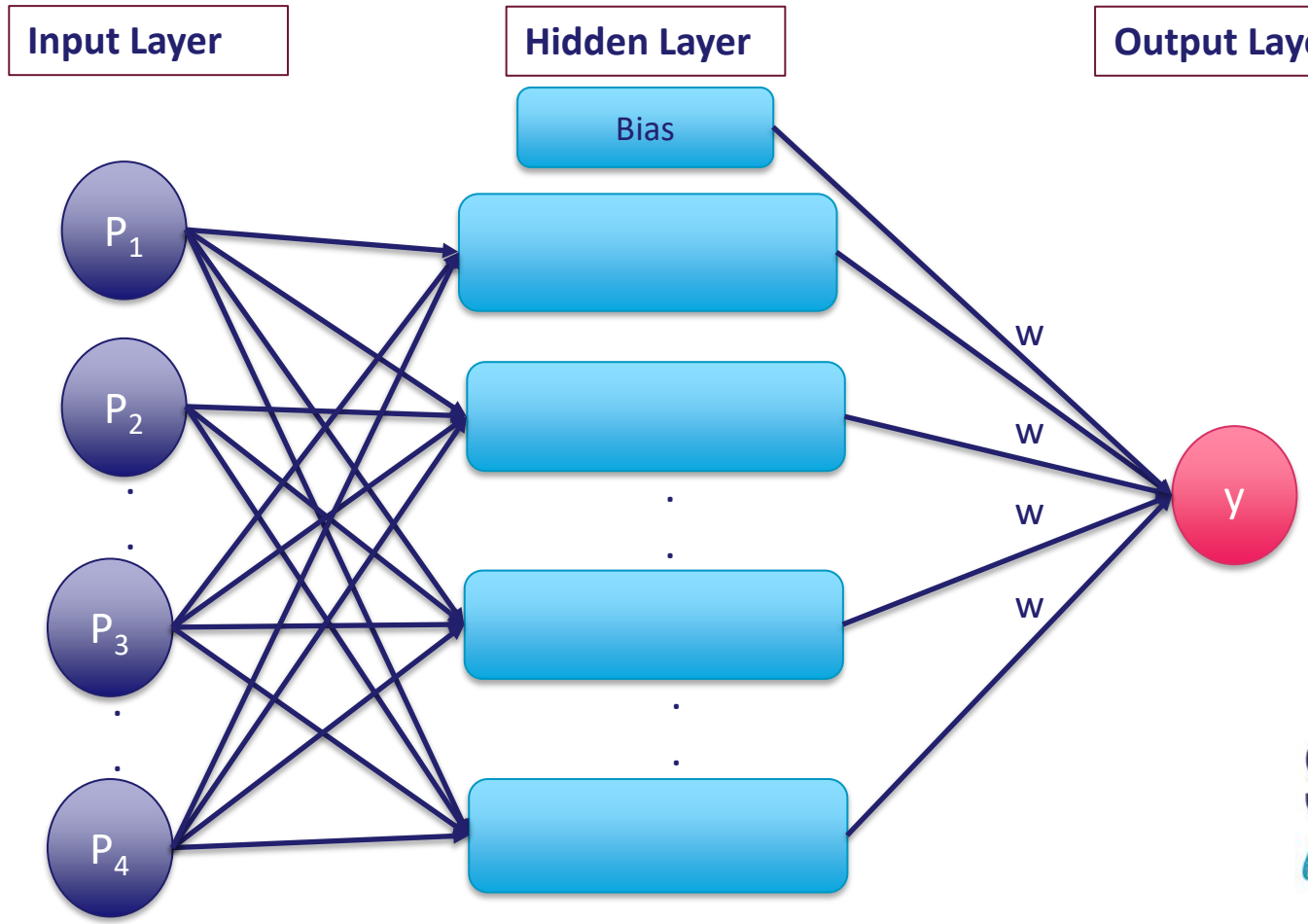


SO WHAT DID WE DO WITH ALL THESE DATA?



