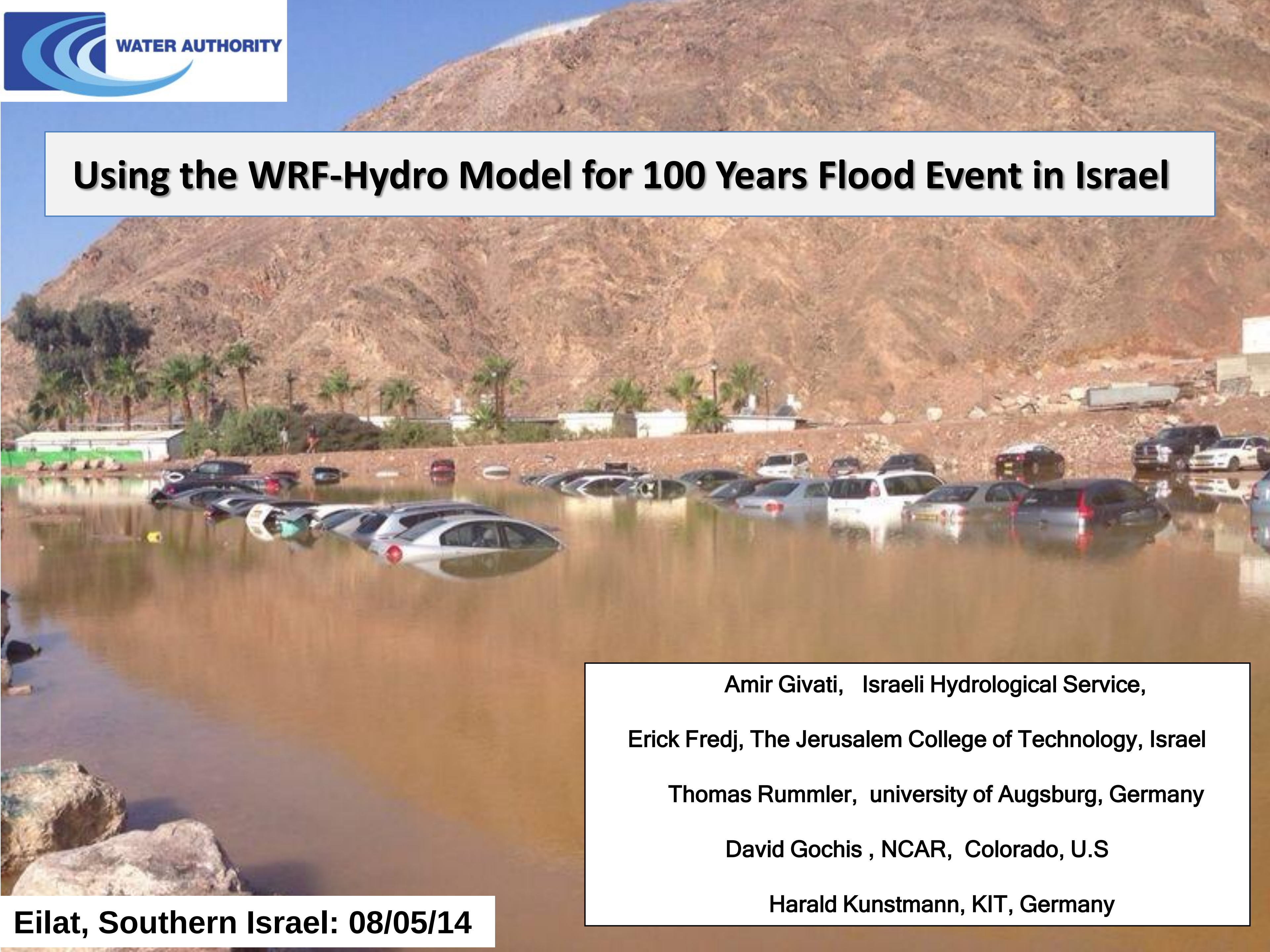
Using the WRF-Hydro Model for 100 Years Flood Event in Israel



Eilat, Southern Israel: 08/05/14

Amir Givati, Israeli Hydrological Service,

Erick Fredj, The Jerusalem College of Technology, Israel

Thomas Rummler, university of Augsburg, Germany

David Gochis , NCAR, Colorado, U.S

Harald Kunstmann, KIT, Germany

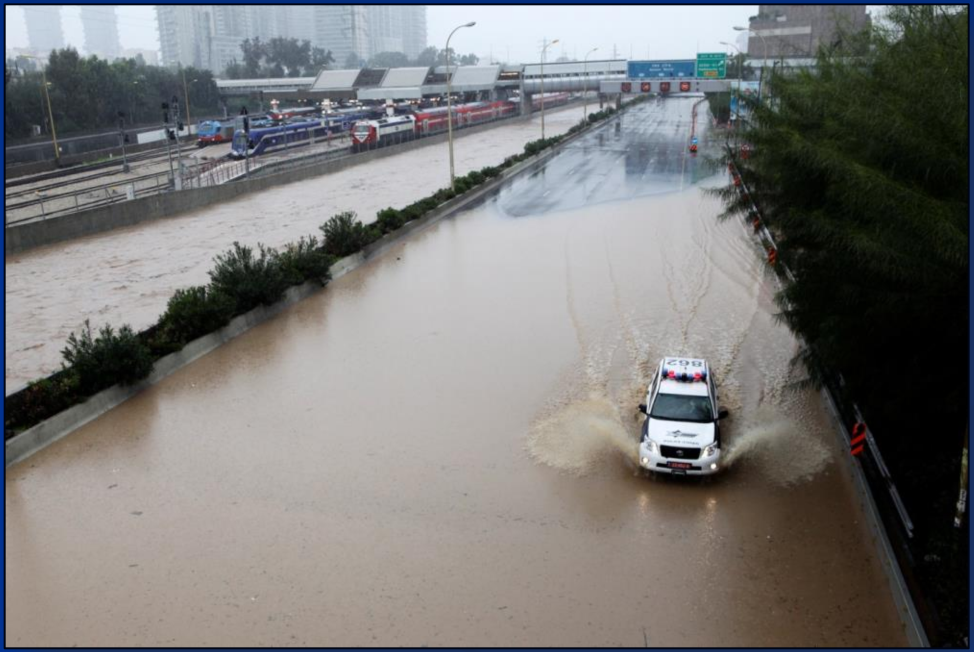
Motivations:

- Developing flood warning system at a country (regional) scale
- Predictions of peak discharges and water volumes vs. it return periods and Exceedance probabilities

Outline

- Example for severe flood events in Israel (2012/13-2013/14)
- WRF-Hydro simulations for 1% flood event in central Israel- The city of Tel Aviv (precipitation and hydrographs)
- Demonstration of the online, operational flood forecasting website operated by the Israeli Hydrological Service – case study from southern Israel (extreme arid environment)

Tel Aviv , 08.01.13:
Flood in the Ayalon high way



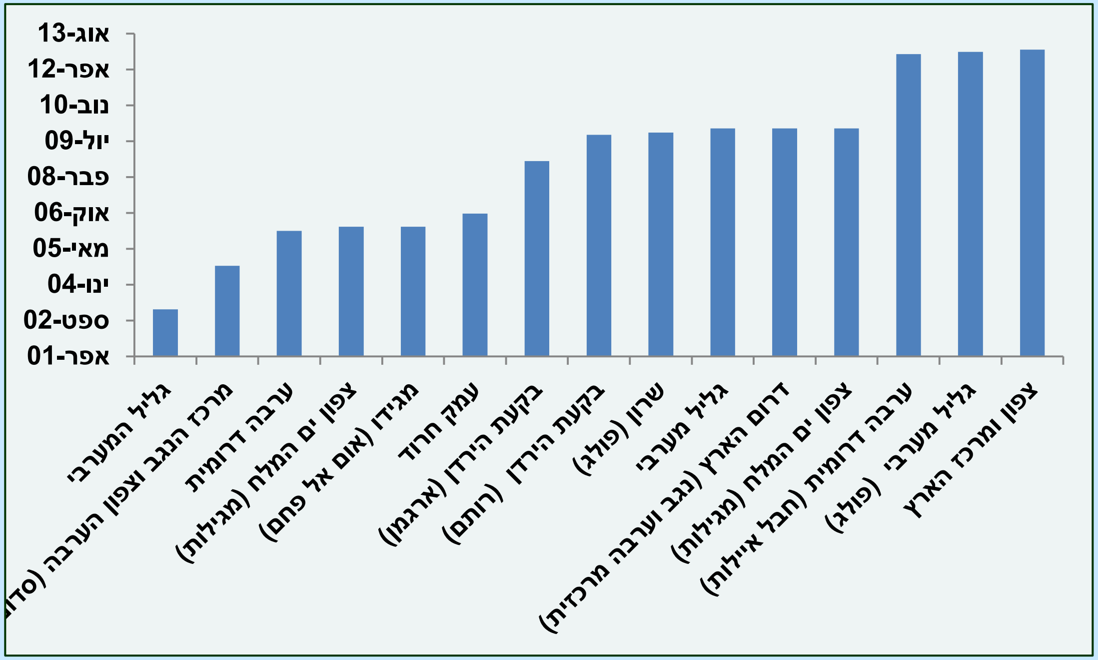
08.01.13
The Jordan River, Northern Israel

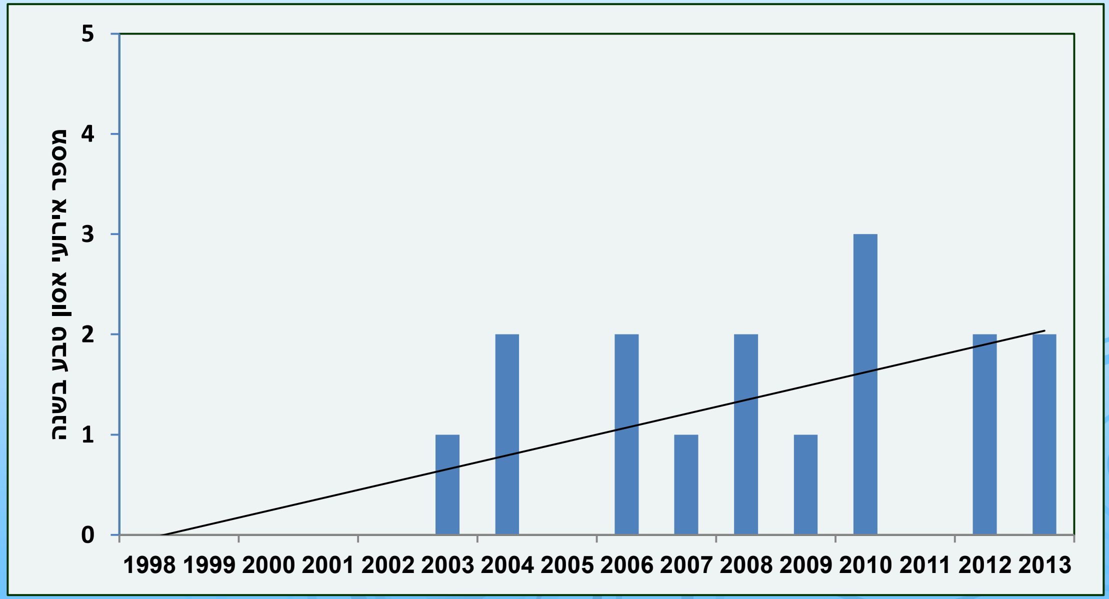
The city of Hedera, Central Israel

Gaza strip: 14.12.13

Nablus, West bank: 08.01.13

Increase in the number of major flood events in Israel



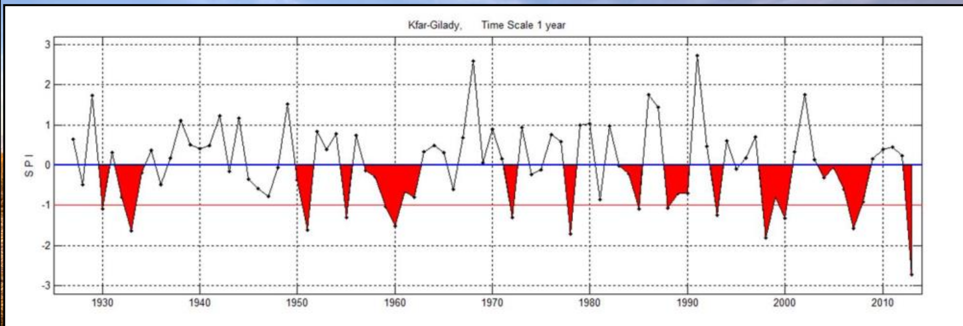


European Environment Agency

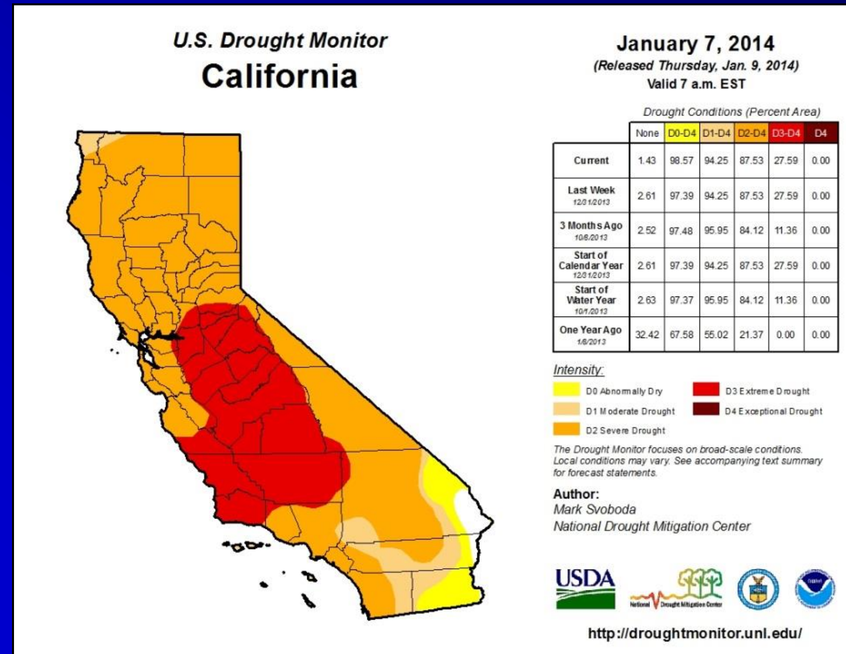
Flood risk in Europe: the long-term outlook

- Floods, storms and other hydro-meteorological events account for around **two thirds of the damage costs of natural disasters**, and these costs **have increased** since 1980, according to a recent EEA assessment of climate change impacts in Europe.
- The observed increase in damage costs from extreme weather events is **mainly due to land use change**, increases in population, economic wealth and human activities in hazard-prone areas and to better reporting. To confirm the exact role played by climate change in flooding trends in past decades, it would be necessary to have more reliable, long-time series data for rivers with a natural flow regime.
- In any case, **it is likely that rising temperatures in Europe will intensify the hydrological cycle, leading to more frequent and intense floods in many regions**. Although quantitative projections for flood frequency and intensity are uncertain, the contribution of climate change to the damage costs from natural disasters **is expected to increase in the future due to the projected increase in the intensity and frequency of extreme weather events in many regions**.
- Considering flood risk in Europe, we can see climate change will be an increasingly important factor. But in many cases, flood risk is also the result of where, and how, we choose to live – increases in costs from flooding in recent decades can be partly attributed to more people living in flood-prone areas."

