Evaluation of Flash flood Events Using NWP Model and Remotely Sensed Rainfall Estimates

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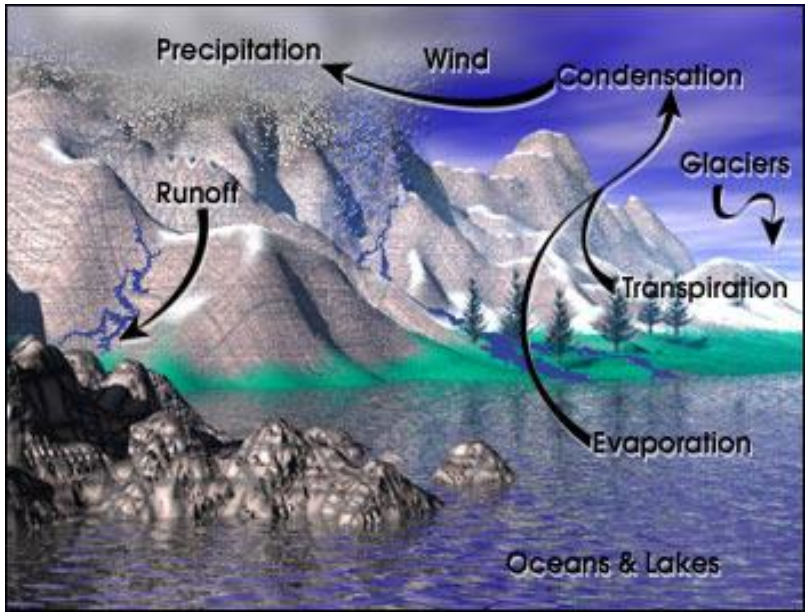
Outline

- Introduction
- Data & Methodology
  - -Satellite, Radar, Station and NWP rain
- Hydrologic Modeling
- Conclusion

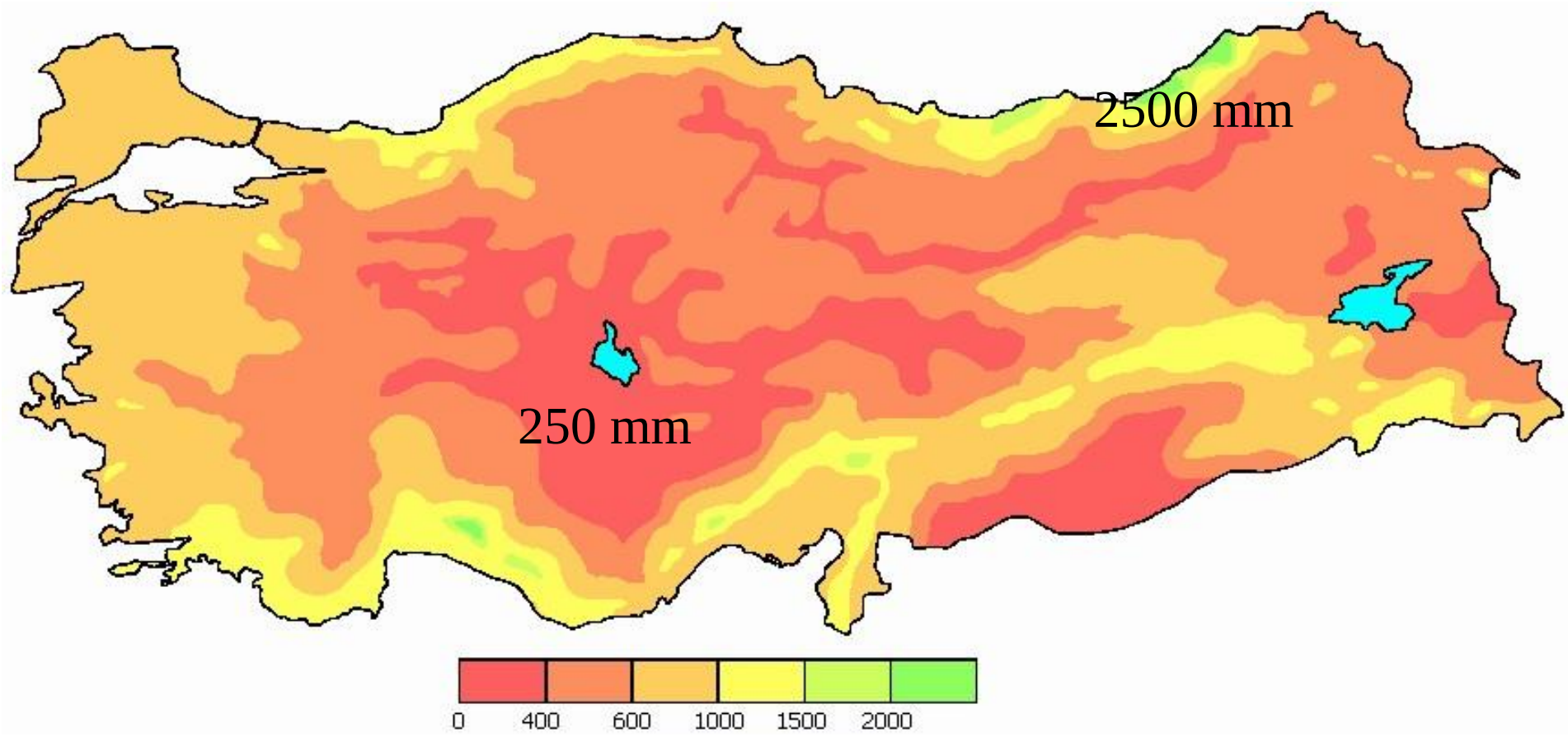
Water and energy cycle

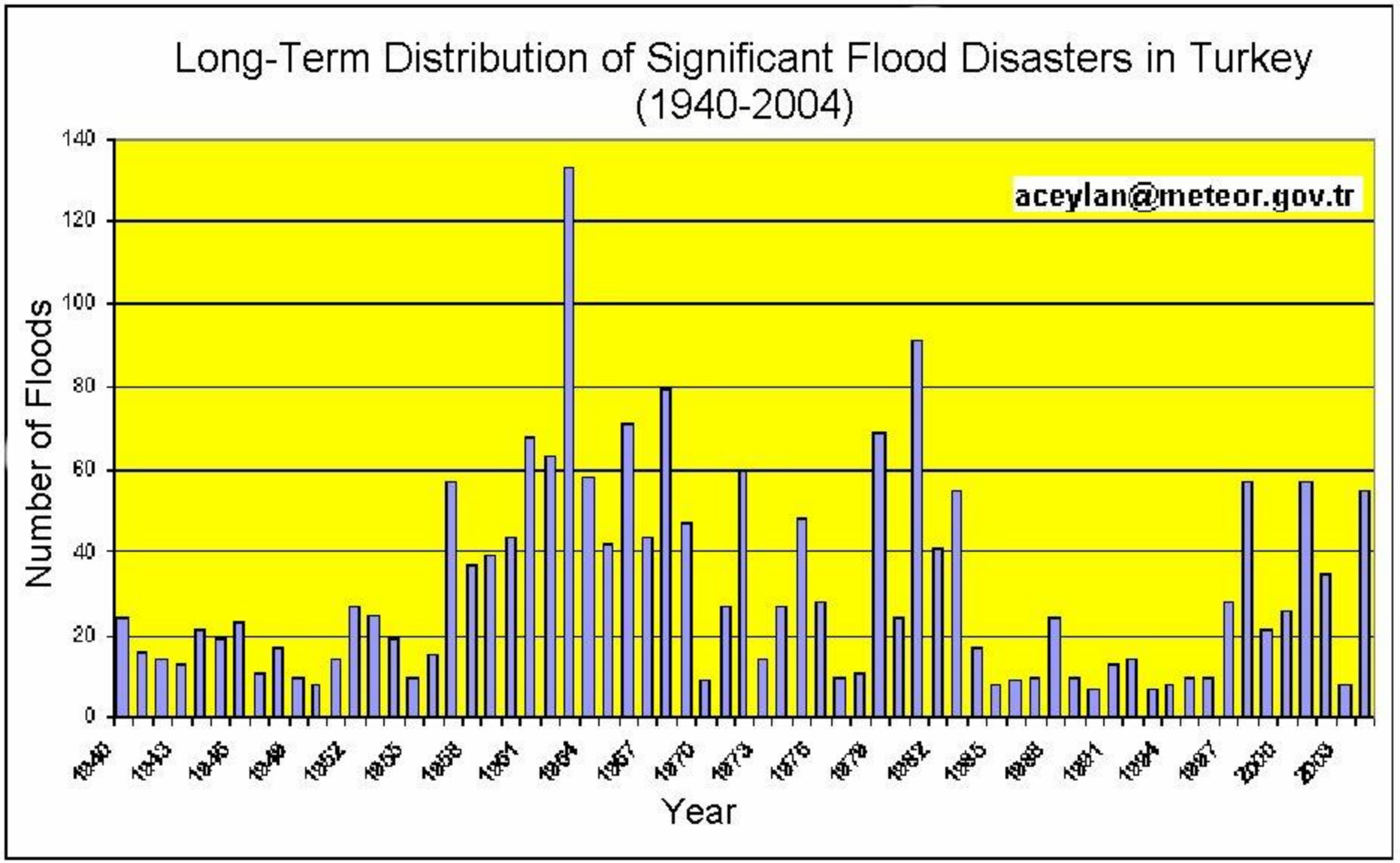


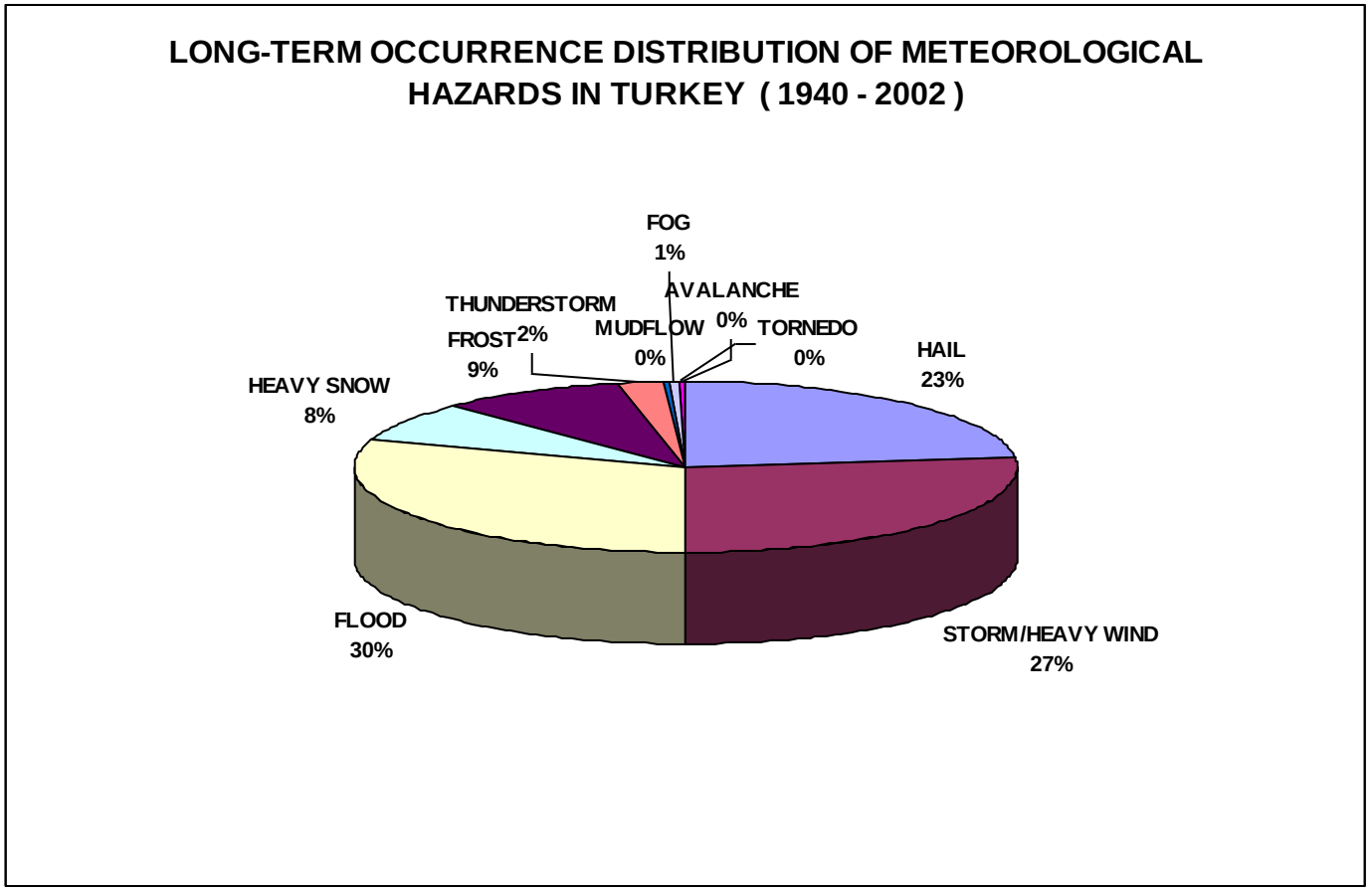
- **Warming climate leads to heavy precipitation events.**