AN ARTIFICIAL NEURAL NETWORK MODEL WAS TRAINED TO PREDICT WATER LEVELS

The Levenberg Marquadt Algorithm was chosen to find a correlation between our input data and target water levels to help predict water levels at 1-day, 3-day, 5-day and 7-day lead times



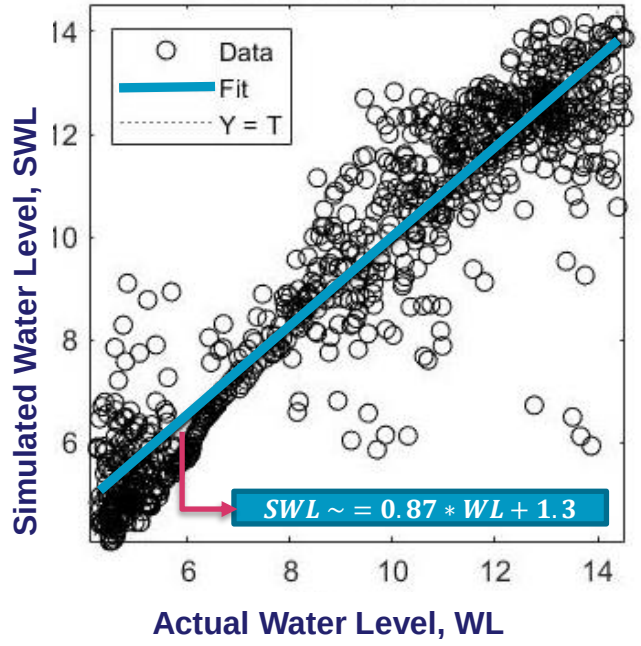
SCIENCE is SOCIETY

FINALLY, WE HAVE SOME RESULTS

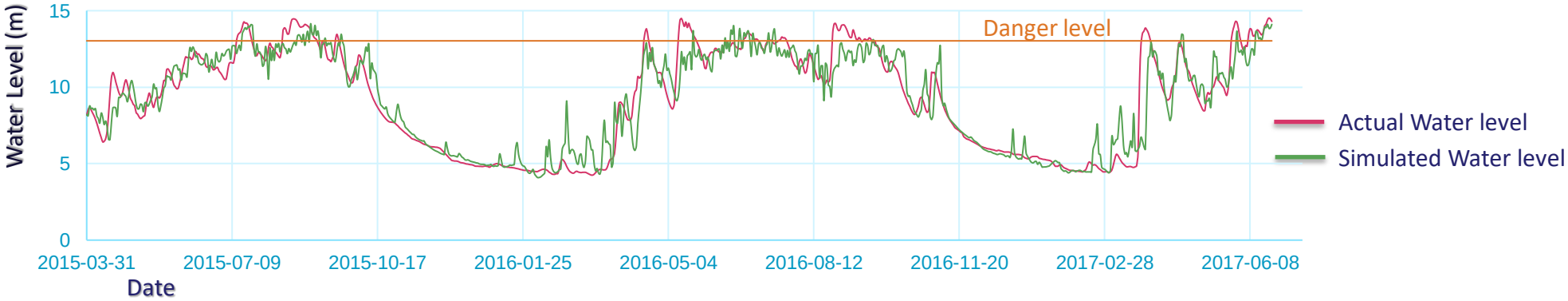
For a Lead Time of 7-days, we observed a Correlation of 0.94 between the input parameters and water level 7 days later

This is what the generated time series looks like:

Correlation Coefficient, R = 0.94



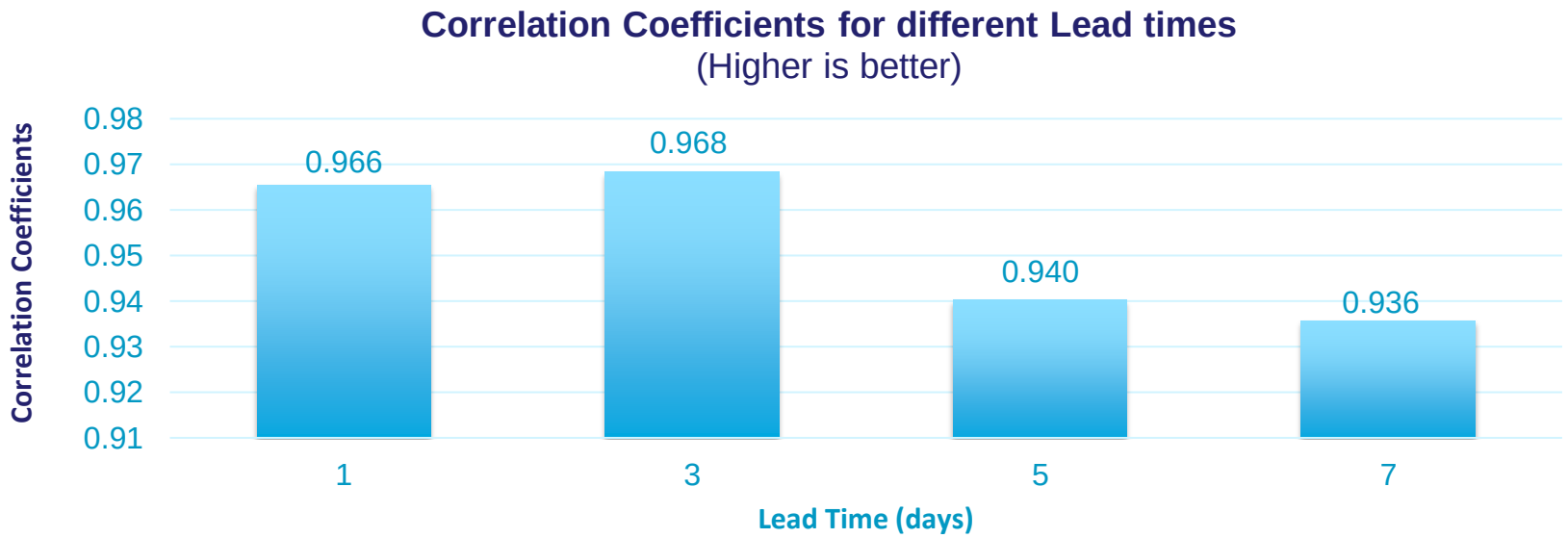
Actual WL and Simulated WL (7day lead)