The recent years reflect extreme weather events



2013/14:
The worst drought in record in Israel



U.K, January 2014

Serbia, May 2014

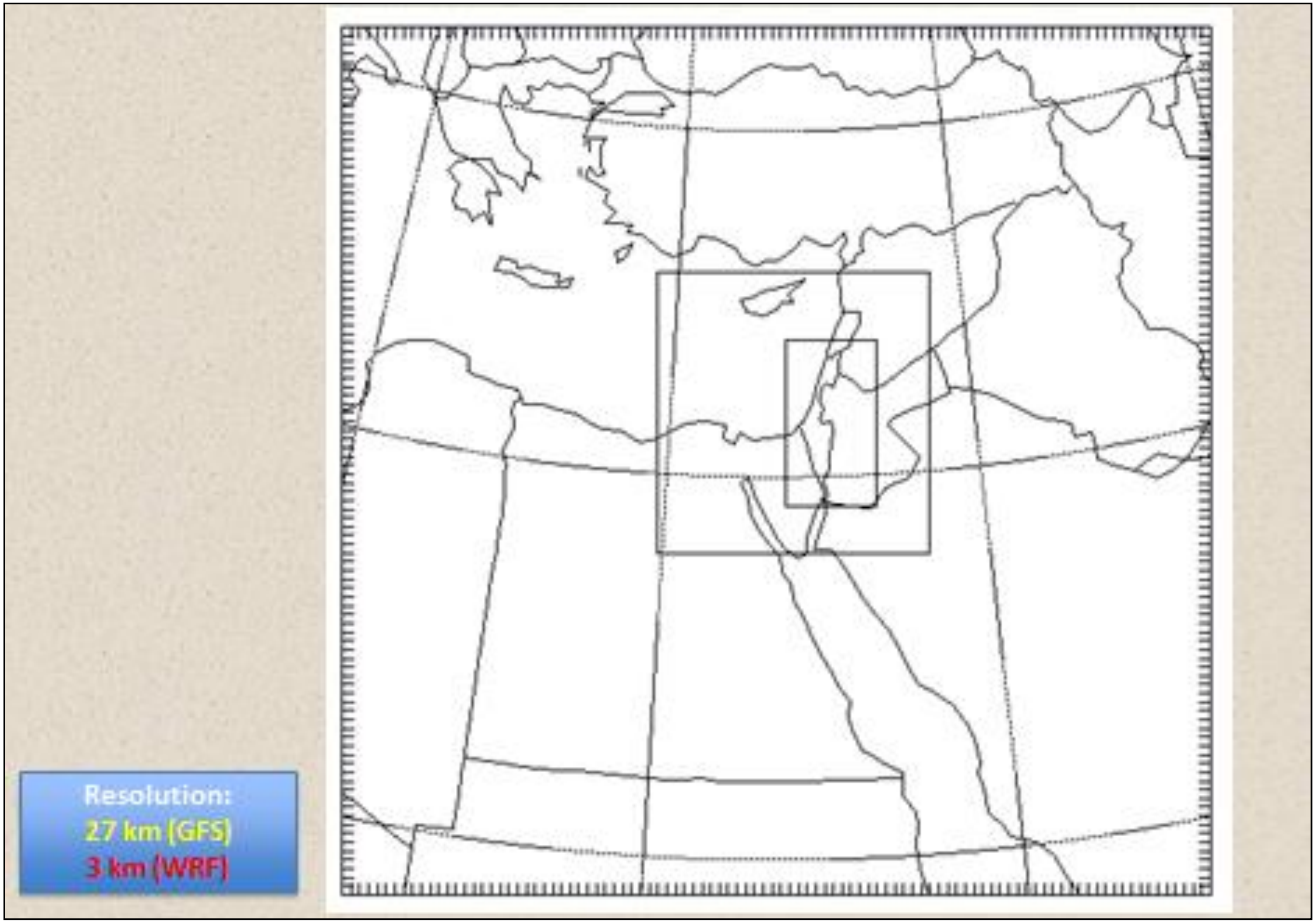
WATER AUTHORITY

Methodology:

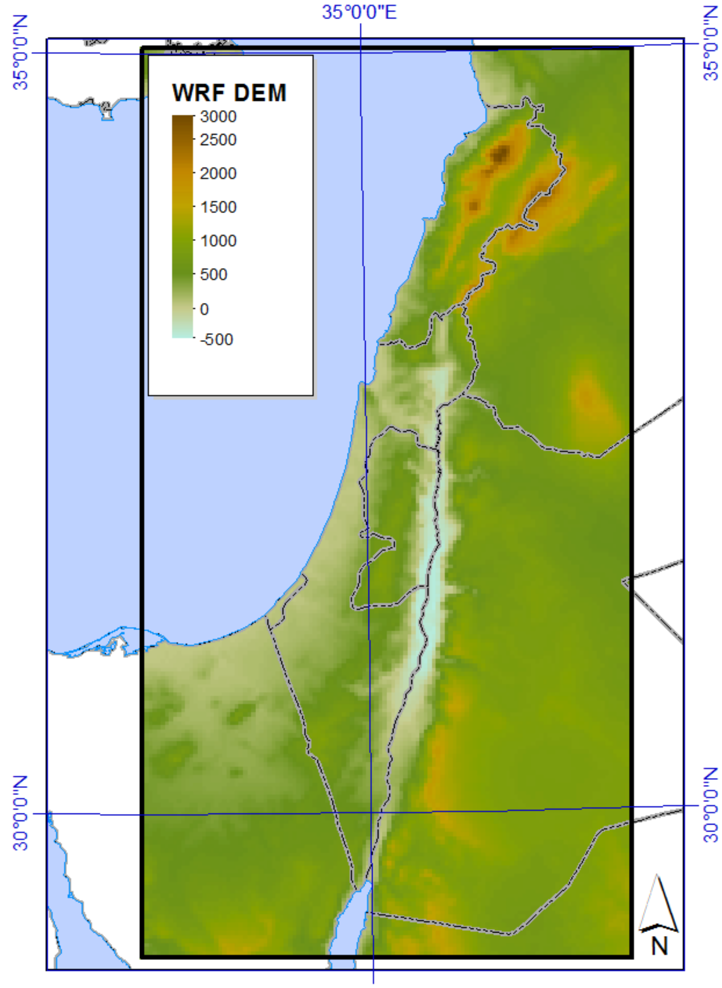
- 2 ways coupling high resolution Hydro-Meteorological modeling (the NCAR WRF- Hydro model)
- 2 runs a day (00z,12z) for 48h in advance
- Using statistics from the Israeli Hydrological Services 120 hydrometeric stations

Nested Grids of WRF simulations at the east Mediterranean
(D2 = 9km, D2 = 3km)

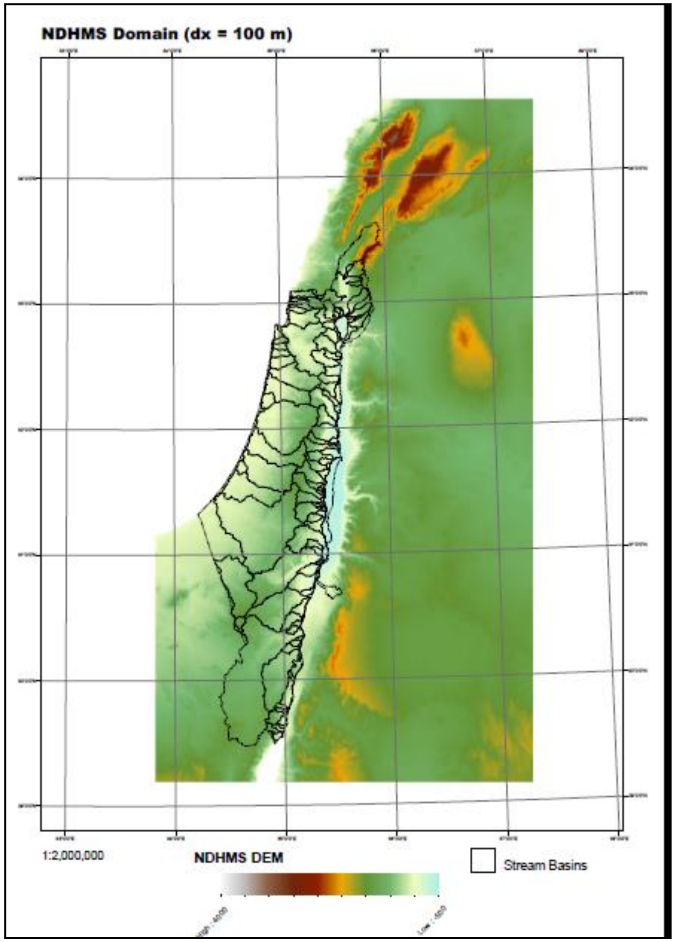
Initial conditions: GFS at 0.5 degree, 00Z, 12z