- **This tends to increase the risk of flood events.**

Annual Rainfall Distribution of Turkey

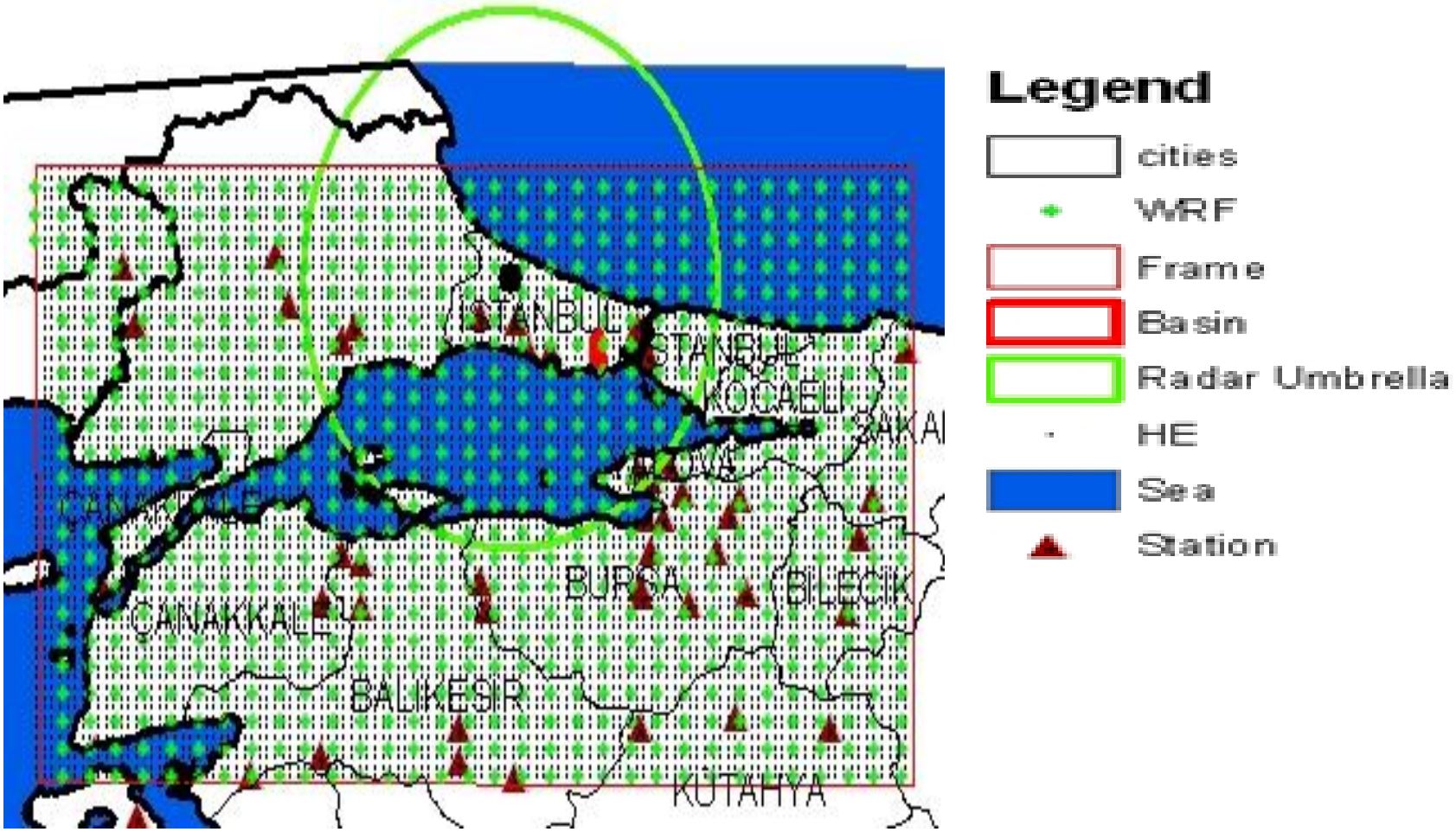



Long-Term Distribution of Significant Flood Disasters in Turkey
(1940-2004)
aceylan@meteor.gov.tr
Number of Floods
Year
0
20
40
60
80
100
120
140
1940
1943
1946
1949
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003



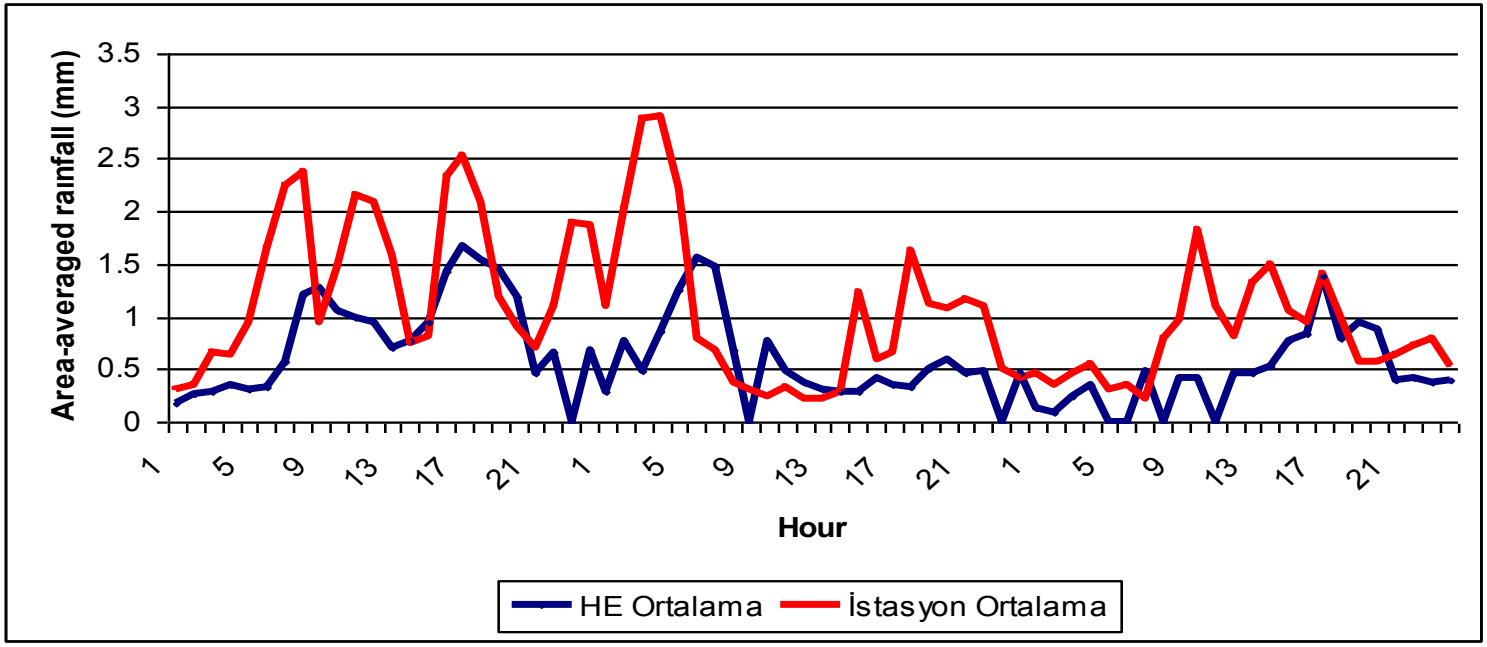
- Flood hazards represented 30 % of all water related disasters in Turkey.
- 1,344 people died due to 1,768 floods in last 50 years in Turkey.
- Economic damage is more than USD 3,000 million during this period.
- 255,640 ha agricultural area was effected.

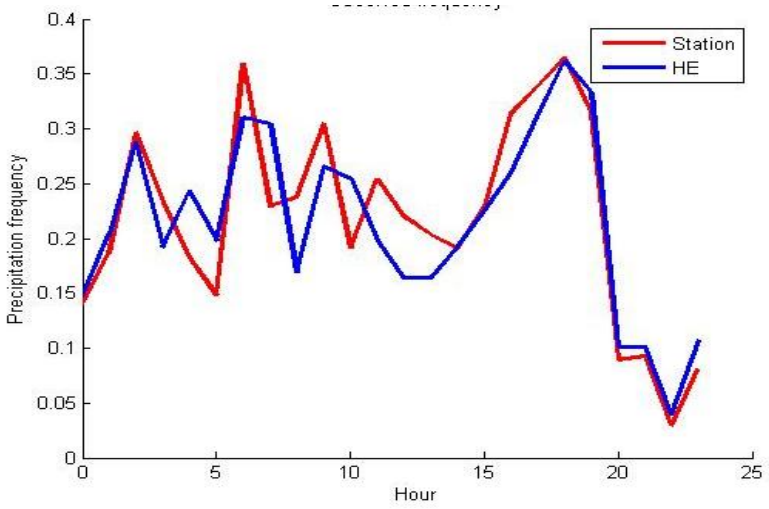
MAJOR FLOODS AND LOSSES				
DATE	**AREA AFFECTED**	**LOSS EVENT**	**ECONOMIC LOSS**	**DEATHS**
9-15 May 1993	Eastern and Southeastern Parts	Heavy rain	Hundreds of houses damaged. Major losses to agriculture	5
1-2 Dec. 1994	SE, Adana	Heavy rain	Hundreds of houses damaged. Major losses to agriculture	
1-5 May 1995	E, Bitlis	Heavy rain	$23,000,000.00	
8-14 July 1995	Istanbul, Senirkent, Ankara, Trabzon	Heavy rain, landslides	$ 30,000,000.00	70
3-5 Nov. 1995	Izmir, Isparta, Antalya	Floods	$ 50,000,000.00	61
6 Feb. 1996	Izmir, Antalya, Canakkale	Heavy rain	1,000 houses damaged	5
9 Aug. 1996	Istanbul	Heavy rain	$ 4,000,000.00	
11-13 Aug. 1997	Istanbul, Zonguldak, Bursa, Bolu	Heavy rain, landslides	$ 1,000,000.00	13
6-22 May 1998	North, Southeast, South and Anatolia	Heavy rain, large hail, landslides, mudslides	$ 2,000,000,000.00	27
12 June 1998	Sanliurfa, Diyarbakir	Heavy rain	Roads flooded, bridge destroyed	8
9-13 Aug. 1998	Trabzon	Torrential rain, landslides	300 building, 1 mosque destroyed	10
27 May 2000	Samsun, Tokat, Carsamba, Salipazari,	Heavy rain	Hundreds of houses flooded, roads, bridges damaged.	2
7-18 May 2001	Hatay, Osmaniye, Konya, Nevşehir	Rainstorm, torrential rain	$ 3,500,000.00	3
10-12 May 2001	Antalya	Heavy rain	500 homes flooded, 37 buildings damaged, 4 bridges collapsed	
10-14 Nov. 2001	Rize, Artvin	Heavy rain, mudslides	Buildings, roads, highways, bridges damaged	8
Dec. 2001	Mersin, Izmir, Istanbul, Ankara, Icel, Yalova	Heavy rain, blizzards, high wind speeds	$ 30,000,000.00	5
23-25 July 2002	Rize, Corum, Yozgat, Kars, Tokat, Van	Torrential rain, high wind speeds, mudslides	$ 20,000,000.00	40