SCIENCE is SOCIETY

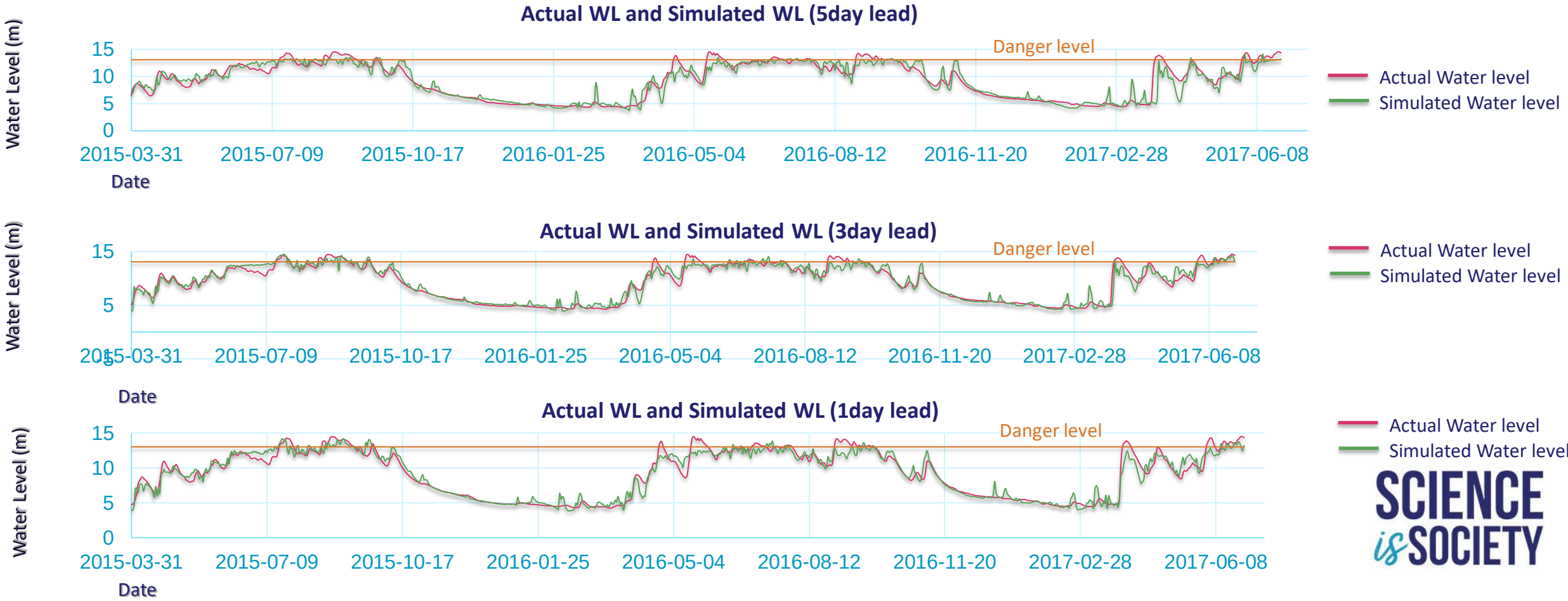
EVALUATION OF FORECAST MODEL FOR DIFFERENT LEAD TIMES

The Correlation values for different lead times look like this:



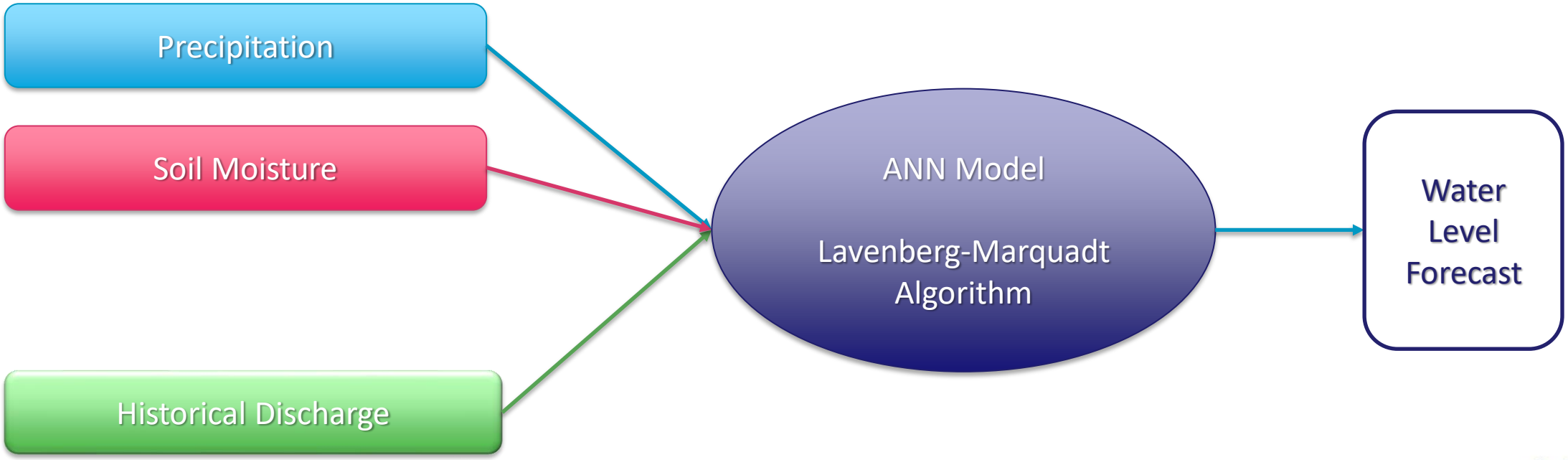
SCIENCE is SOCIETY

EVALUATION OF FORECAST MODEL FOR DIFFERENT LEAD TIMES

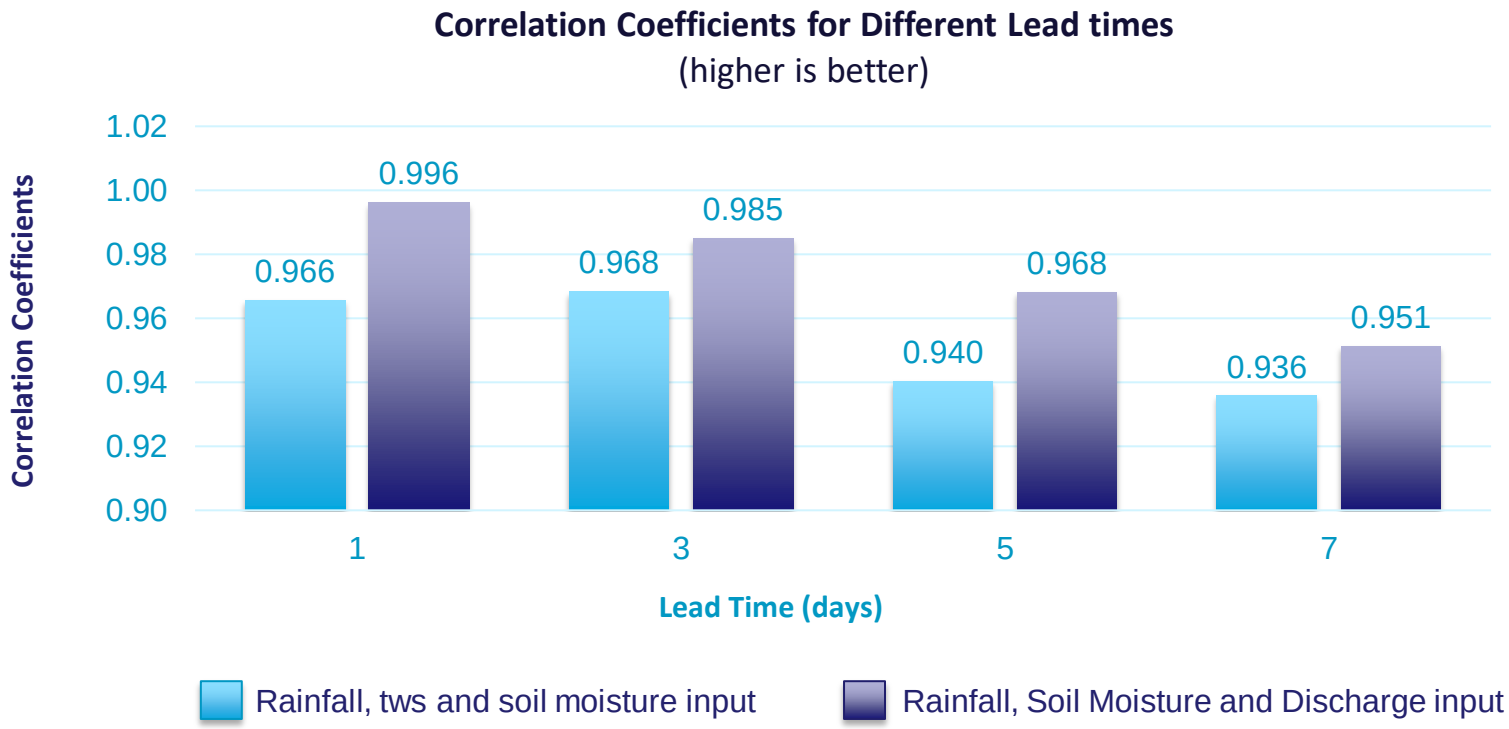


SCIENCE *is* SOCIETY

THEN WE USED ANOTHER INPUT PARAMETER TO OUR MODEL