NDHMS – Static Input

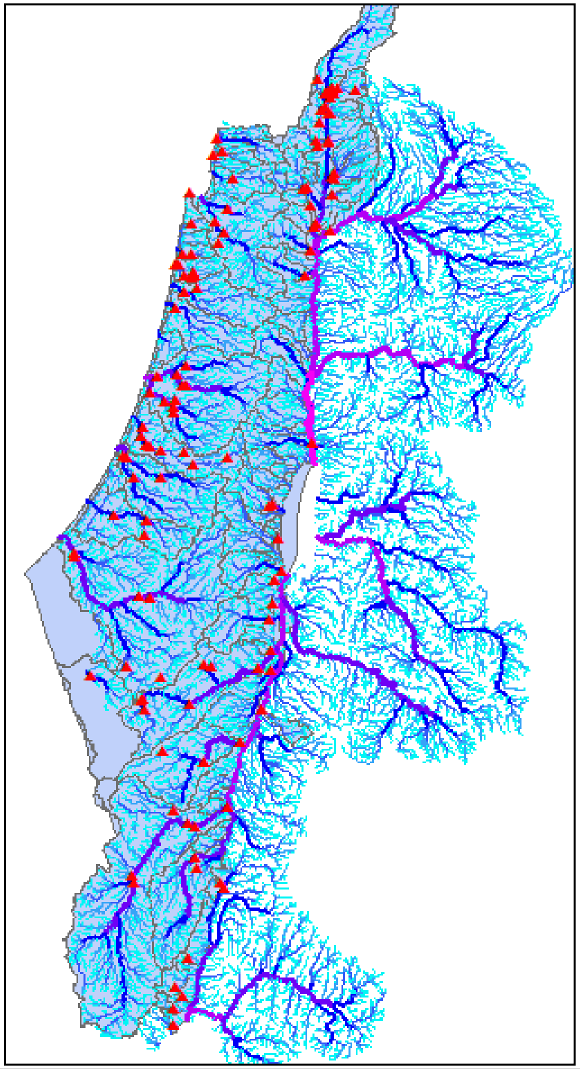


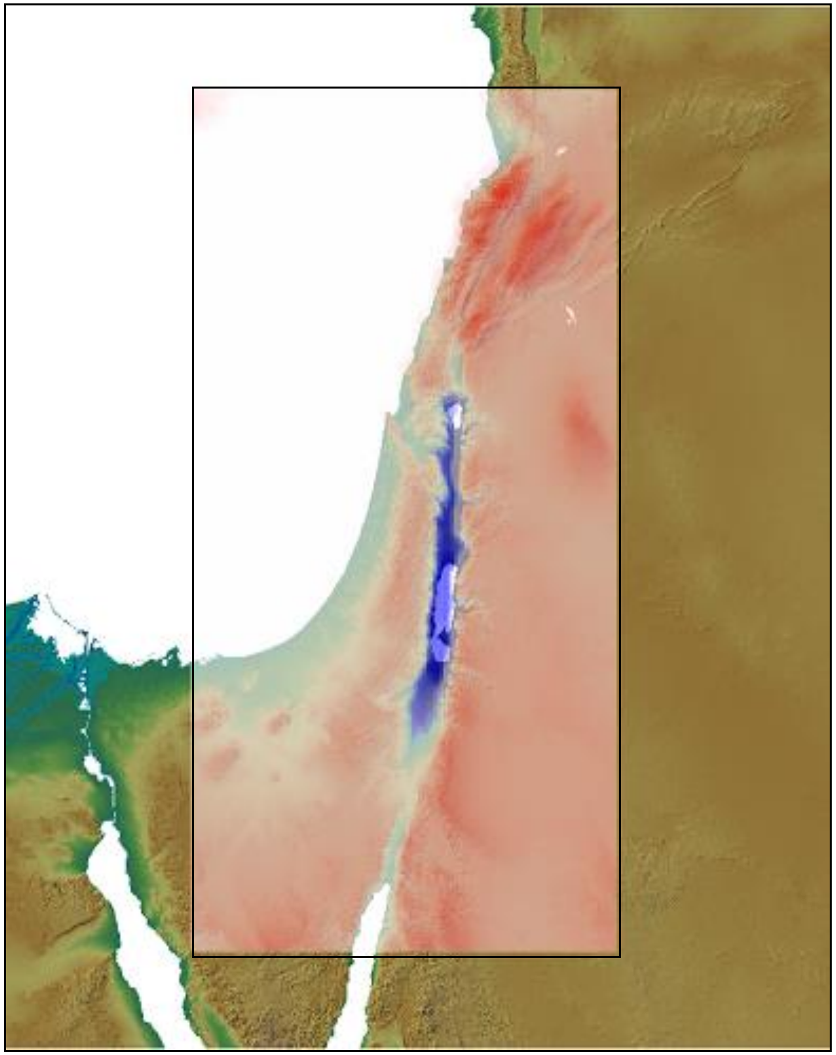
Δx = 3 km



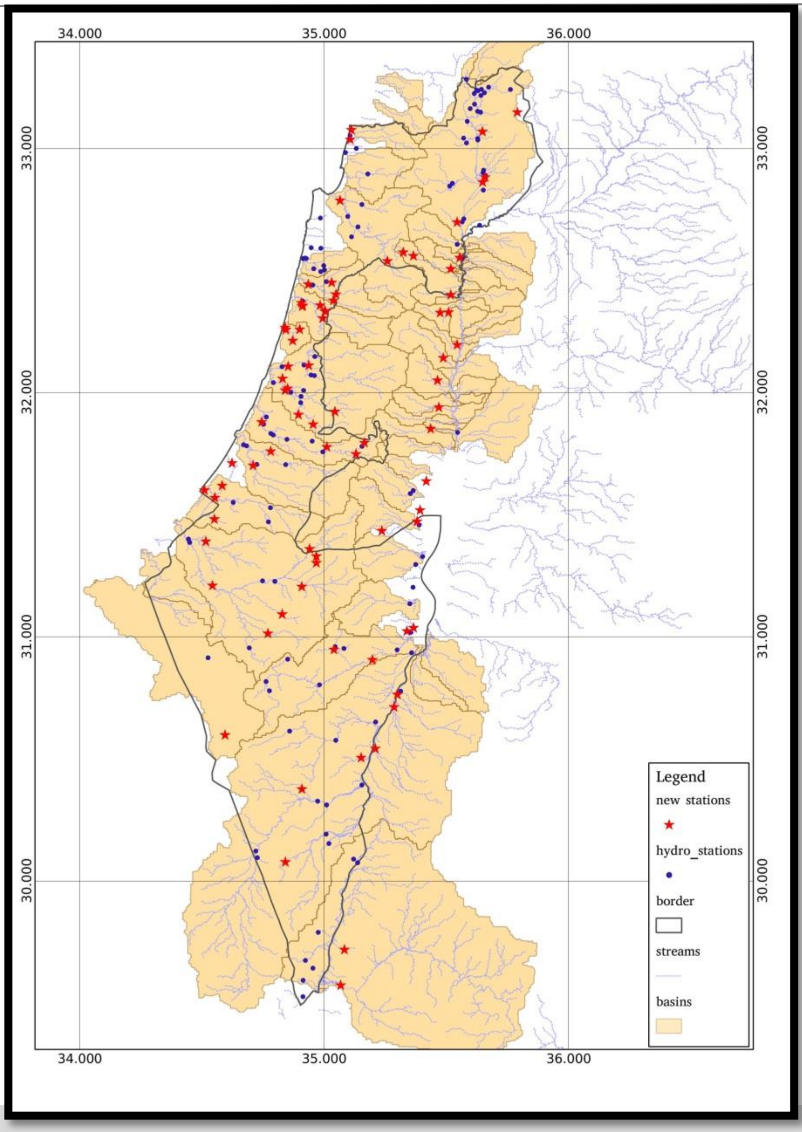
Δx = 100 m

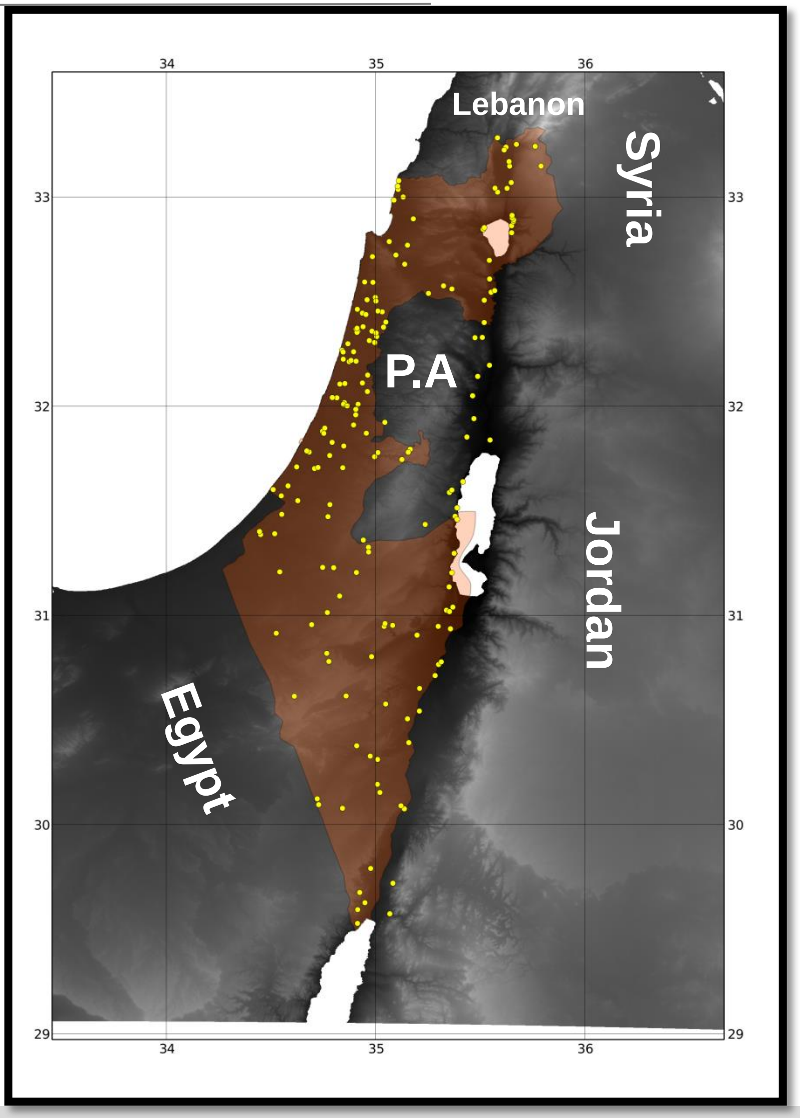
WRF-Hydro – Domain



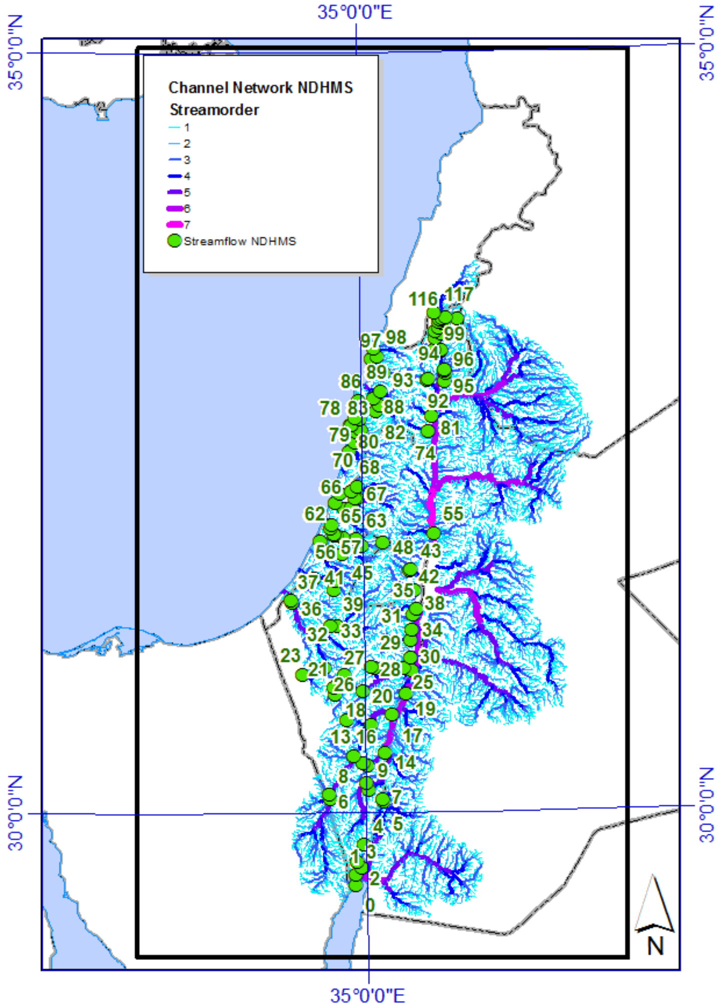


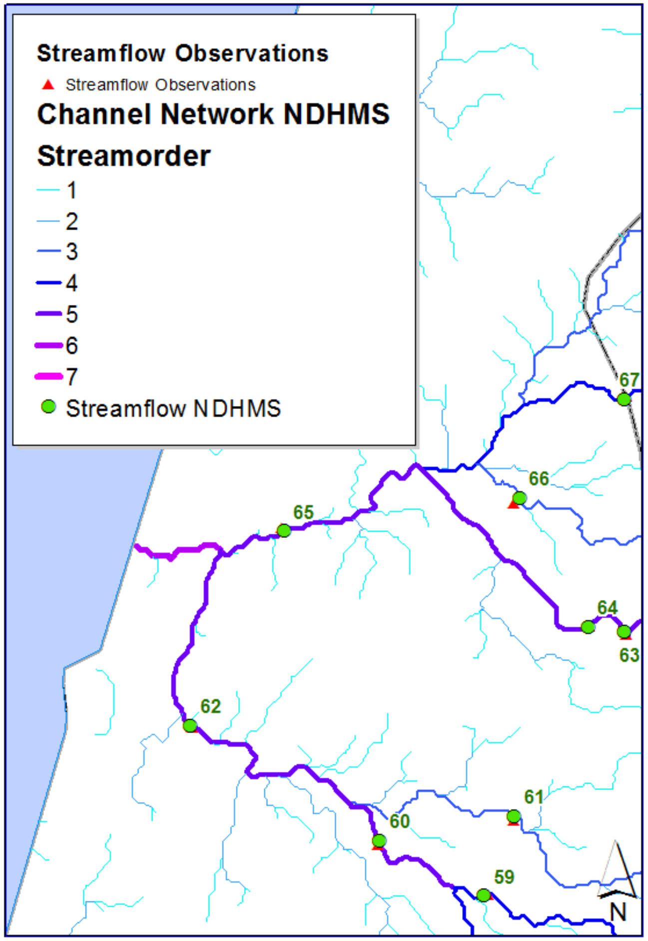
WRF-Hydro – Domain





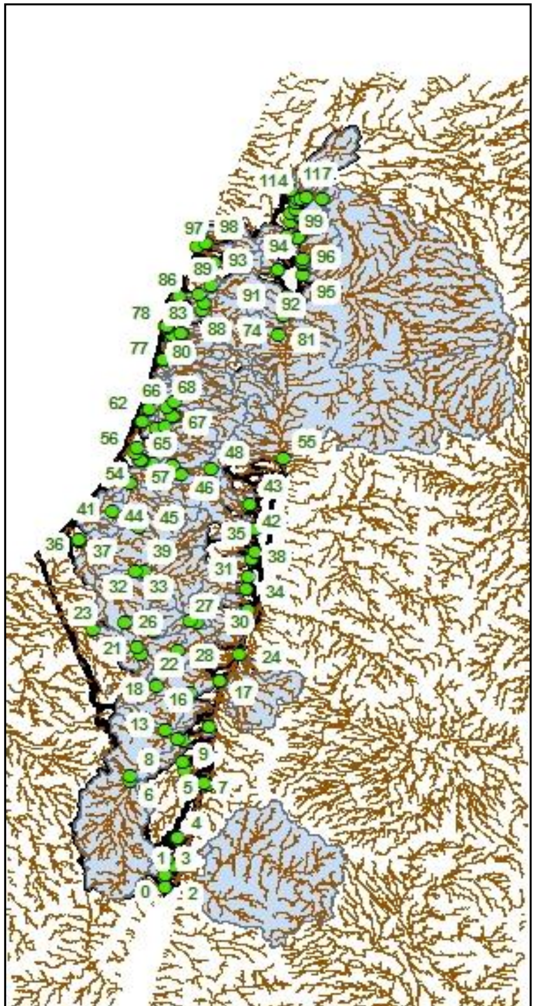
WEF-Hydro – Static Input

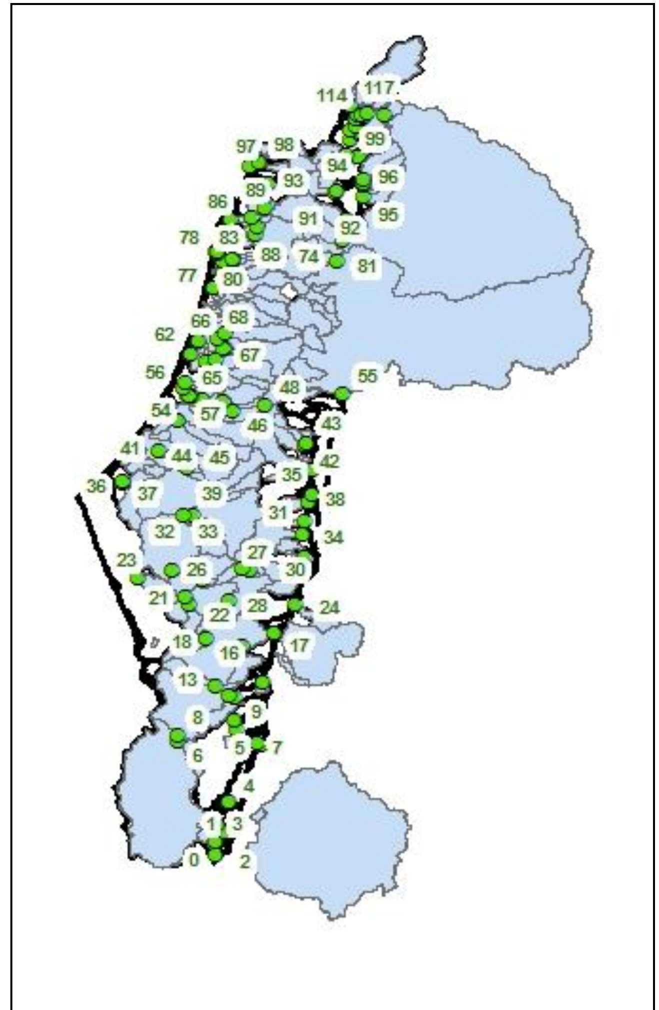




STREAM ORDER

170 locations of the Israeli WRF-Hydro 48 hours operative flood forecasting system