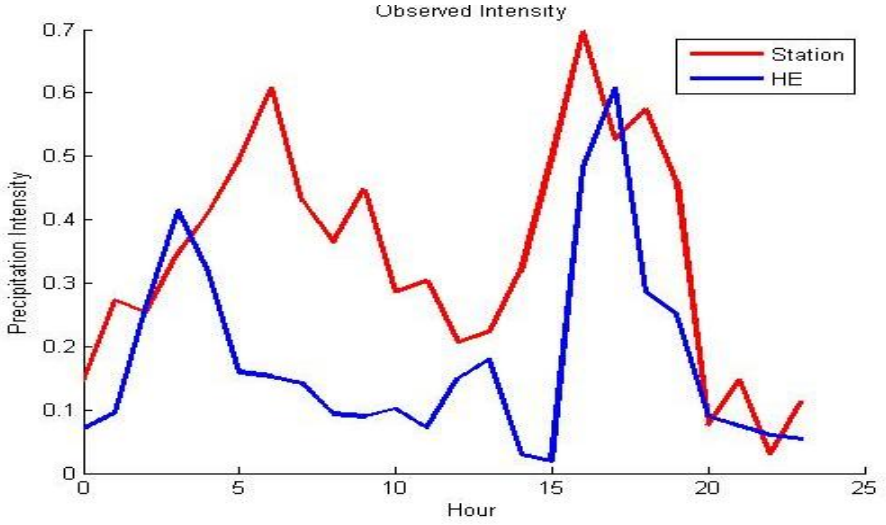


- Investigation of heavy rainfall events occurred during Sep 7-12 2009.
- Rainfall occured 10 times gerater than September average value (25 mm) during these days.
- Station, satellite, radar, and NWP model rainfall data are used.

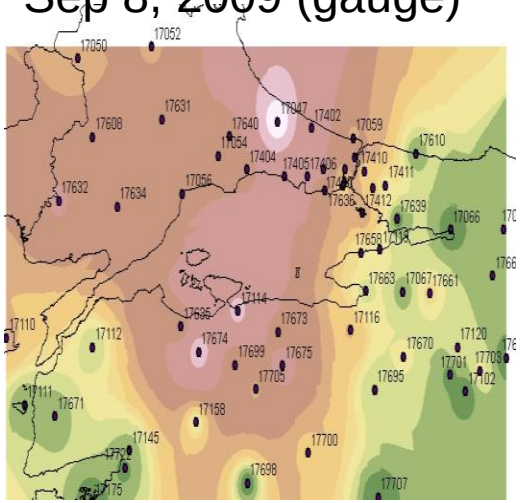
NOAA's Satellite Rainfall Algorithm: Hydro Estimator (HE)



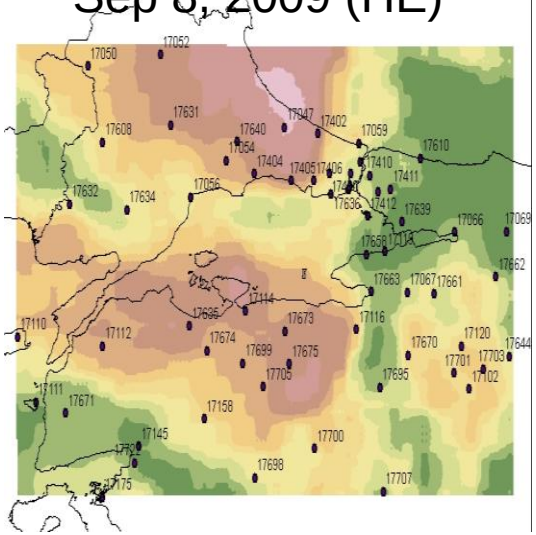




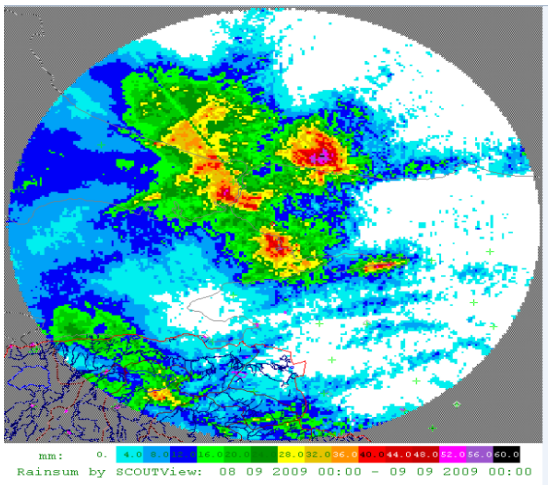
Sep 8, 2009 (gauge)



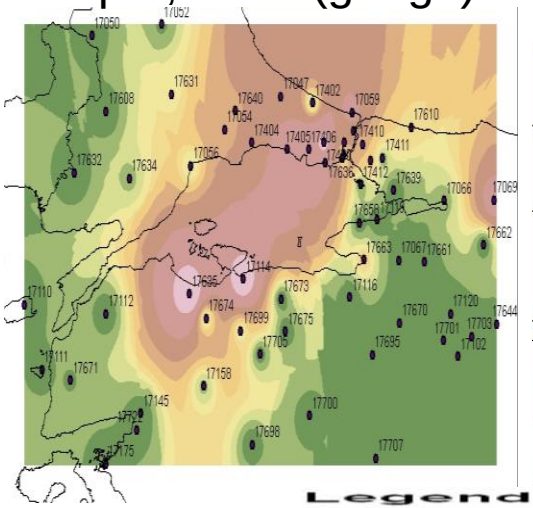
Sep 8, 2009 (HE)



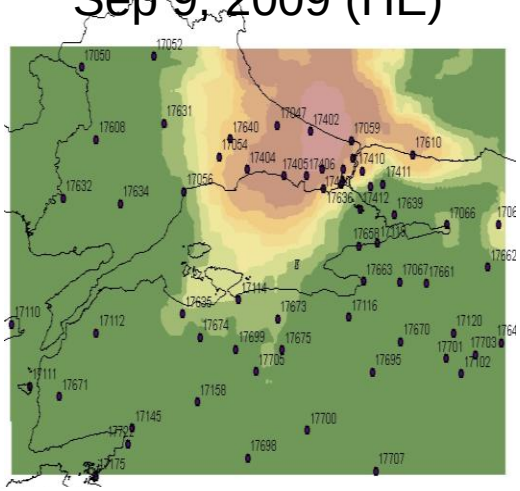
Sep 8, 2009 (Radar)



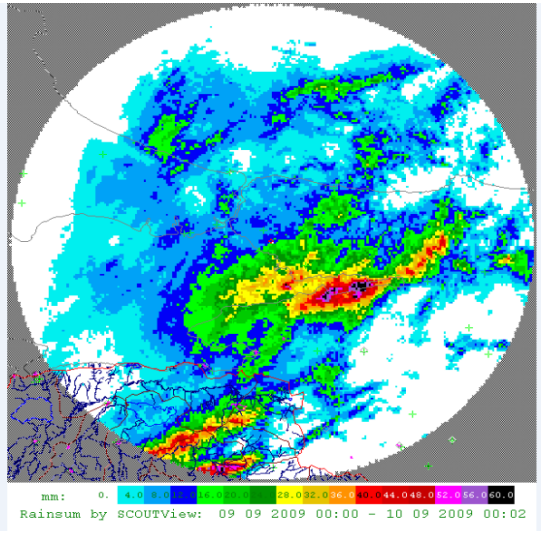
Sep 9, 2009 (gauge)

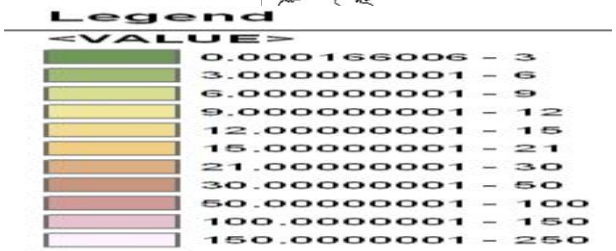


Sep 9, 2009 (HE)



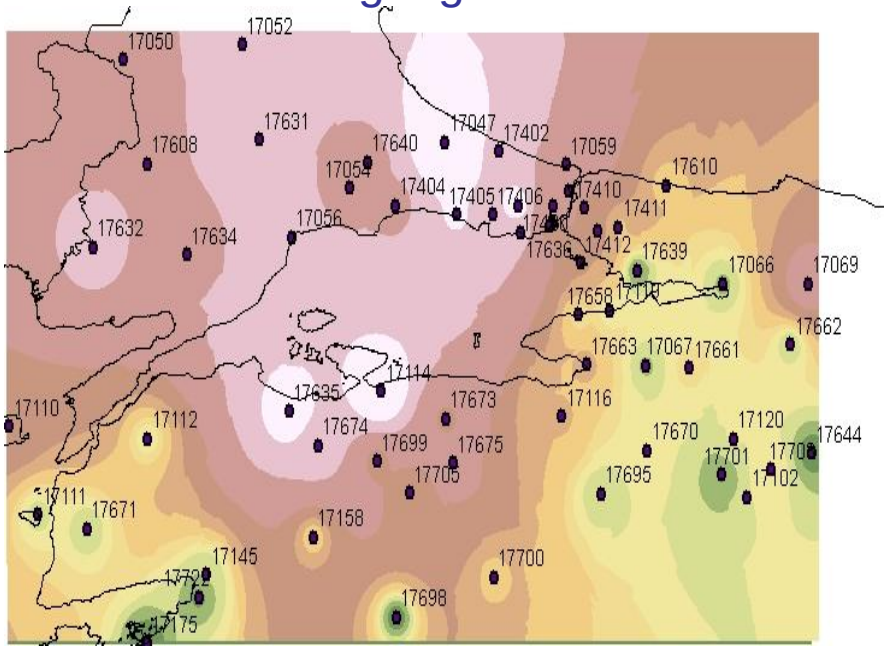
Sep 9, 2009 (Radar)