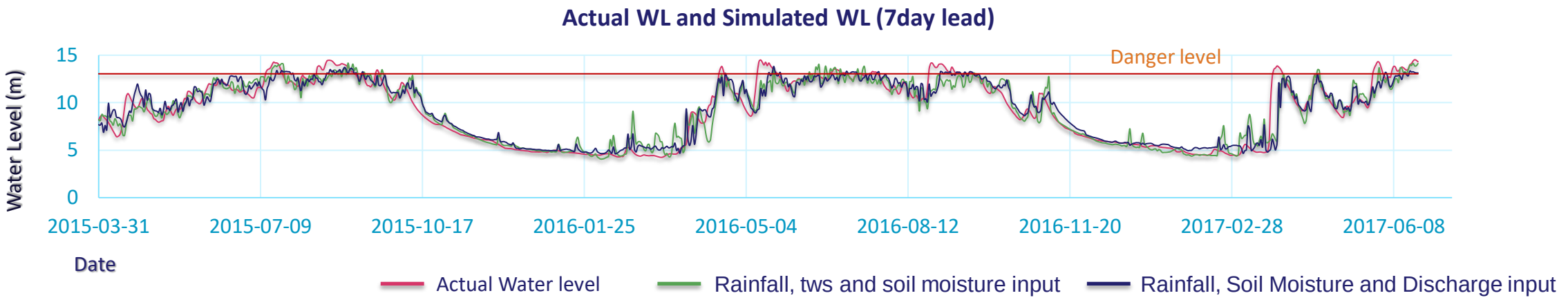


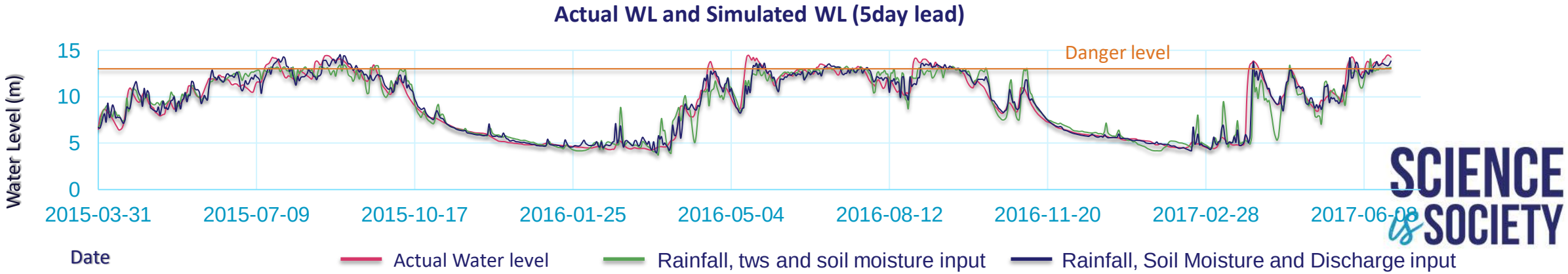
WE NOTICED A SIGNIFICANT IMPROVEMENT IN THE RESULTS IF WE INCLUDE HISTORICAL DISCHARGE DATA INSTEAD OF TWS IN THE MODEL