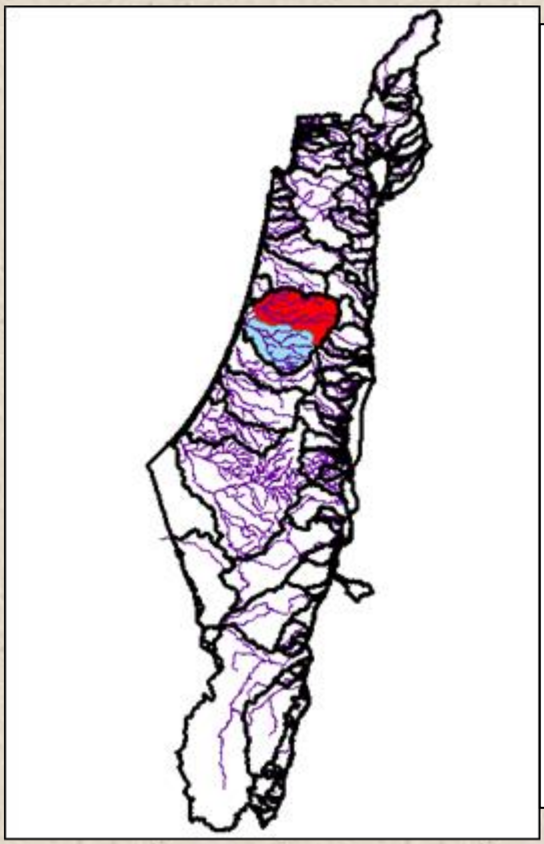


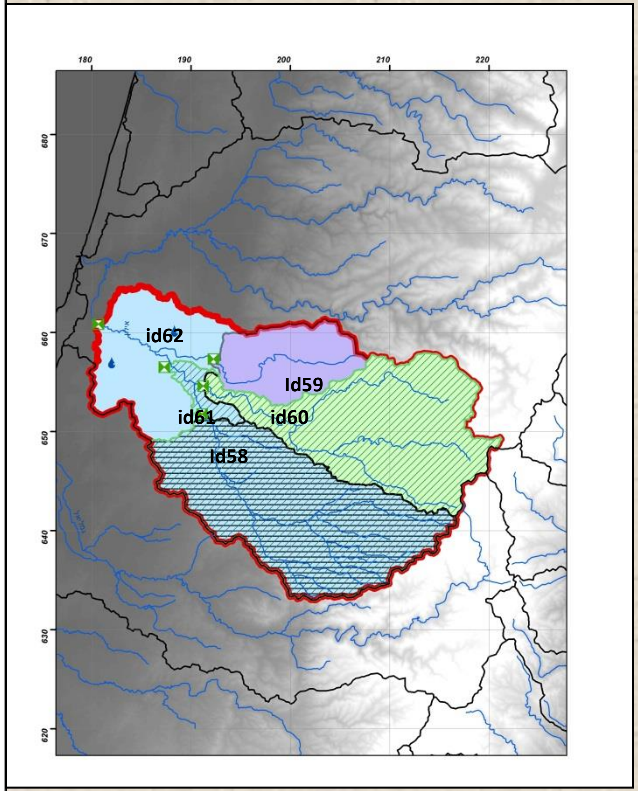


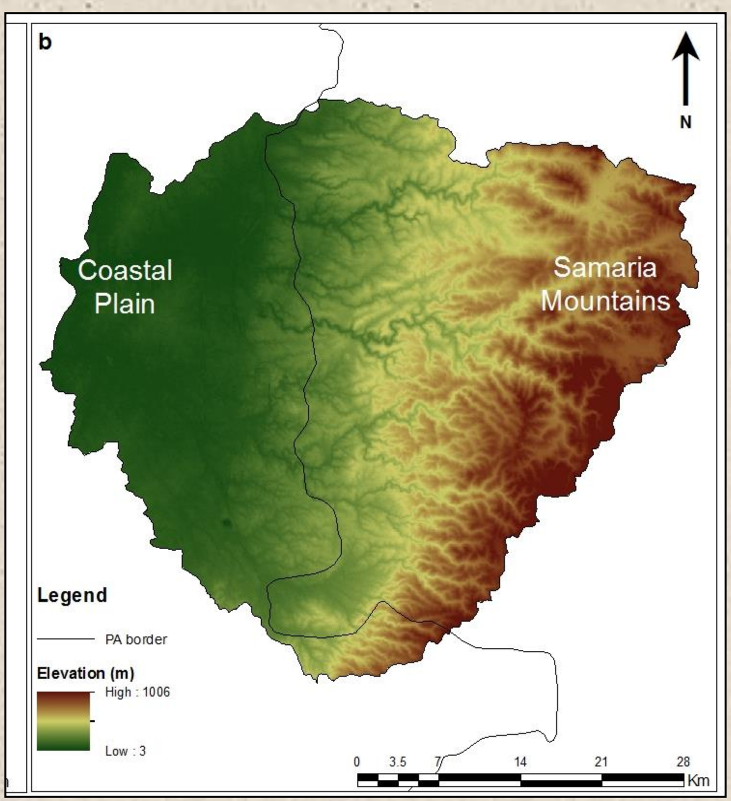
Case studies:
Simulating WRF-Hydro for 5 storms at different magnitude (Exceedance probability)

- 04-10.01.13 (1%-3% at central Israel)
- 30.01 -03.02.13 (3%-5% at the southern cost)
- 10-14.12.13 (2%-3% southern cost)
- 10-14.03.14 (20%-50%)
- 07-08.05.14 (3% at the southern Israel)

January 2013:
Simulation of the 1:100 years flood event in central Israel: The Yarqon-Ayalon basin

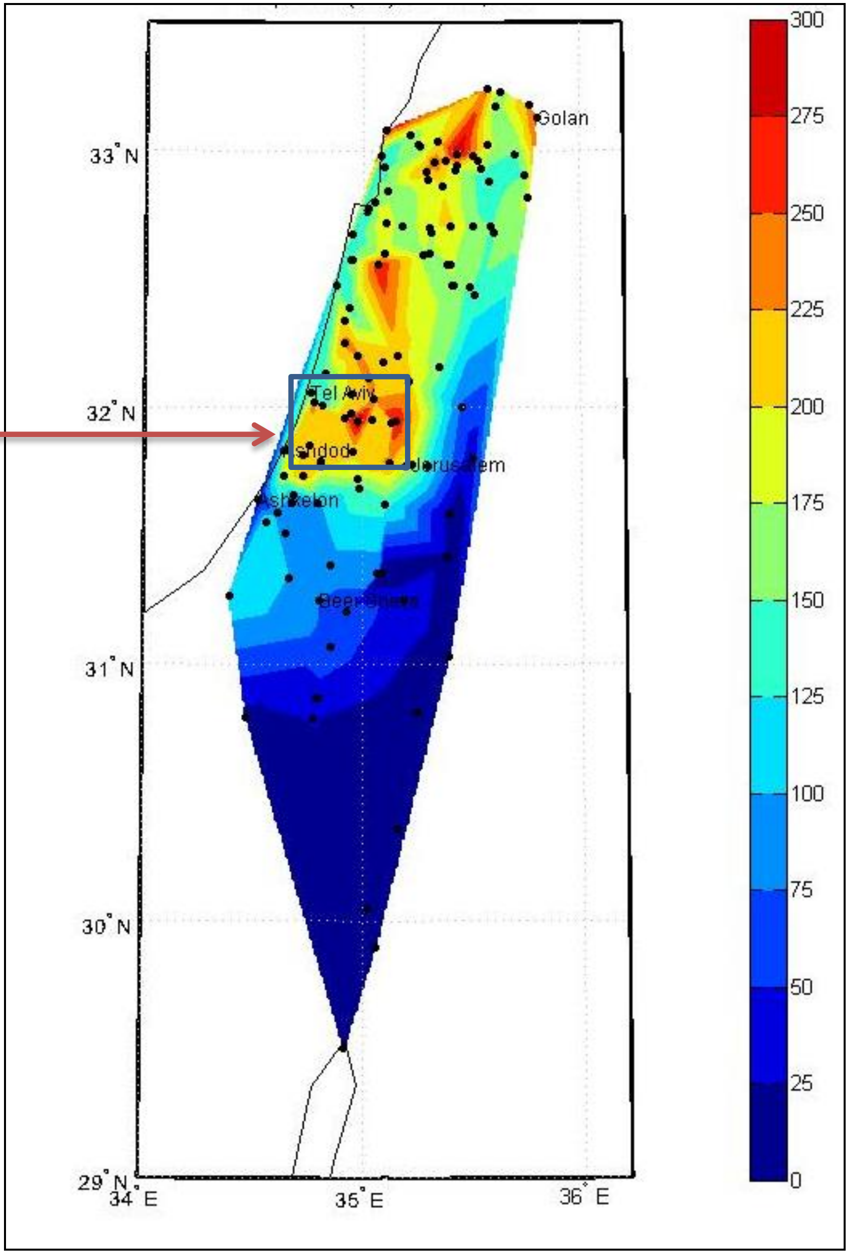






Total measured precipitation (over 120 rain gauges) at the 04-10.01/13 storm

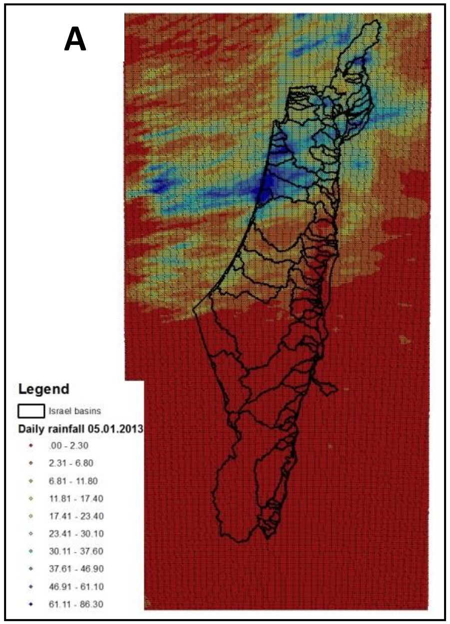
Yarqon-Ayalon basin



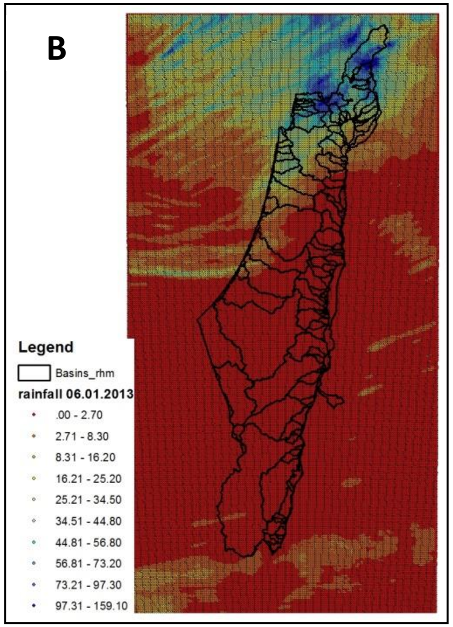
Analysis for the January 2013 major storms:
Flooding in Central Israel
(return period of 1:100 years)

Observed daily precipitation from over 100 rain at the 05/01/13 (A), 06/01/13 13 (B), 07/01/13 13 (C) and 08/01/13 (D)