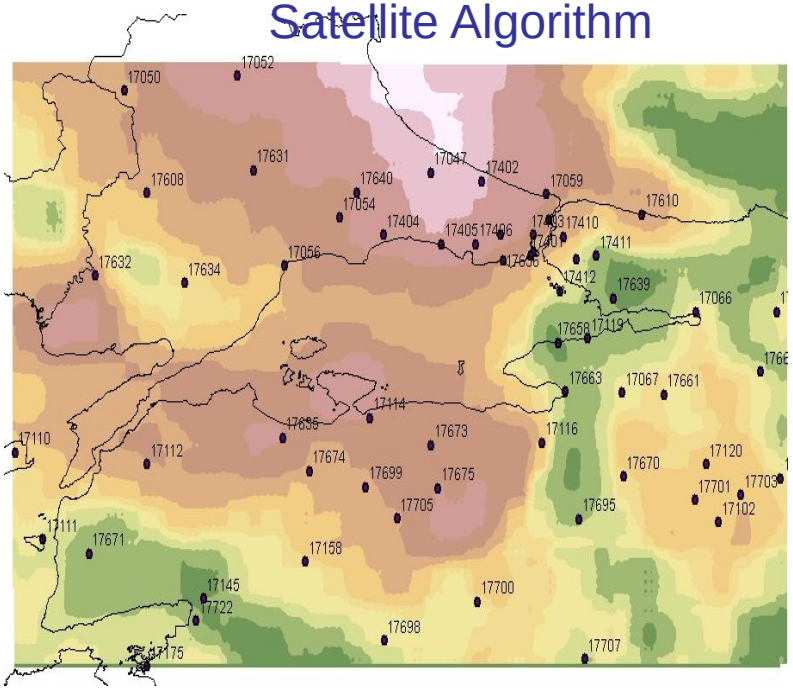


Event totals for 7-9 Sep, 2009

Rain gauge



Satellite Algorithm



Legend

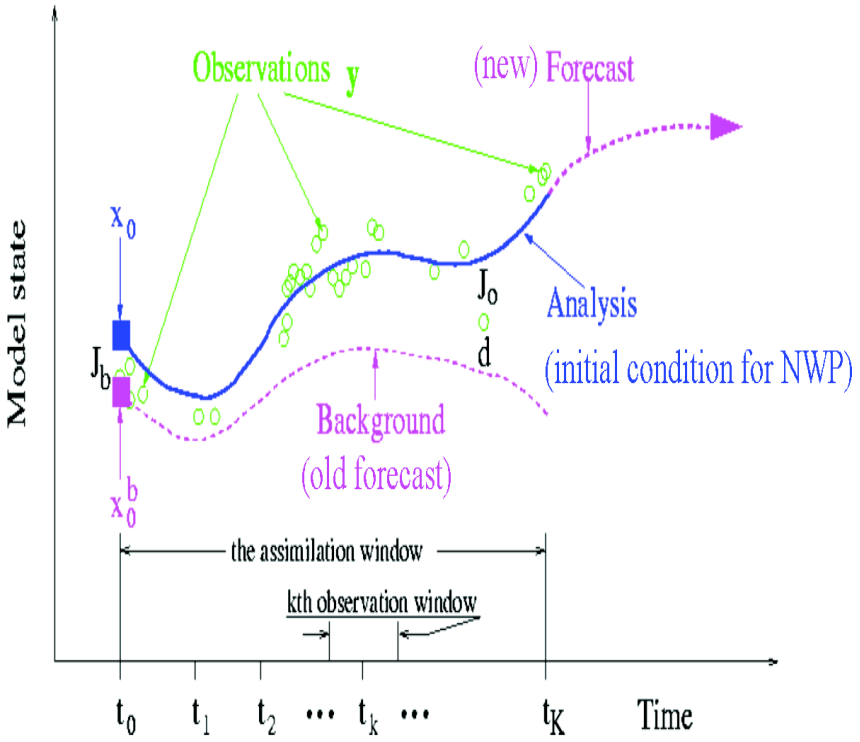
<VALUE>
0.000166006 - 3
3.000000001 - 6
6.000000001 - 9
9.000000001 - 12
12.00000001 - 15
15.00000001 - 21
21.00000001 - 30
30.00000001 - 50
50.00000001 - 100
100.0000001 - 150
150.0000001 - 250

Weather Research and Forecasting (WRF) model

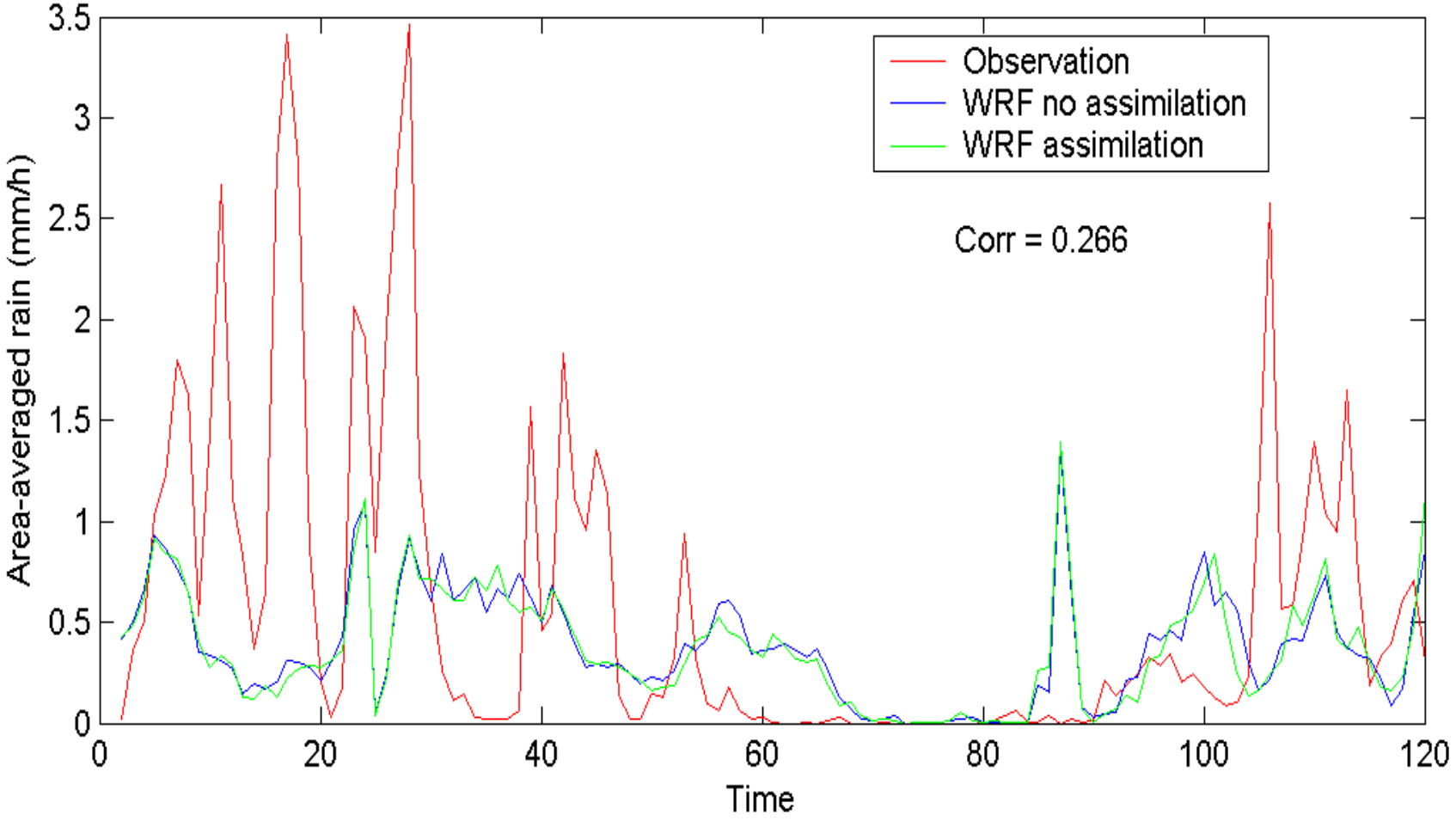
Simulations:

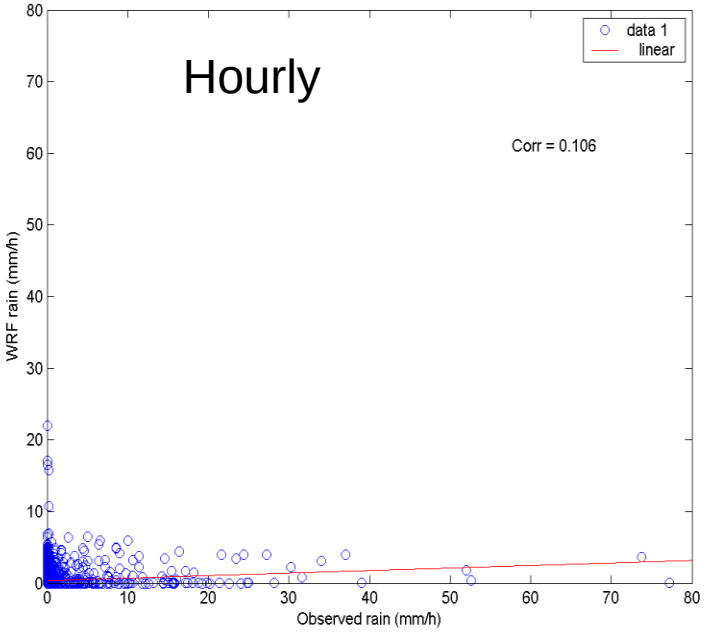
12-km and 4-km WRF domain setups

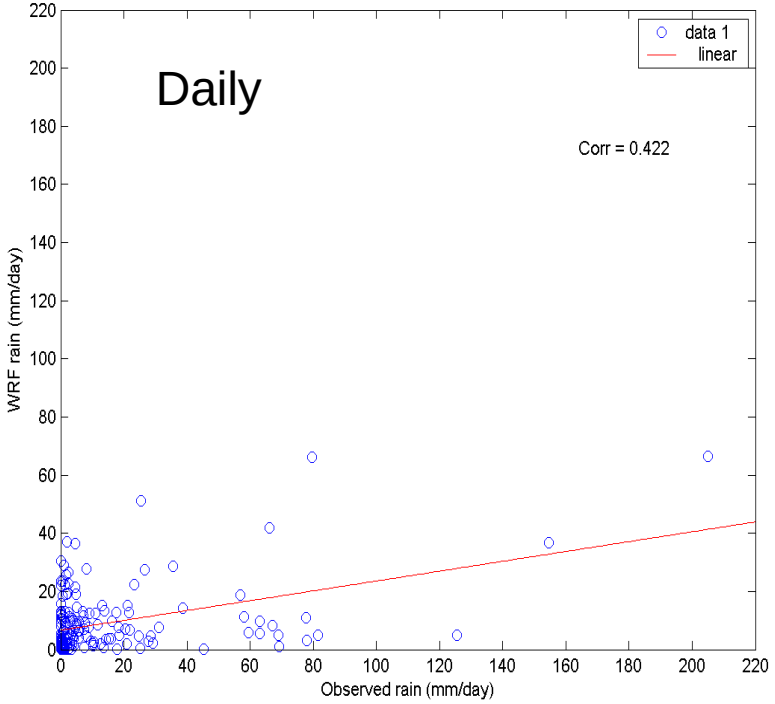
3-D Var data asimilation



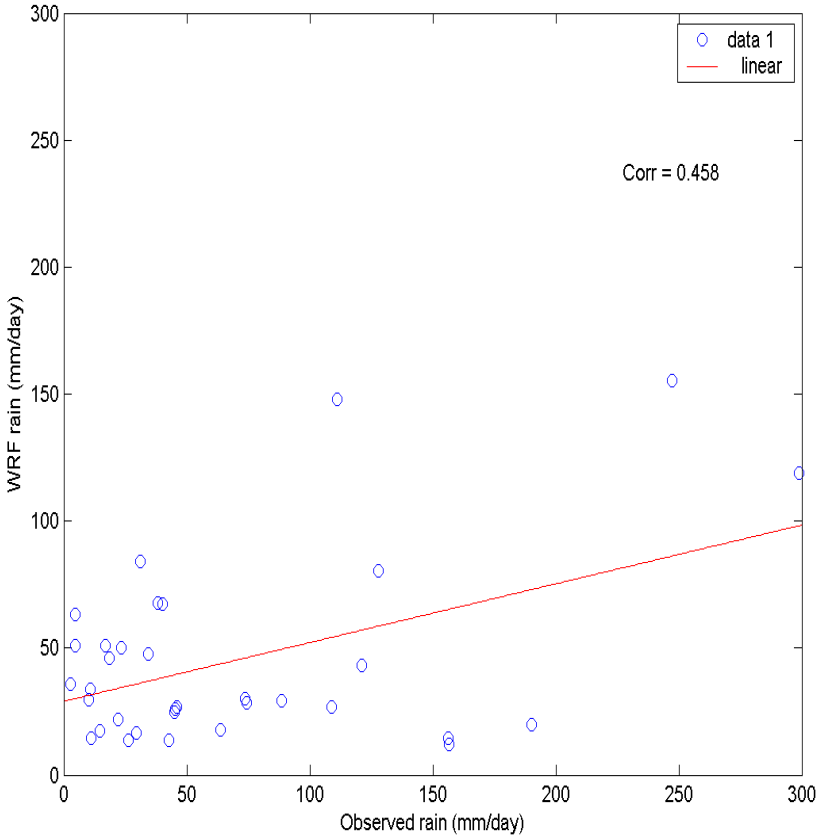
WRF with and without 3D-Var Simulations for Sep 8,9,10,11, and 12, 2009



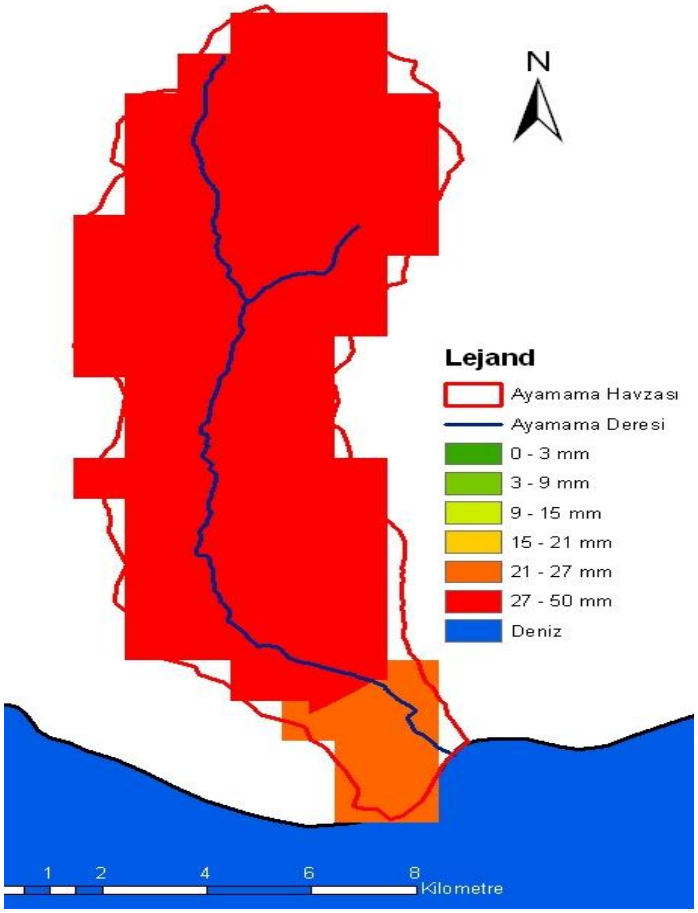




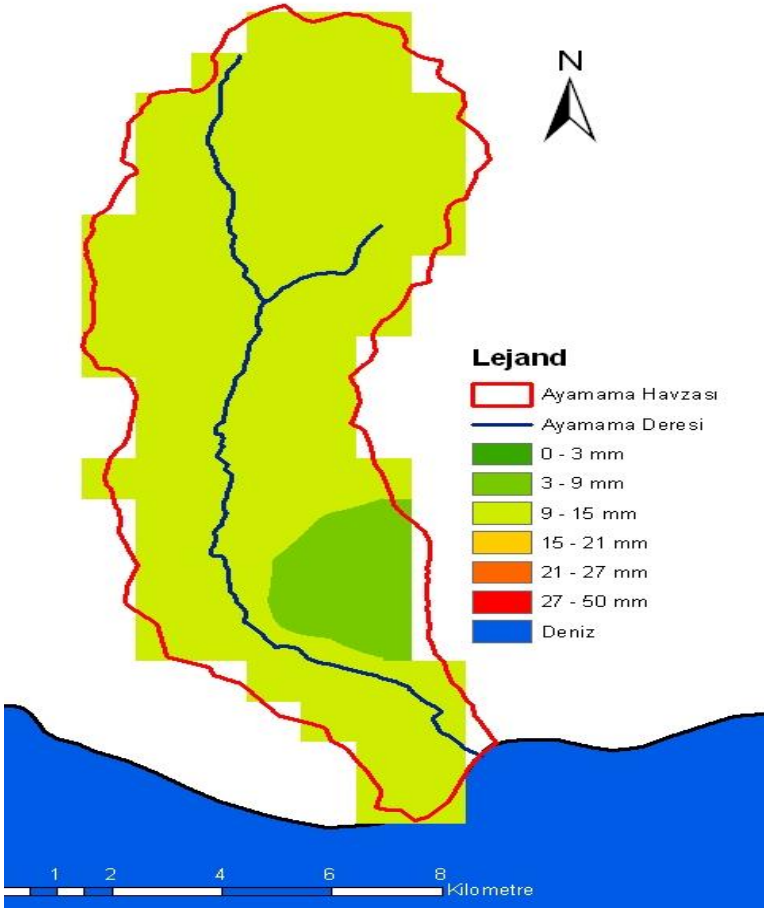
Event Totals



Gauge rain (Sep 8, 2009)

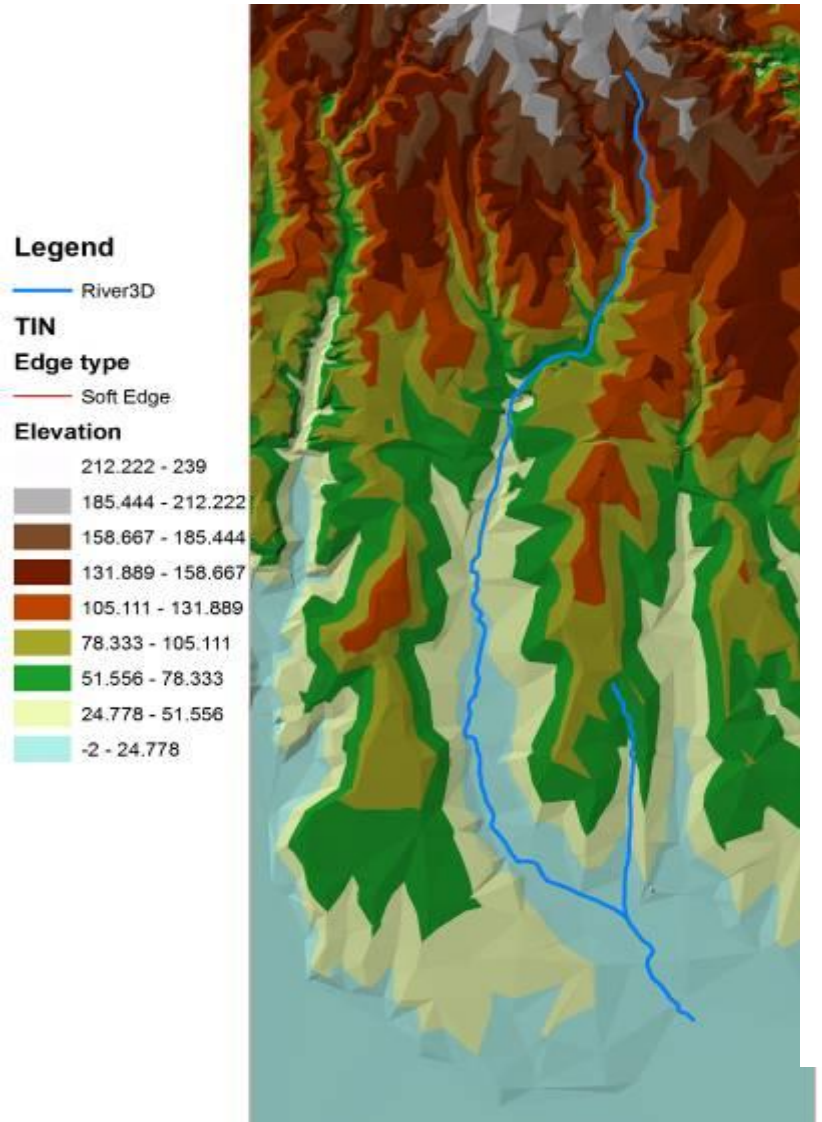


Satellite rain (Sep 8, 2009)

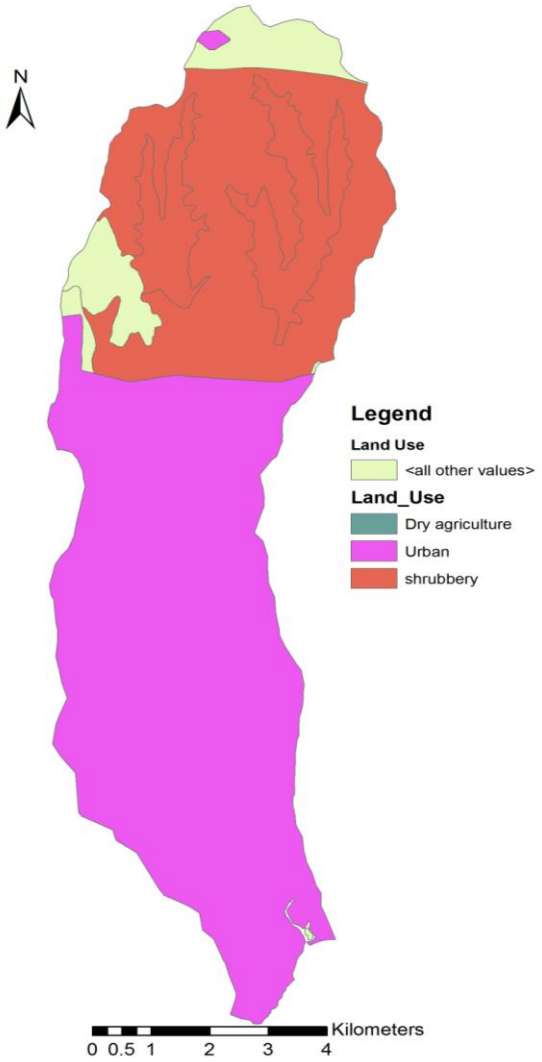


Ayamama Basin Characteristics:

1/5000 scaled Topographic map is used in the study.