SCIENCE is SOCIETY

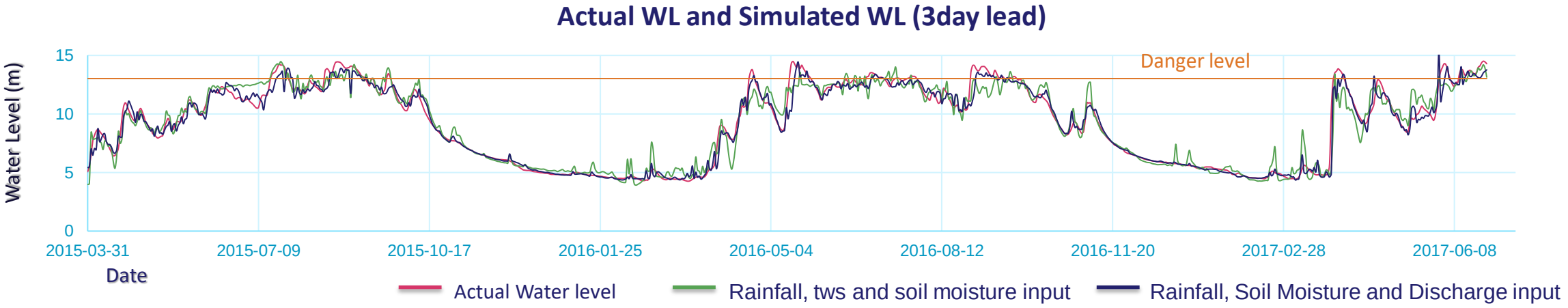
COMPARISON OF FORECAST FROM THE TWO MODELS WITH DIFFERENT INPUT PARAMETERS

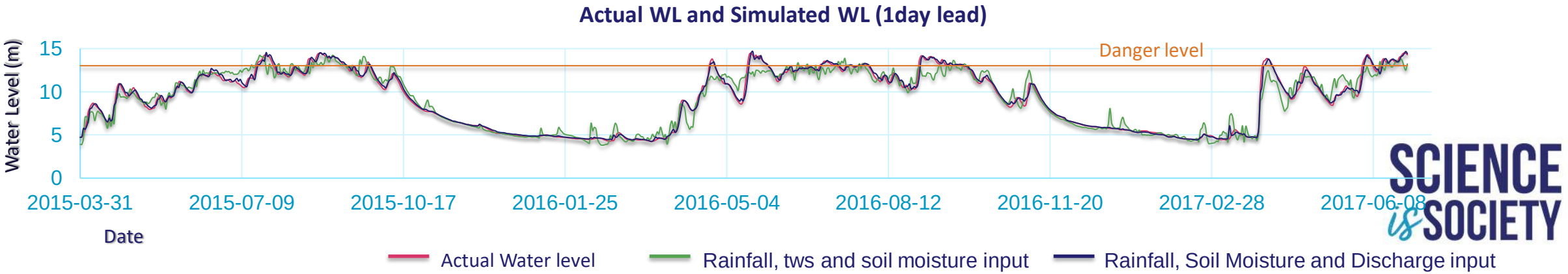




SCIENCE is SOCIETY

COMPARISON OF FORECAST FROM THE TWO MODELS WITH DIFFERENT INPUT PARAMETERS





SCIENCE *is* SOCIETY

IN CONCLUSION,

A somewhat reliable medium range (5-7 days) forecast is possible using SMAP retrieved Soil moisture data and tws data retrieved from GRACE-DA datasets.

Use of GRACE data is unsuitable for flood forecast due to its latency

Incorporating Discharge data as input can help improve the results even further.

THANK YOU

Find us at:

alveehannan@gmail.com

siam.maksud@gmail.com

jahan@ualberta.ca

AGU FALL MEETING

SCIENCE is SOCIETY