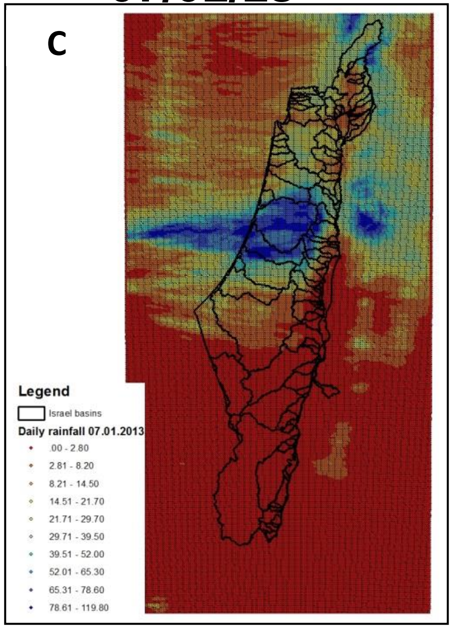
05/01/13



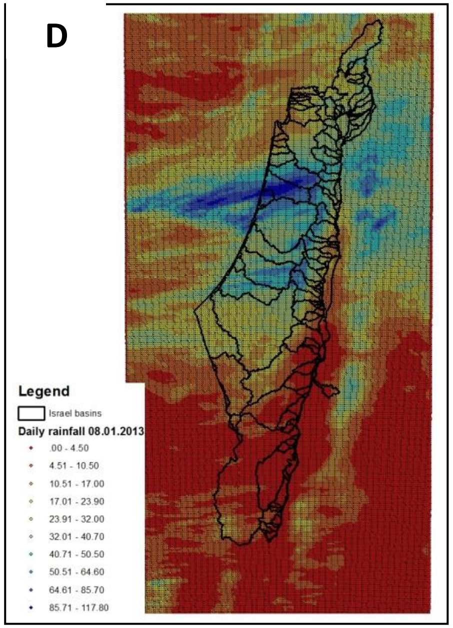
06/01/13



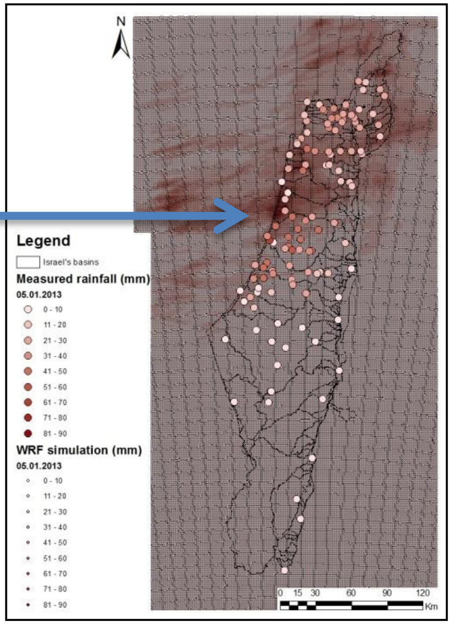
07/01/13

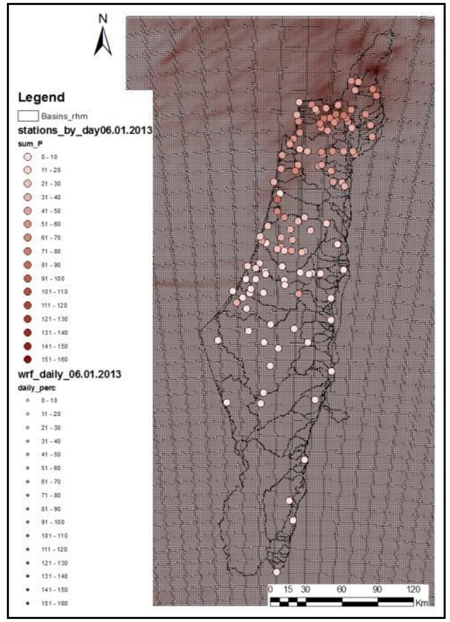


08/01/13

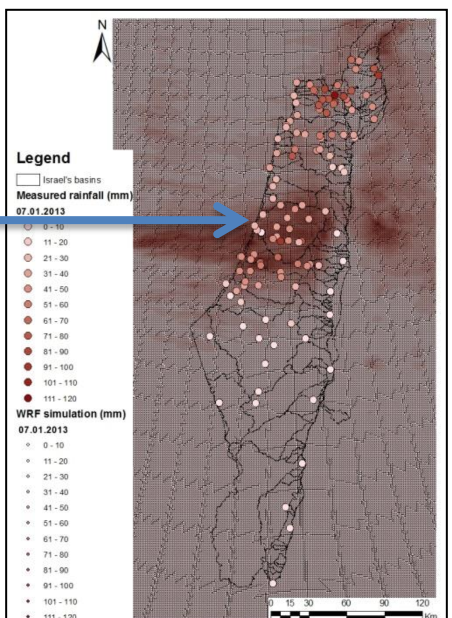


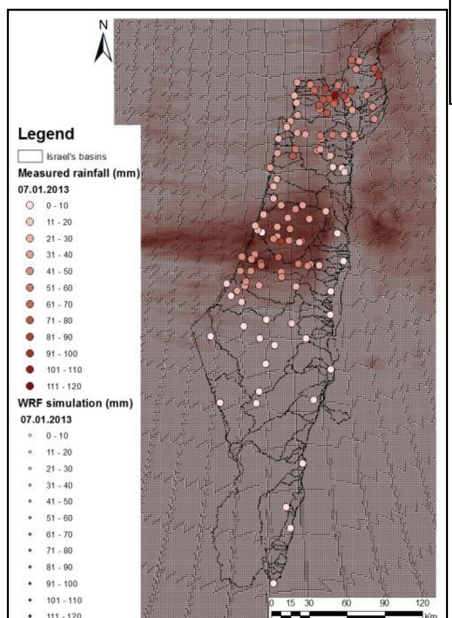
Ayalon





Ayalon

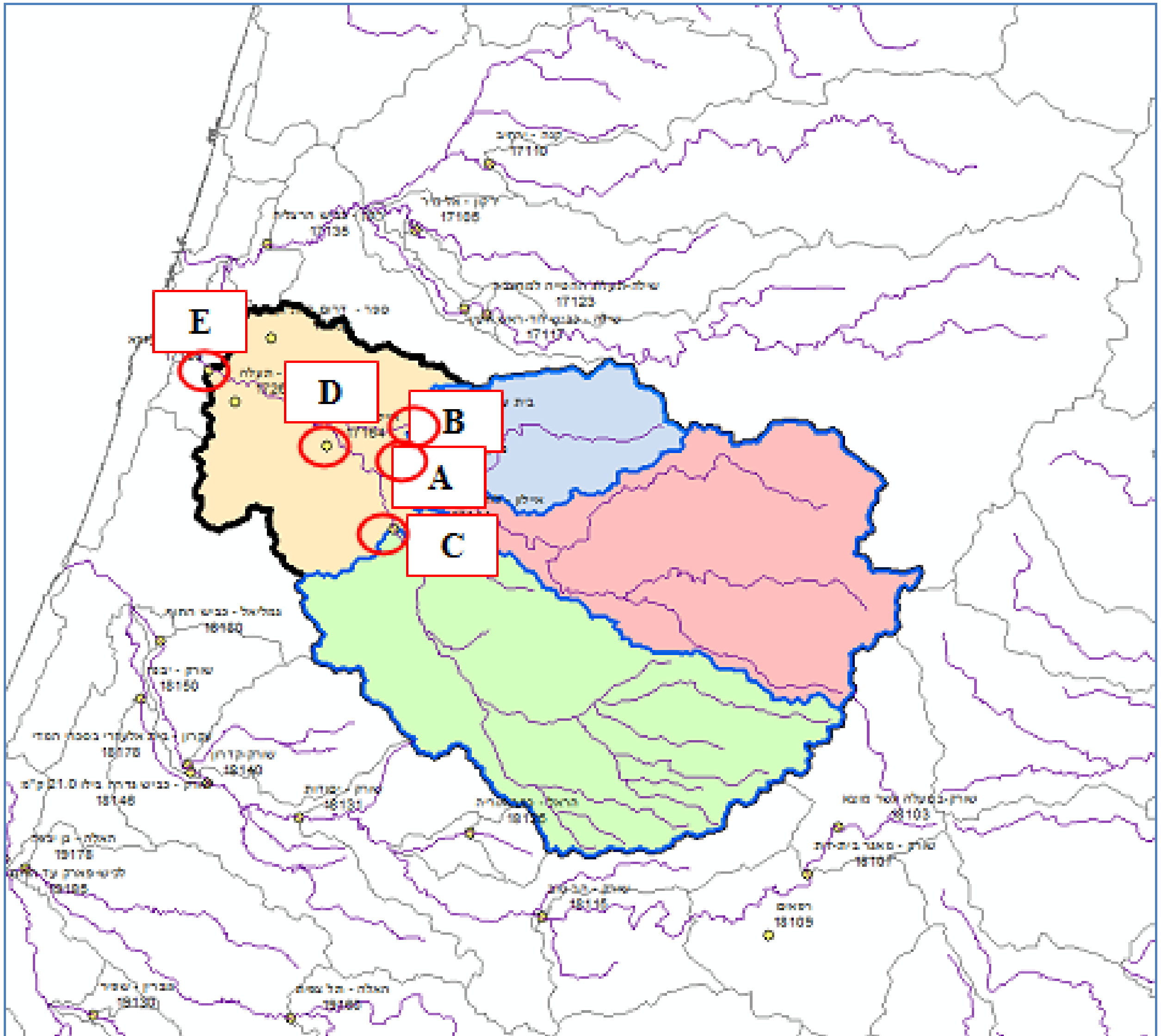




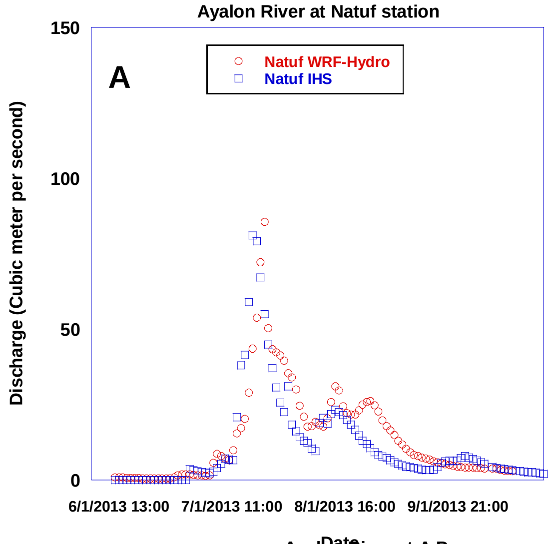
04-10.01.13 :

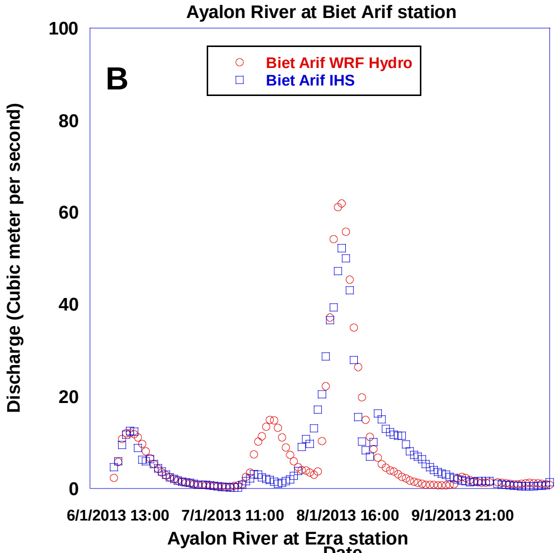
Observed (circles) vs. the WRF simulated daily precipitation (on the background)

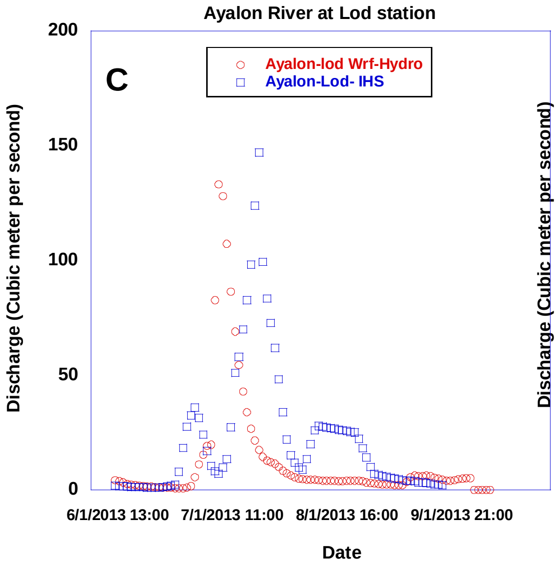
The sub-basins at the Ayalon basin and the locations of the Hydrometric station (in Circles): Natuf (A), Biet Arif (B), Ayalon–Lod (C), Ayalon–A.P (D), and Ayalon-Ezra (E)

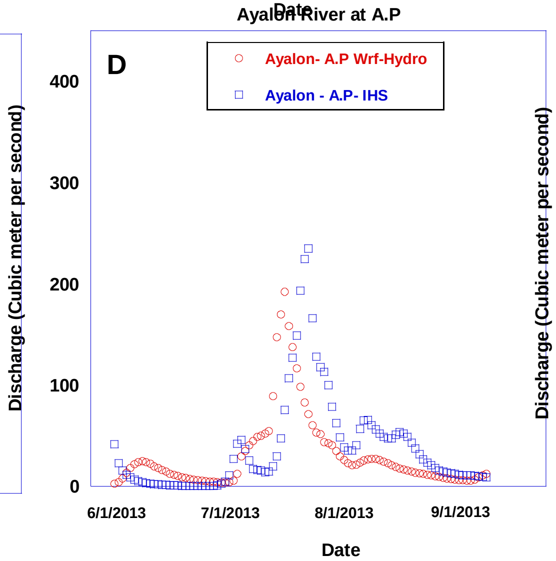


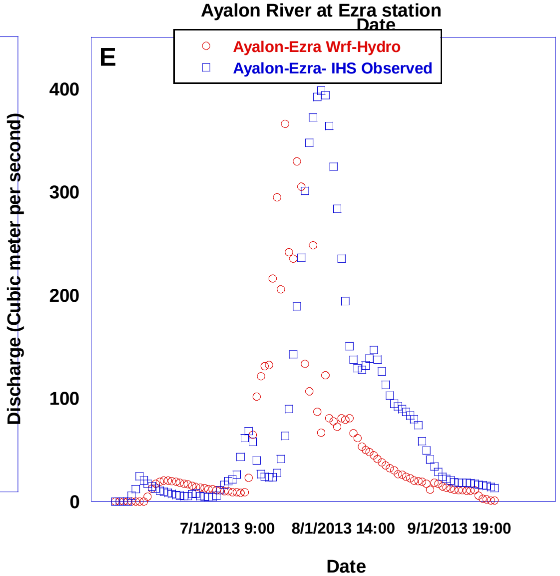
WRF-Hydro Simulated (in red) vs. observed discharge (in blue) for the 5 hydrometric stations at Ayalon basin at the 05-10.01.13 storm