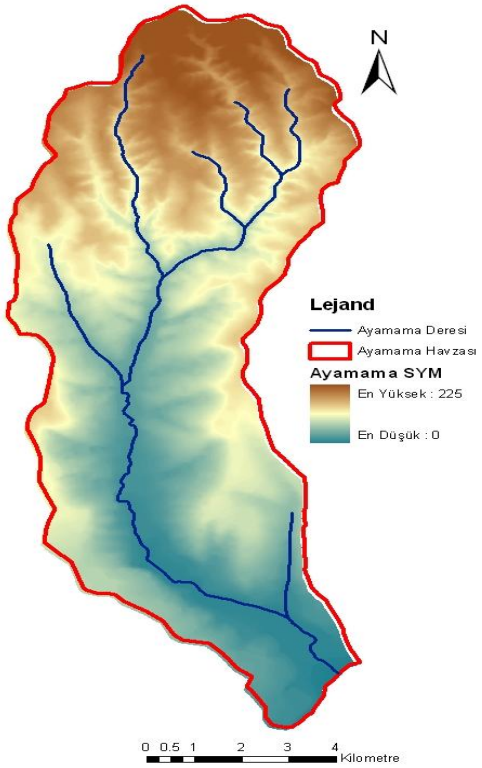
Land use



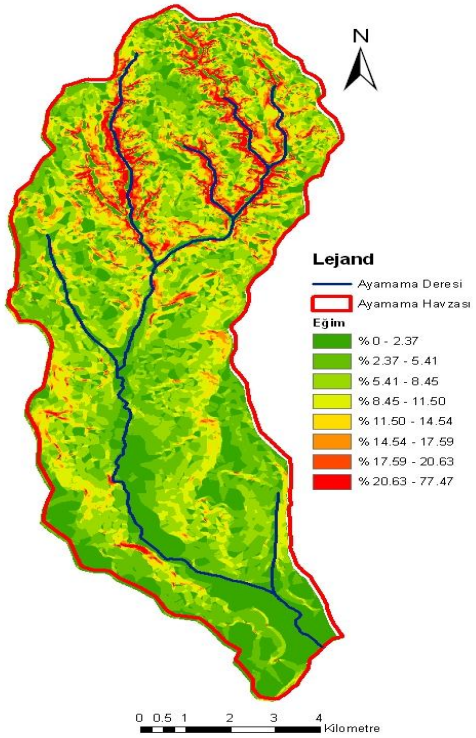
Soil type

Ayamama Basin Characteristics:

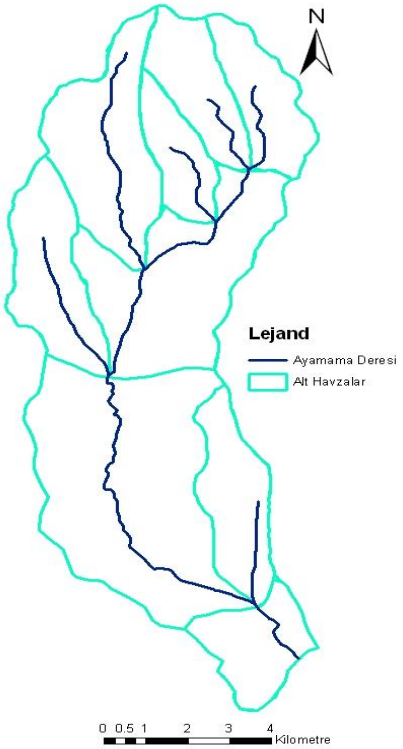
Topography



Sope

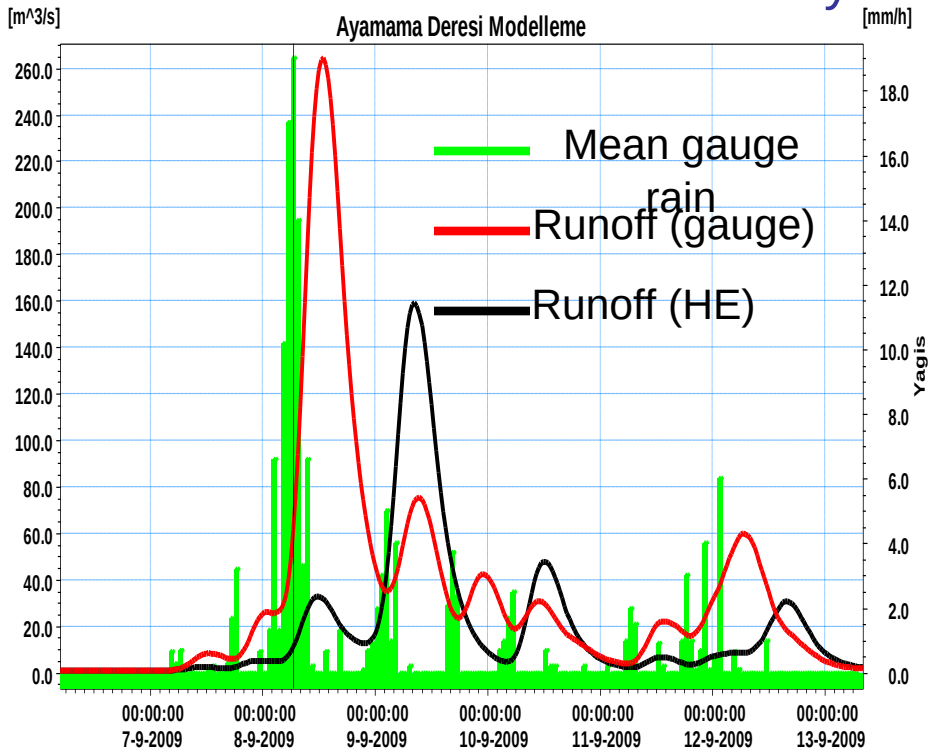


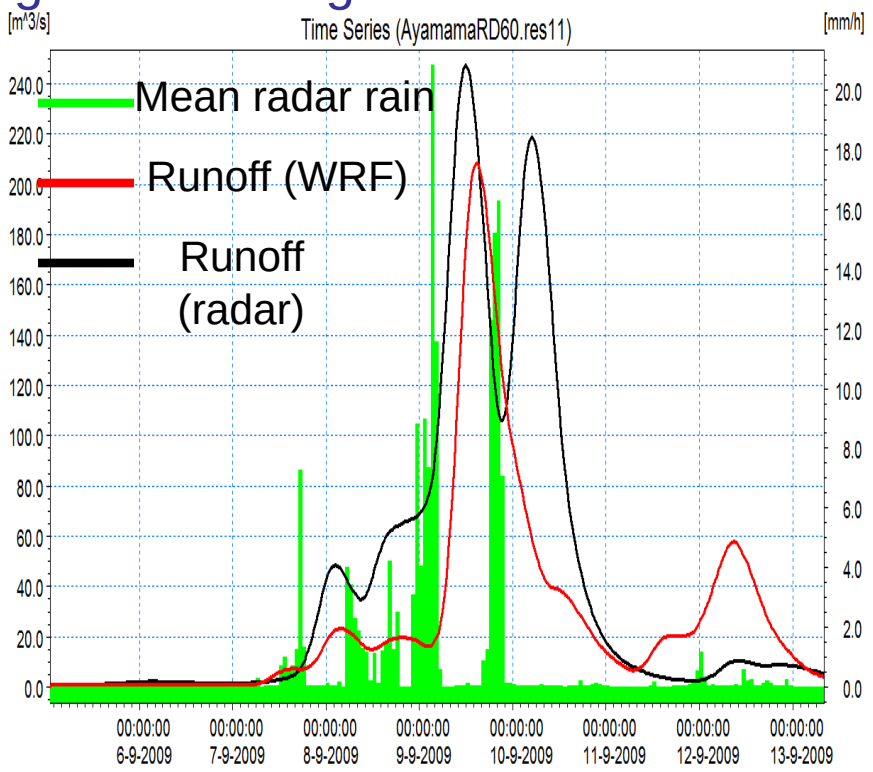
Sub-basins

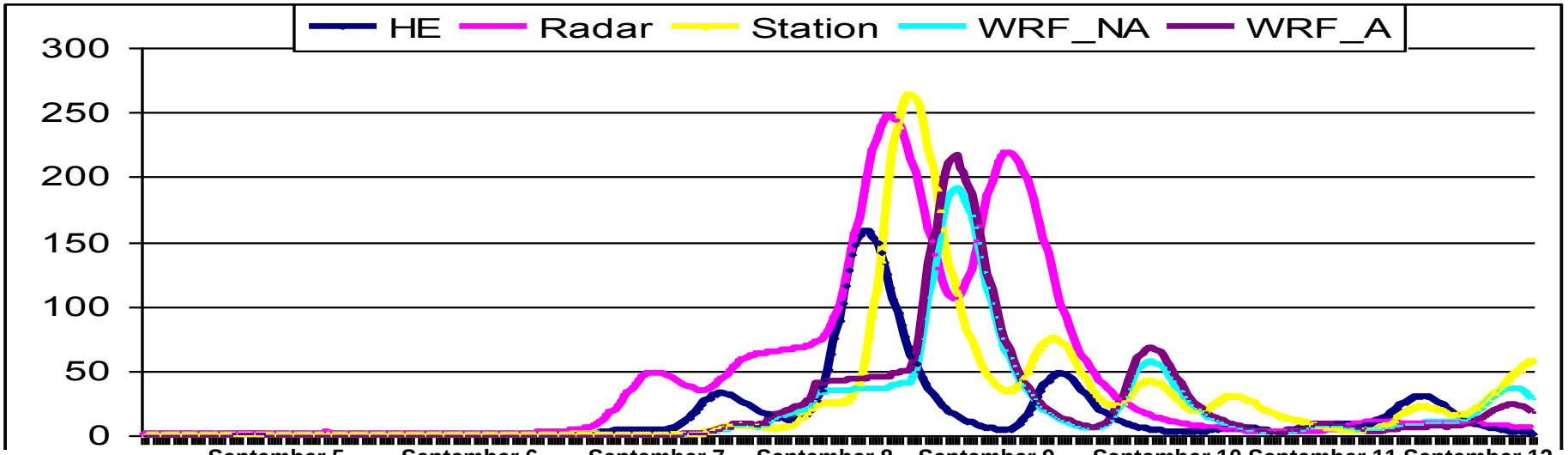


Mean slope	**Mean Elevation**	**Accumulation Time**	**Longest Channel Length**	**Basin Area**
6.94 %	86,64 meter	7.11 hour	41,314 km	71,02 km^2

HEC-HMM Hydrological Modeling

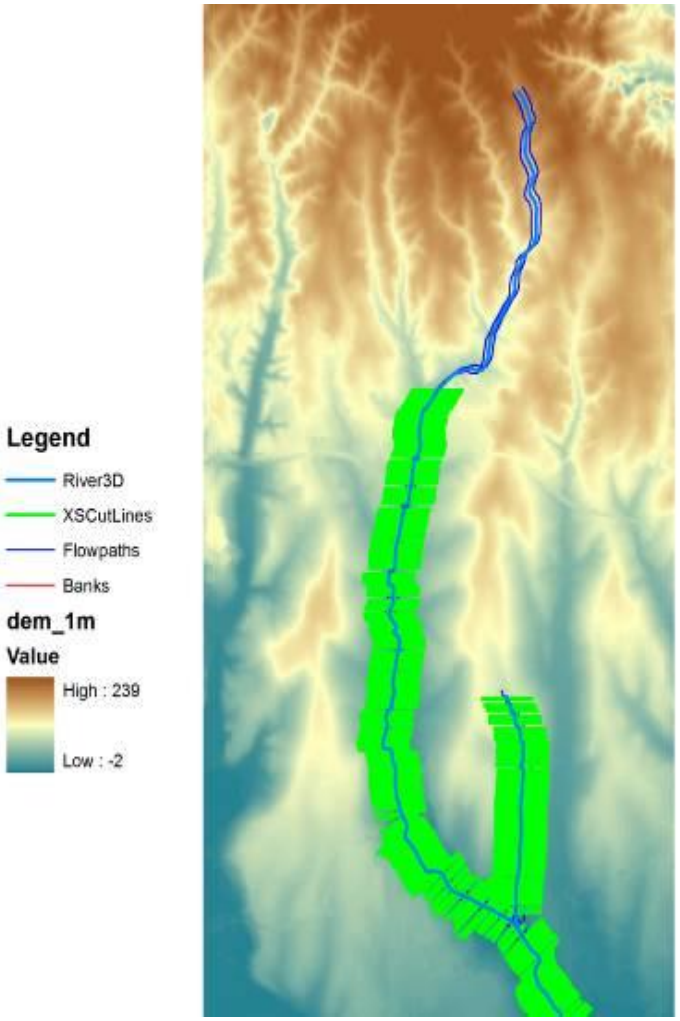




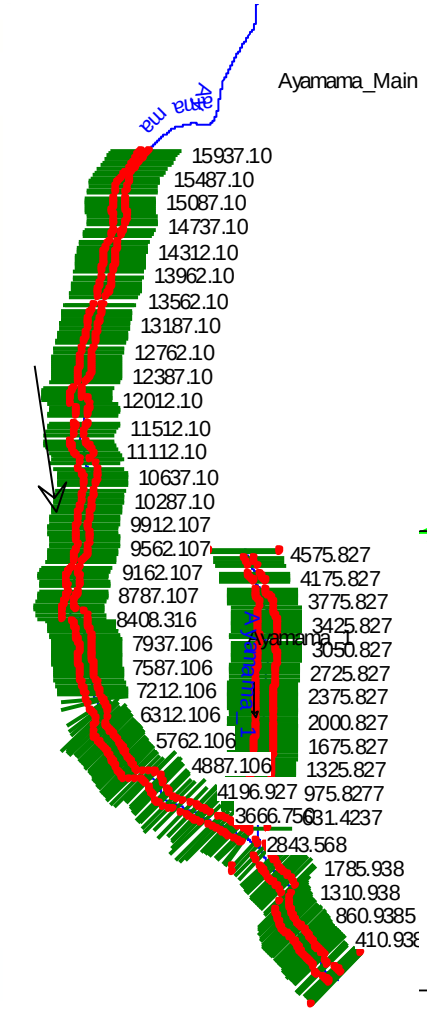


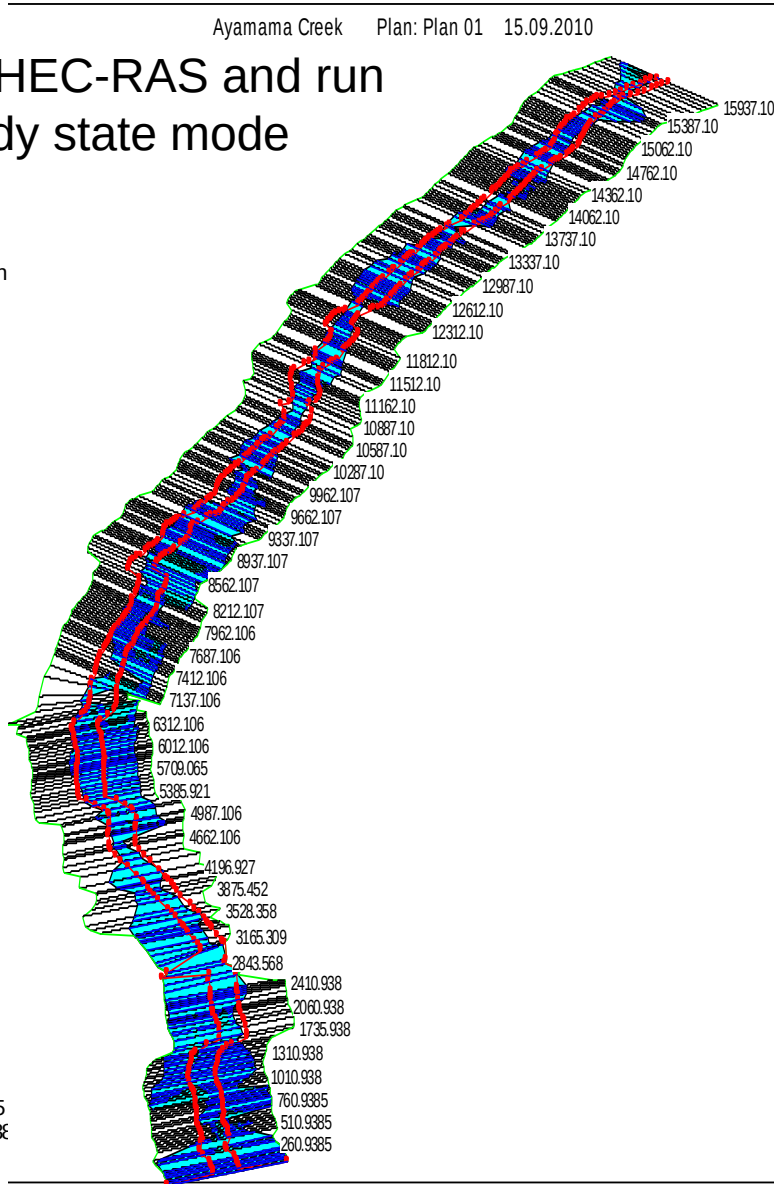
Water coverage calculations along with river path for determining flooded areas

Input is prepared in ArcGIS with help of HEC-GeoRAS module

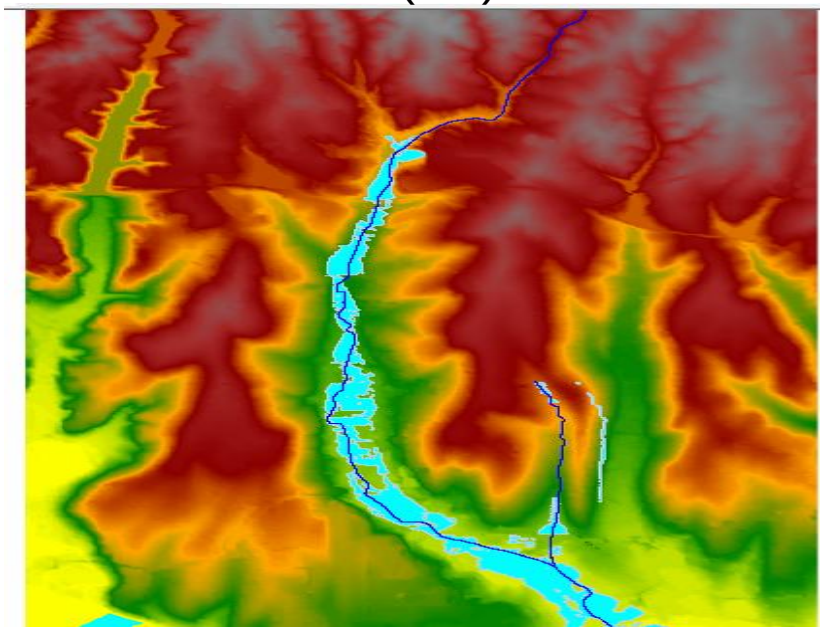


Imported in HEC-RAS and run in steady state mode

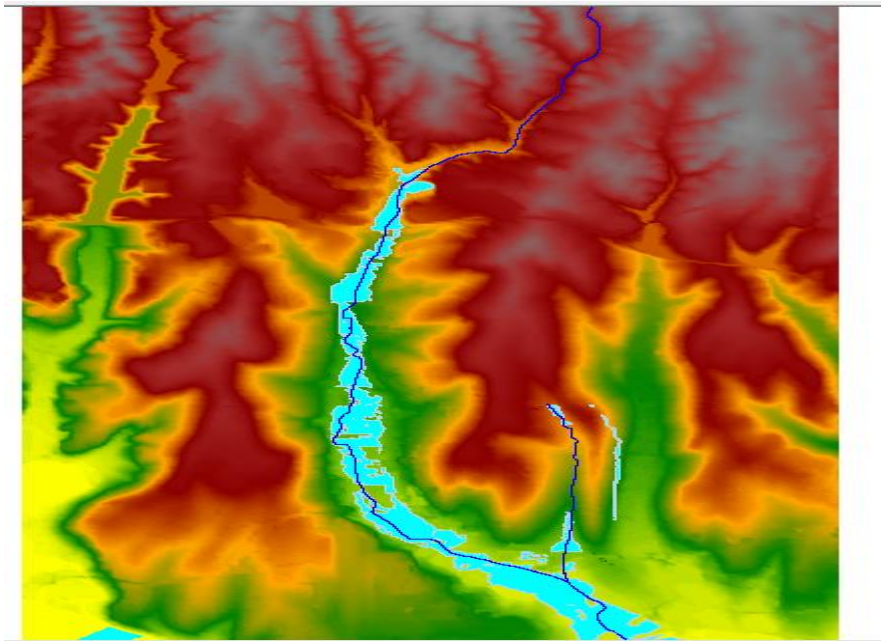




Satellite (HE)