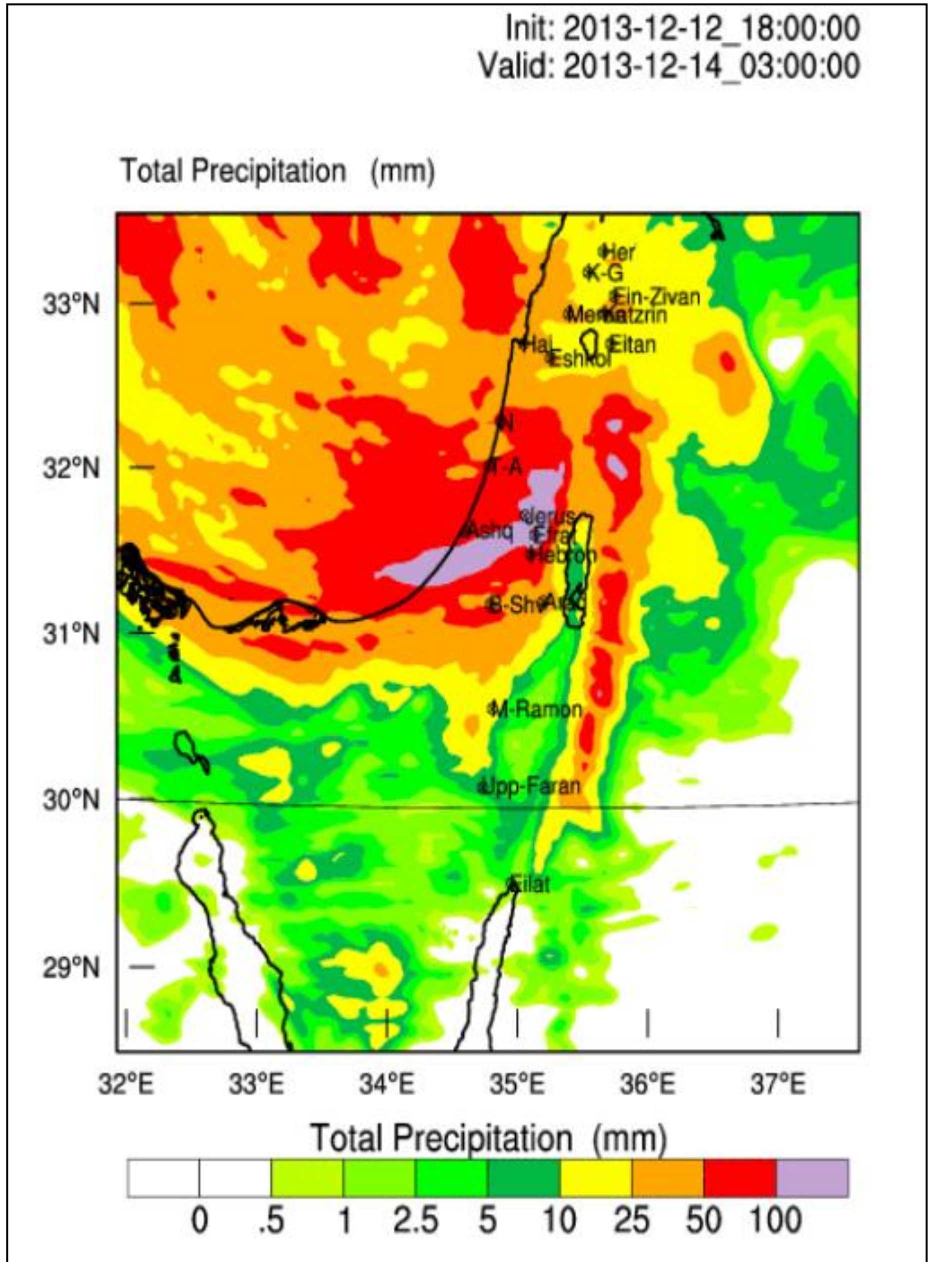




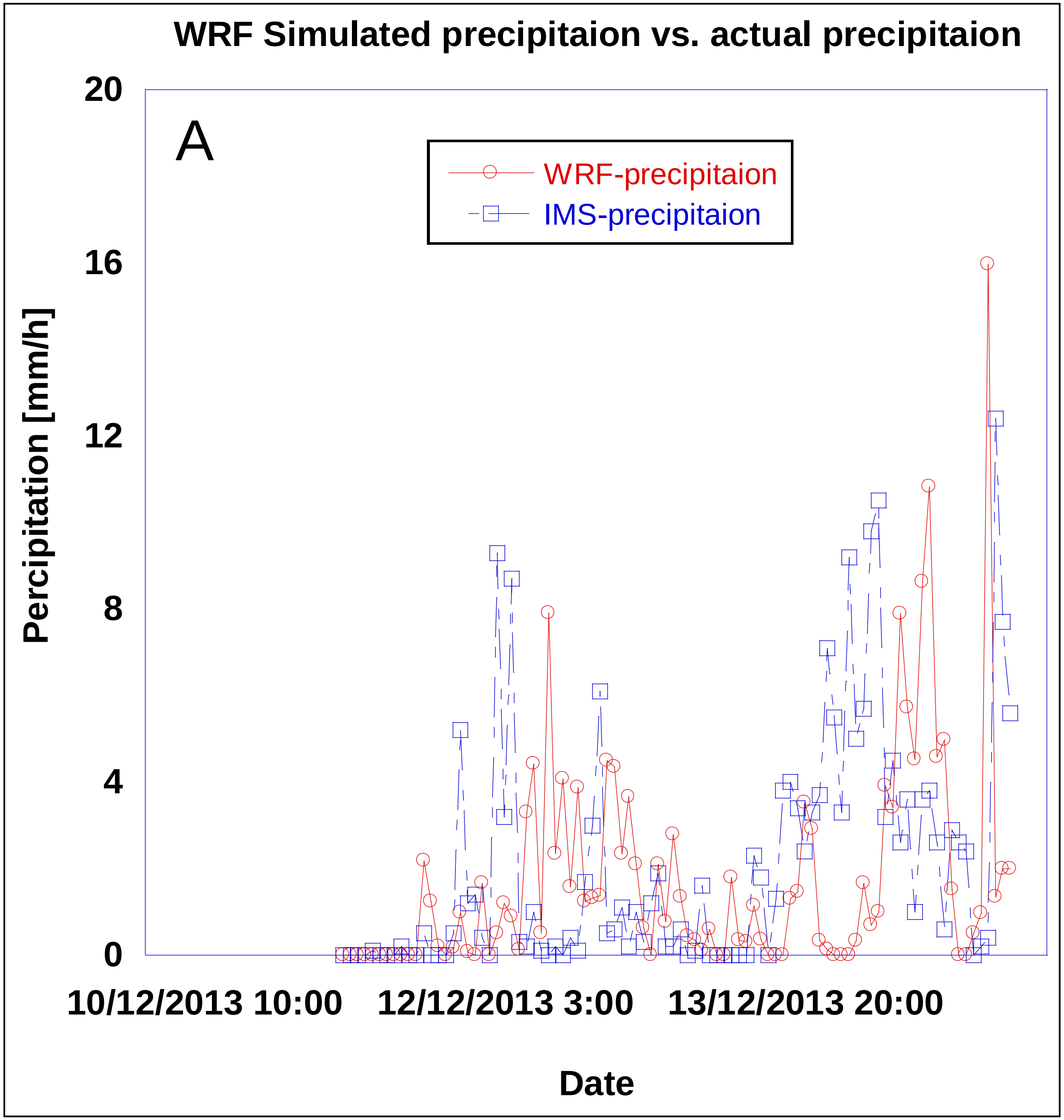


December 2013

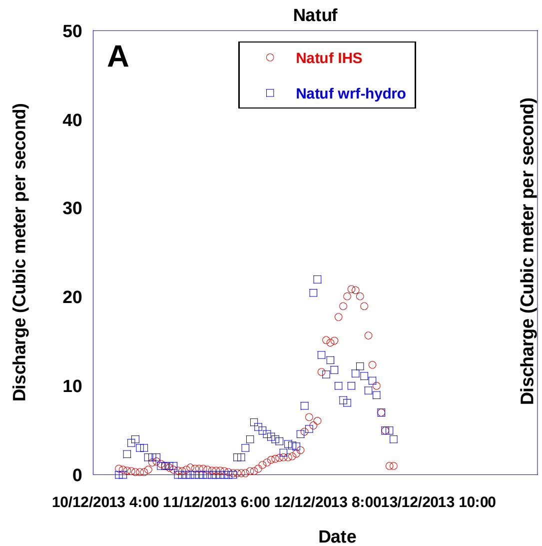
Total storm WRF precipitation

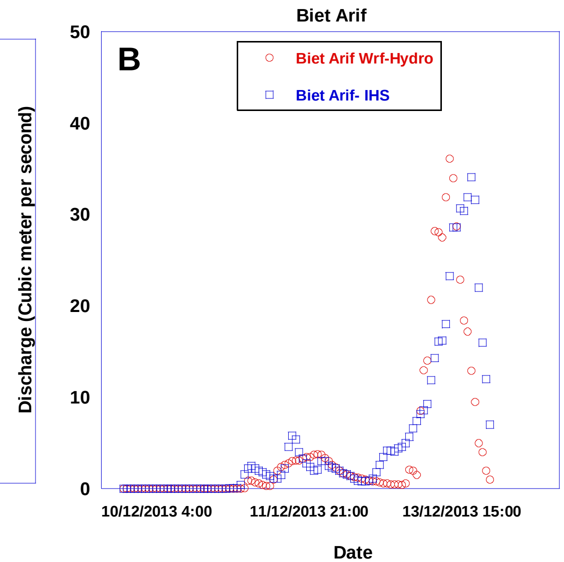


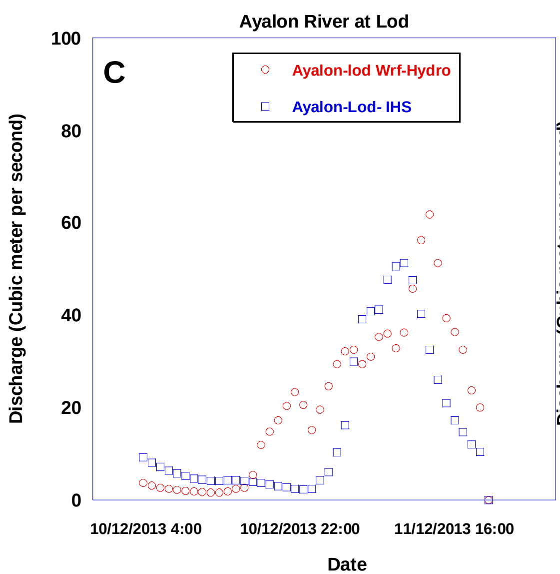
The 10-14.12.13 storm: 180 mm simulated vs. 209 mm observed

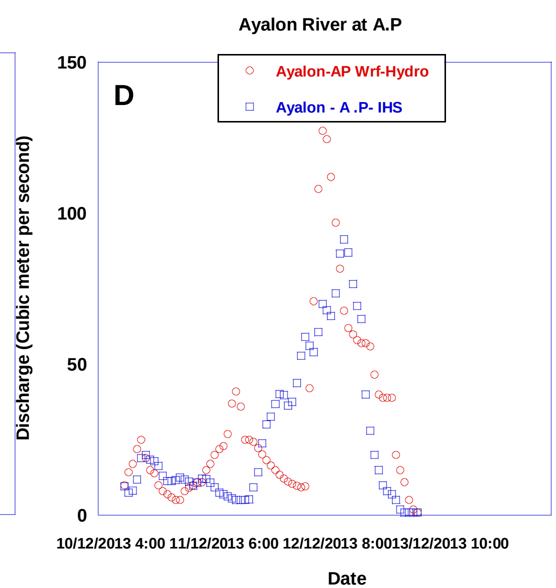


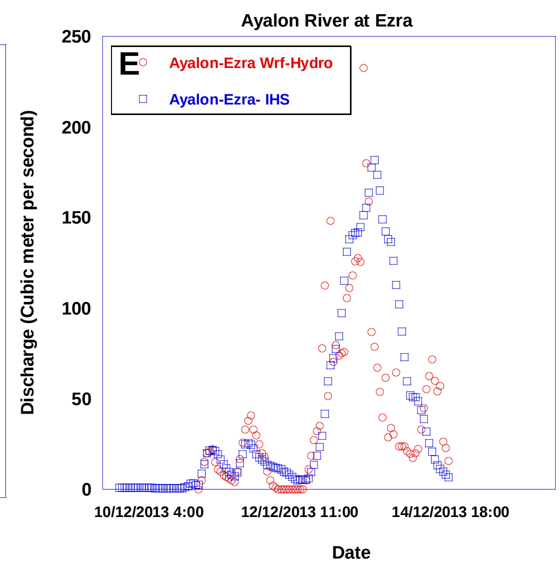
WRF-Hydro Simulated (in red) vs. observed discharge (in blue) for the 5 hydrometric stations at Ayalon basin at the 10-14.12.13 storm