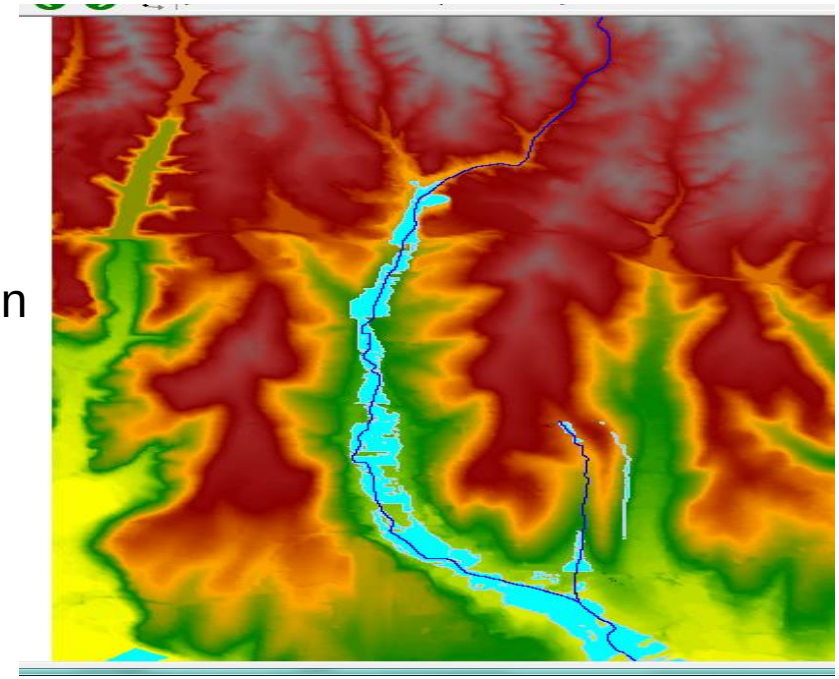


Radar

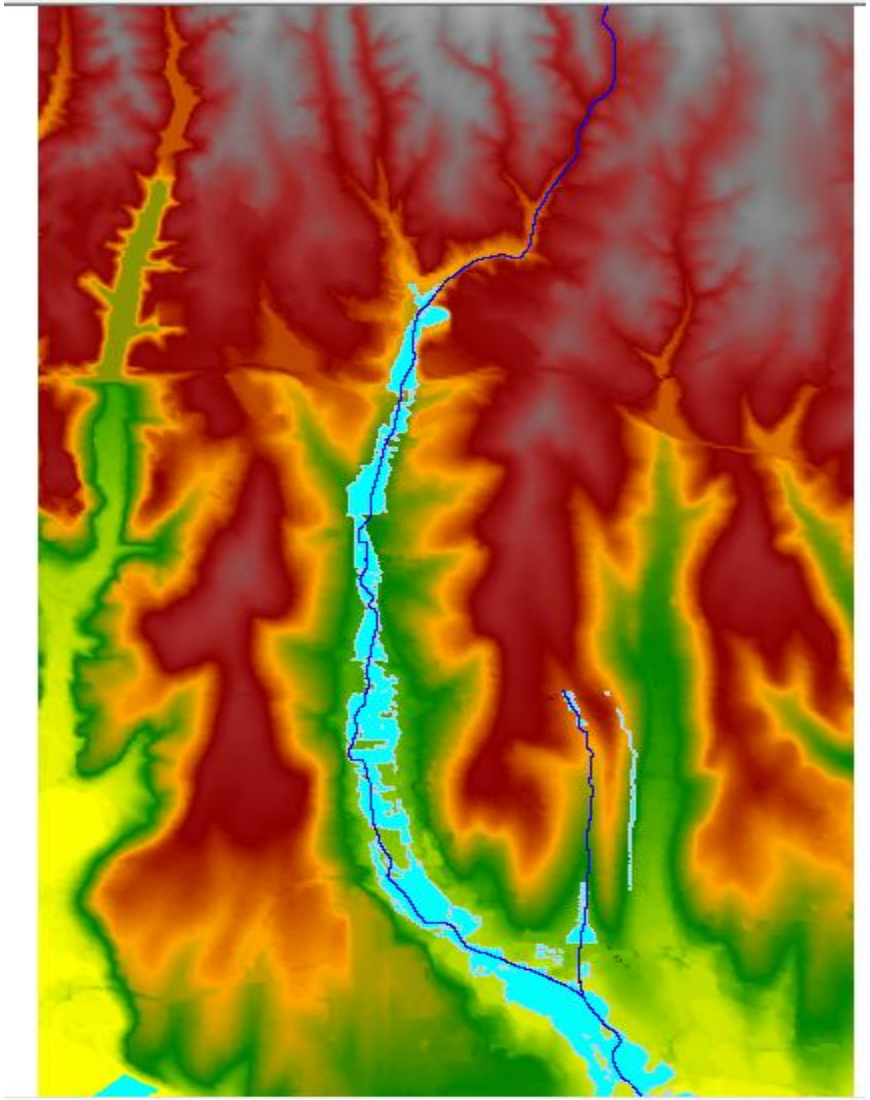


HEC-RAS
Ras Mapper Results:

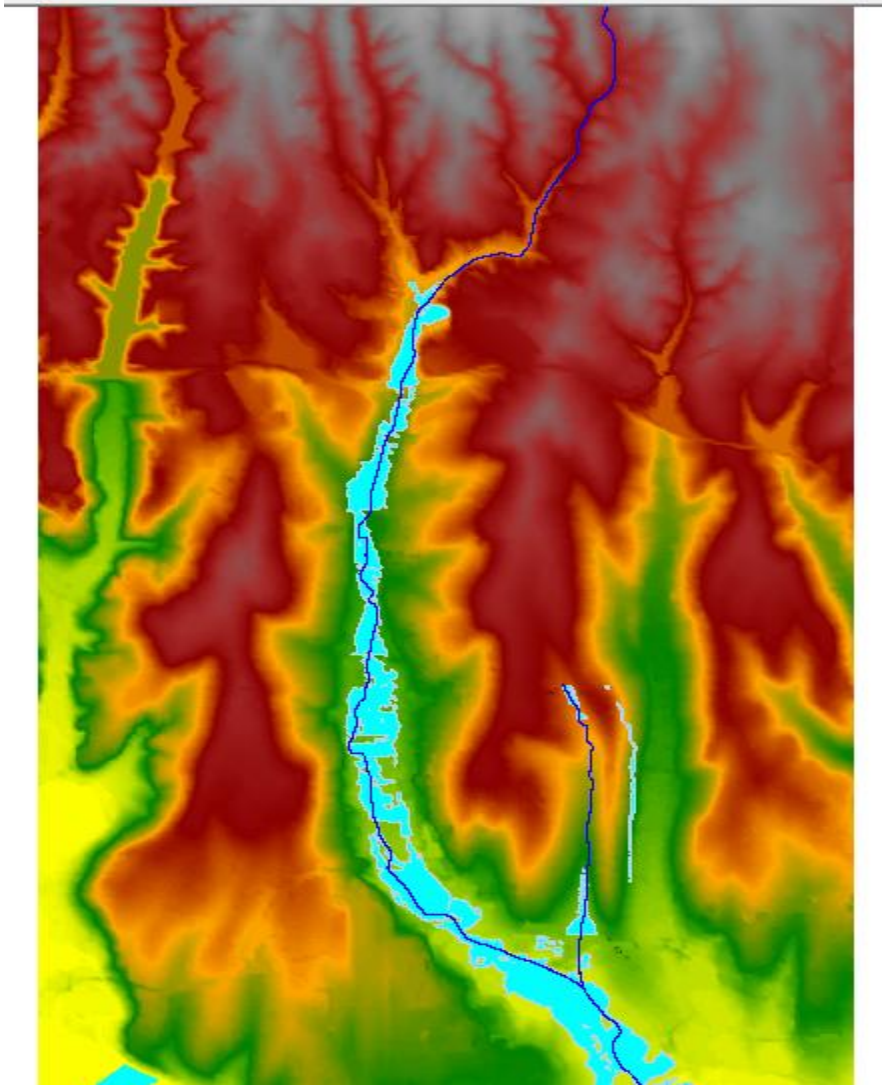
Station



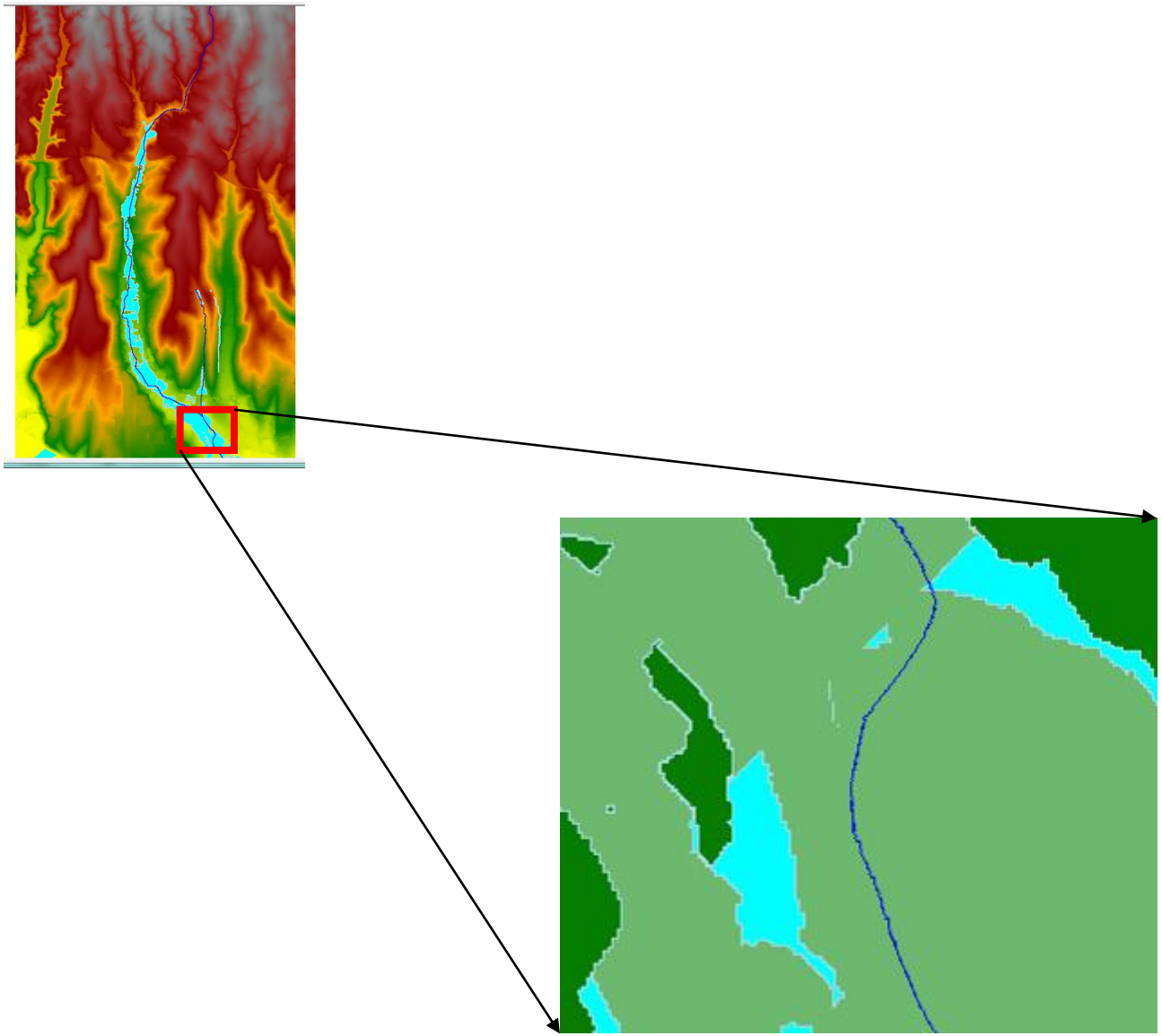
WRF-No assimilation



WRF with assimilation



Comparison between HE and Radar



Summary and Conclusions

•The performance of the HE together with the radar, rain gauge and NWP model data is investigated to monitor and quantify the precipitation events for accuracy assesment and hydrological model application.

•Satellite rainfall estimates potentially improve spatial prediction of precipitation in data poor areas.

•HE underestimates the precipitation, but its frequency cycle matches well with observations.

•The data poor areas can be filled by the radar data but the radar data should be used after full calibration process and error elimination.

•Different precipitation inputs resulted in different storm hydrographs.

•Based on the records, the realistic hydrograph is obtained from radar precipitation data.

•Some differences in the coverage of the flooded areas are obtained in Ayamama basin after using peak values of the storm hydrographs in HEC-RAS program.