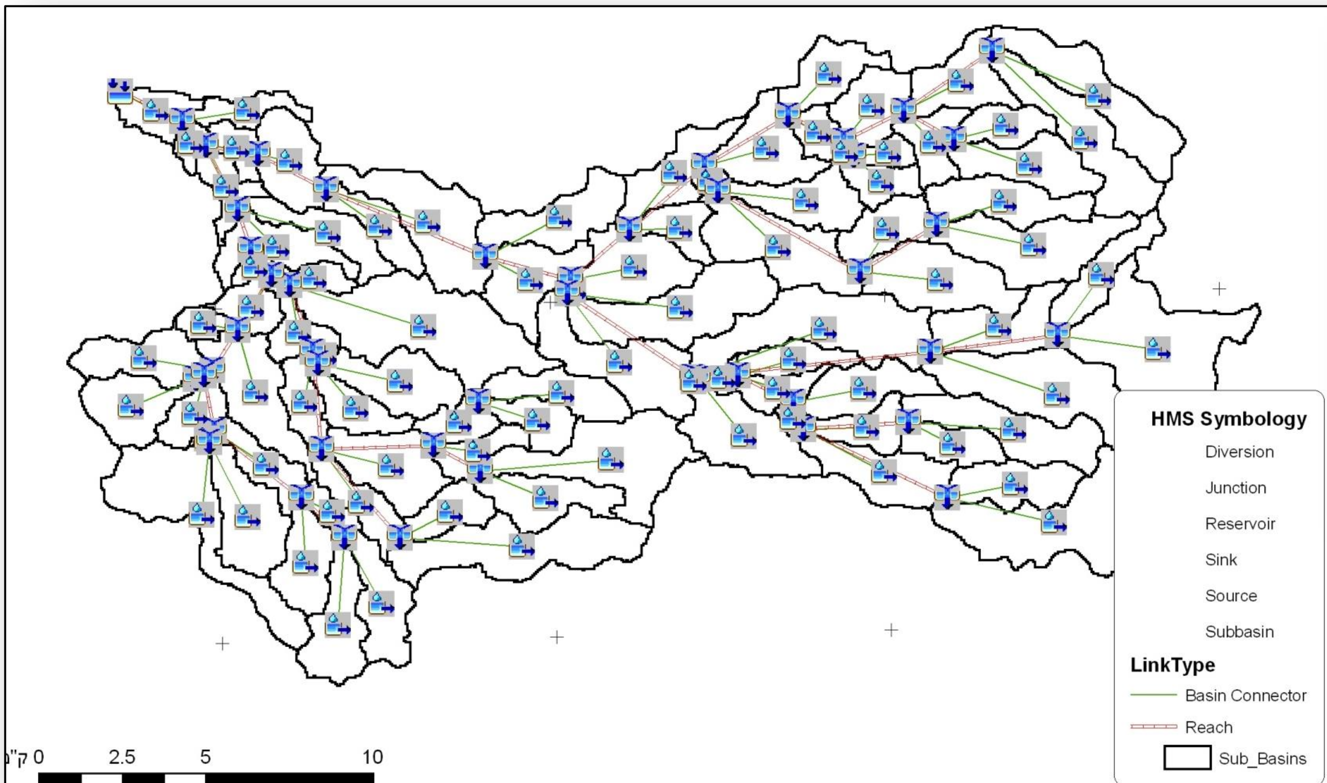


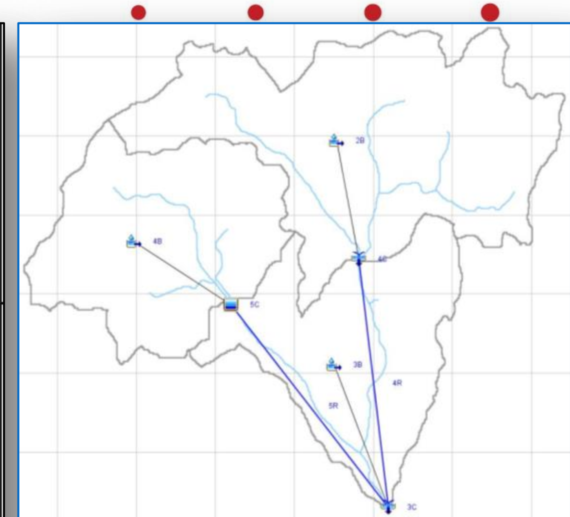




Simulated Hydrographs at the Ayalon basin using measured precipitation

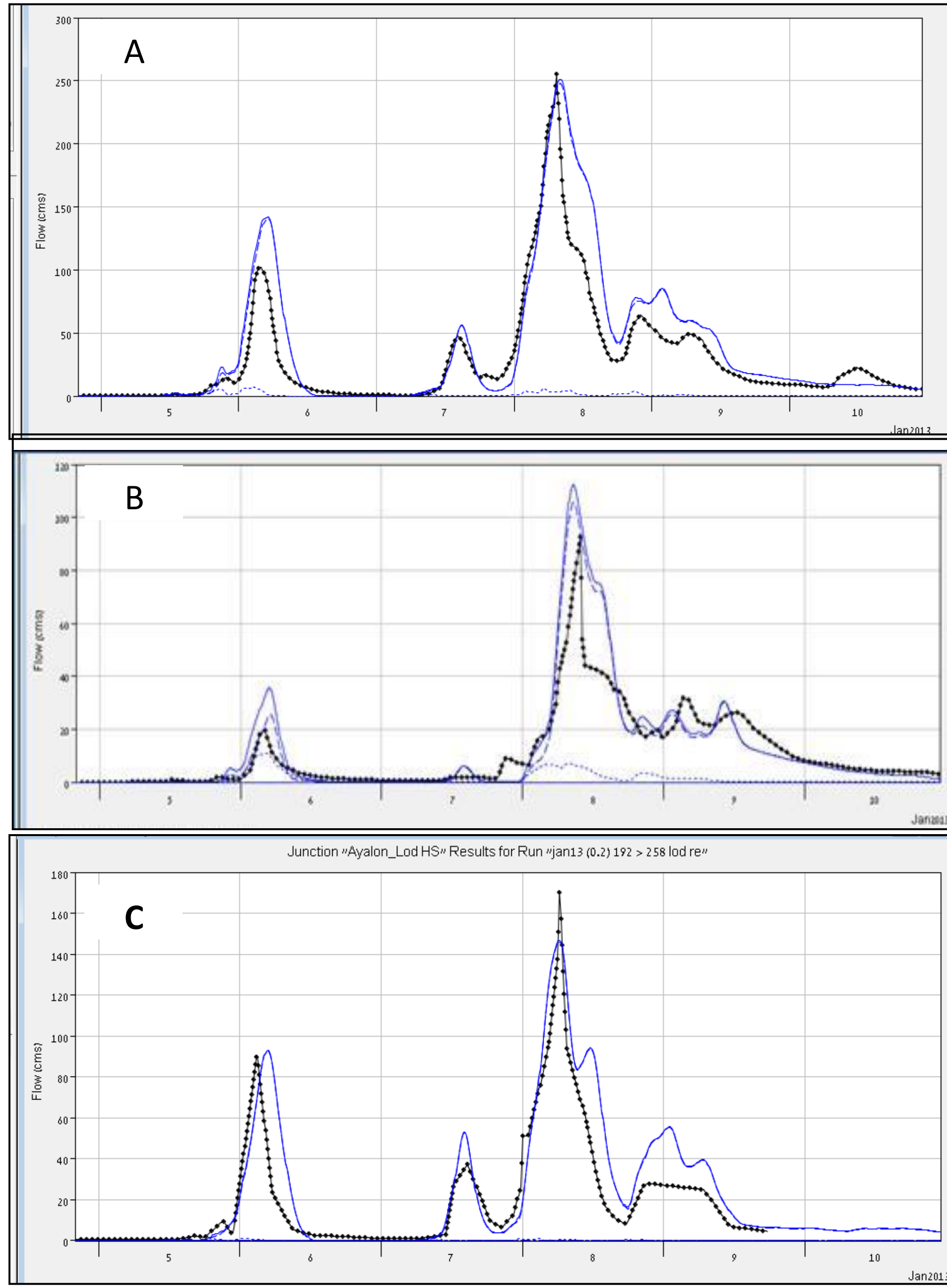
Hydrological model: HEC-HMS

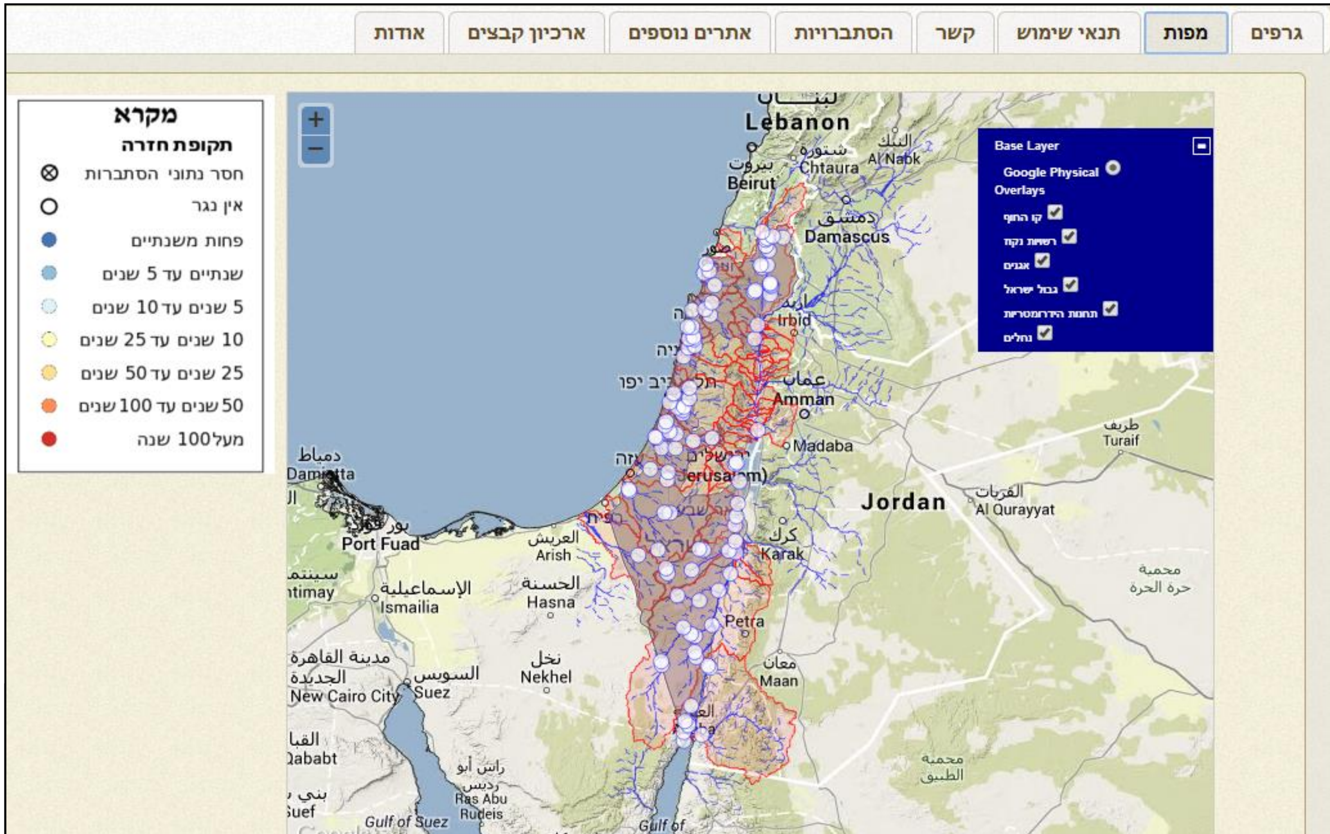




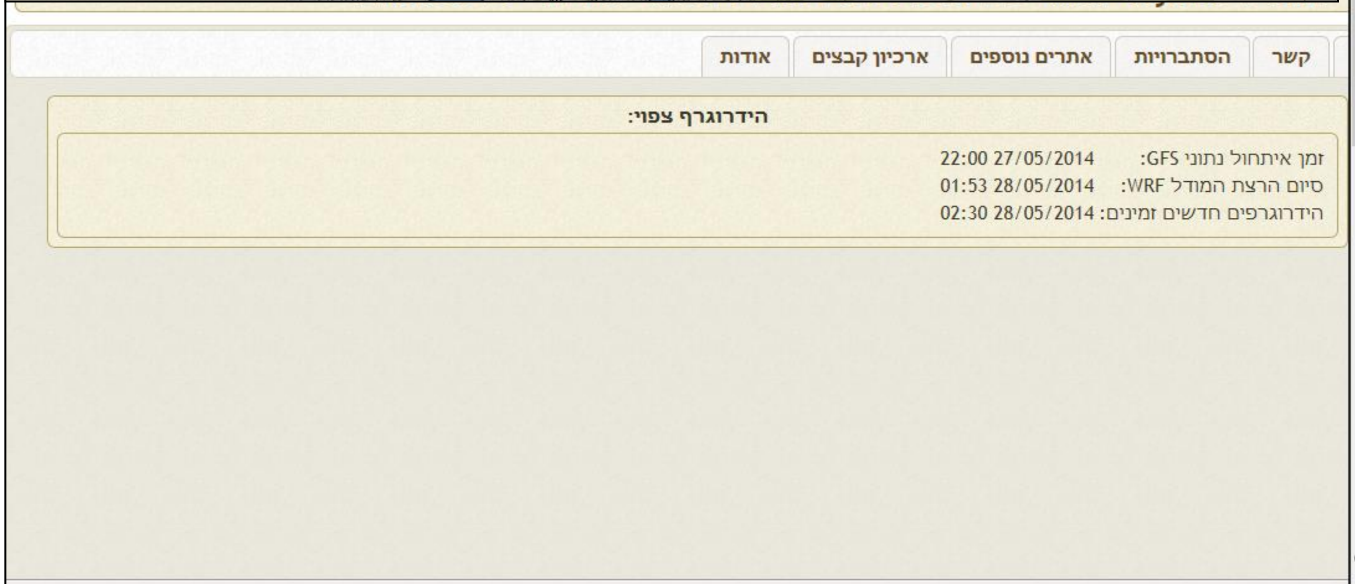
The 04-10.01.13 storm:

HEC-HMS Simulated (in blue) vs. observed discharge (in black) for 3 hydrometric stations at Ayalon basin: Ayalon - A.P (A), Ayalon – Natuf (B) and Ayalon-Lod (C)

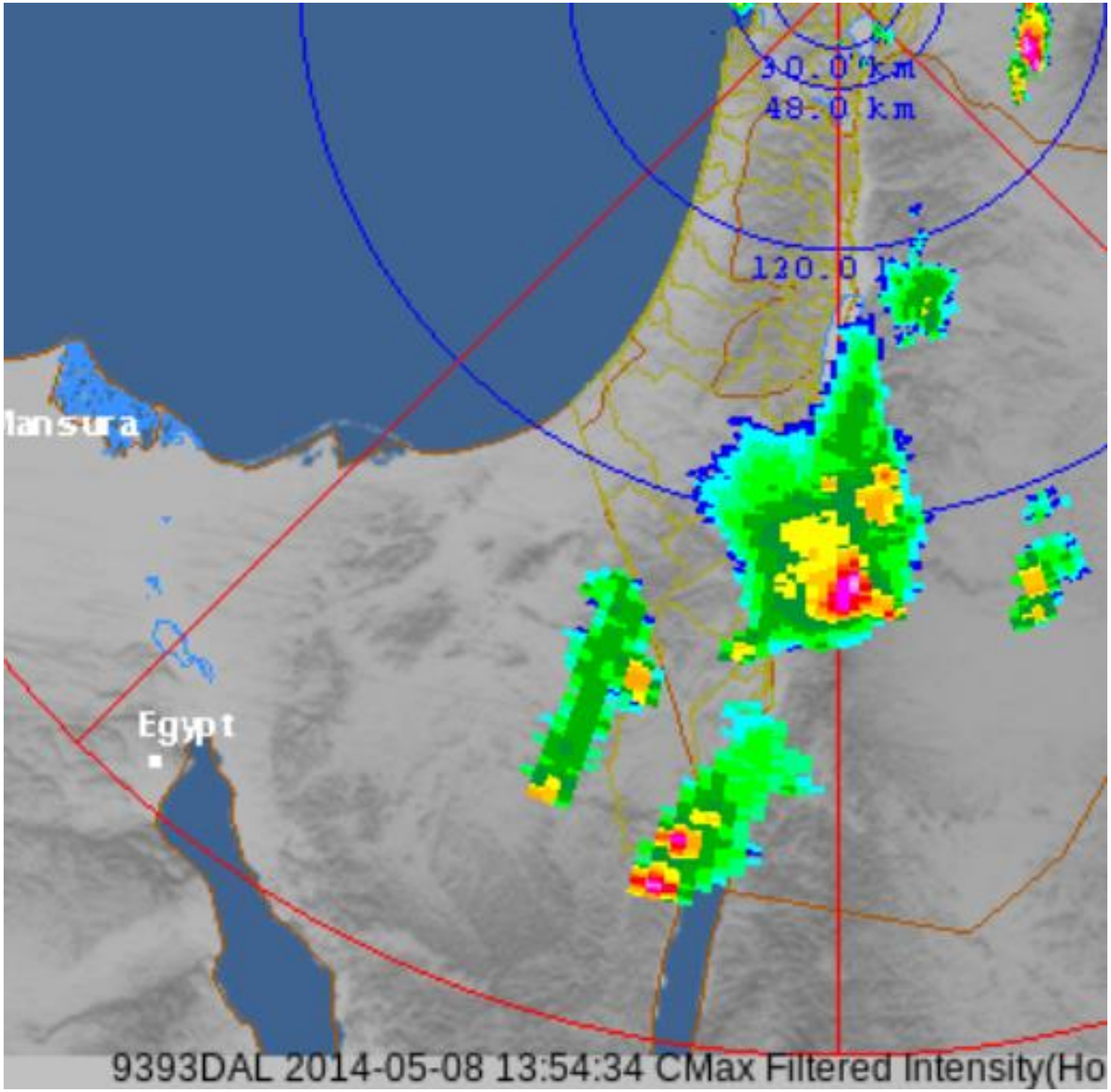




The Israeli Hydrological Service operational WRF-Hydro forecast website: http://maps.arava.co.il/ihs/



Extremely high radar echoes in southern Israel: 08/05/14



Negev desert, Israel

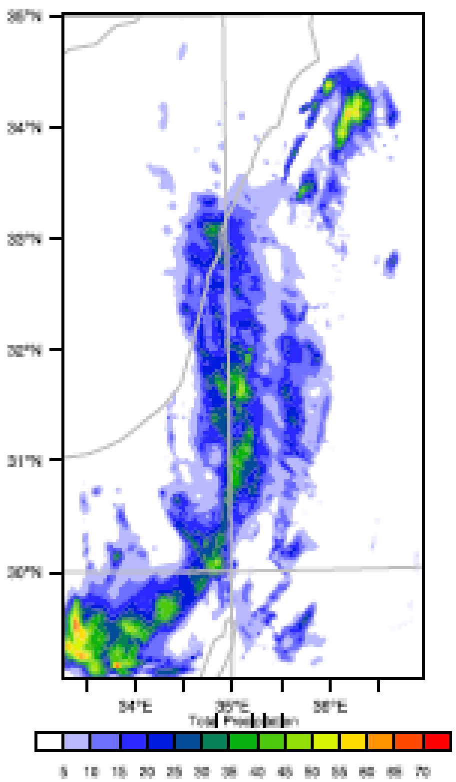
Amman, Jordan

7-8.05.2014 floods events

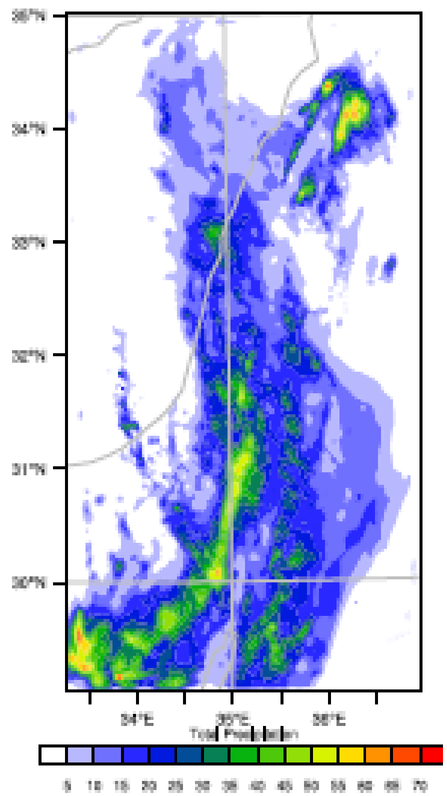
WRF simulated precipitation

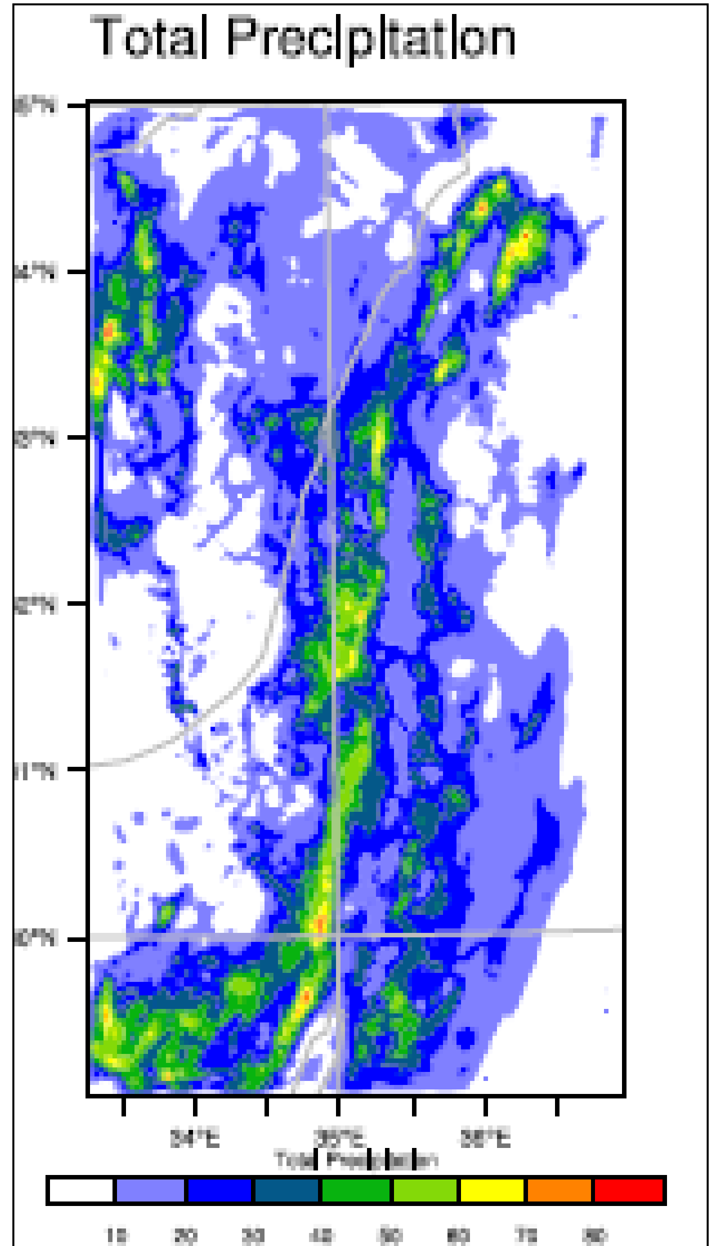
07.05.14 00:00 09.05.14 23:00

07.05.14 00:00-23:00

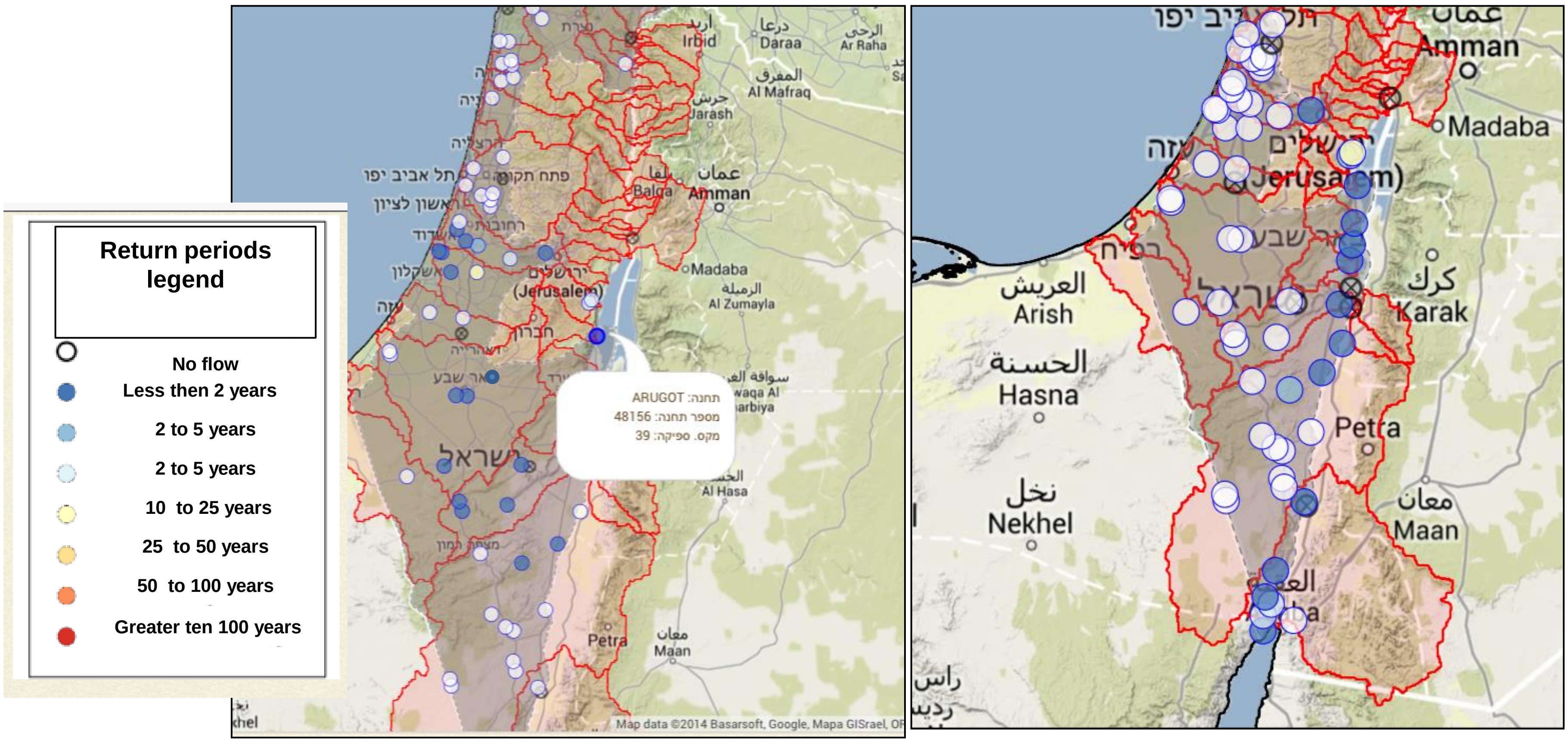


07.05.14 00:00-06:00

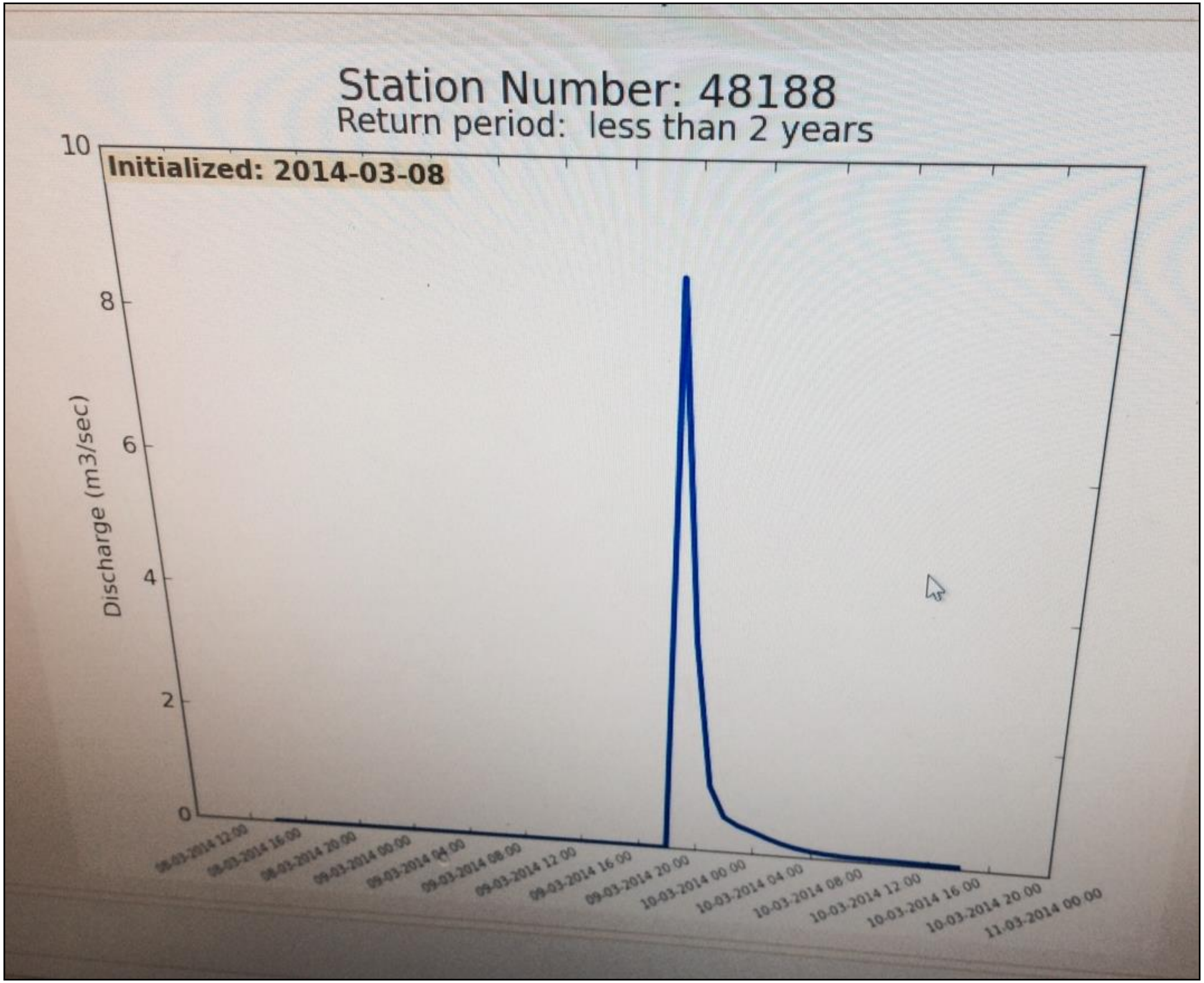




7-8.05.2014 floods events:
Map of predicting peak discharges



48 hours in advance predicted hydrograph: Judea desert



Summary

- The WRF-Hydro was able to simulated the hydrographs extreme flood events in Israel (in time and space).
- Using initial conditions based on ensemble of meteorological models (ECMWF in addition to the GFS, GEFS) may improve the input to the model and so the hydrological simulations (multi-model ensemble provides a better indication concerning the occurrence, intensity and timing of the two observed discharge peaks_.
- Using probabilities for floods stages/level based on ensemble can also help to overcome the precipitation accuracy issue.

- Running the WRF-Hydro for climate simulations: Dynamical downscaling of global climate models (initial conditions) to try to better understand the projected changes in the future hydrological cycle (runoff, recharge to aquifers, lakes)