Flood Management and Remedial Measures for Dikmen, Northern Cyprus

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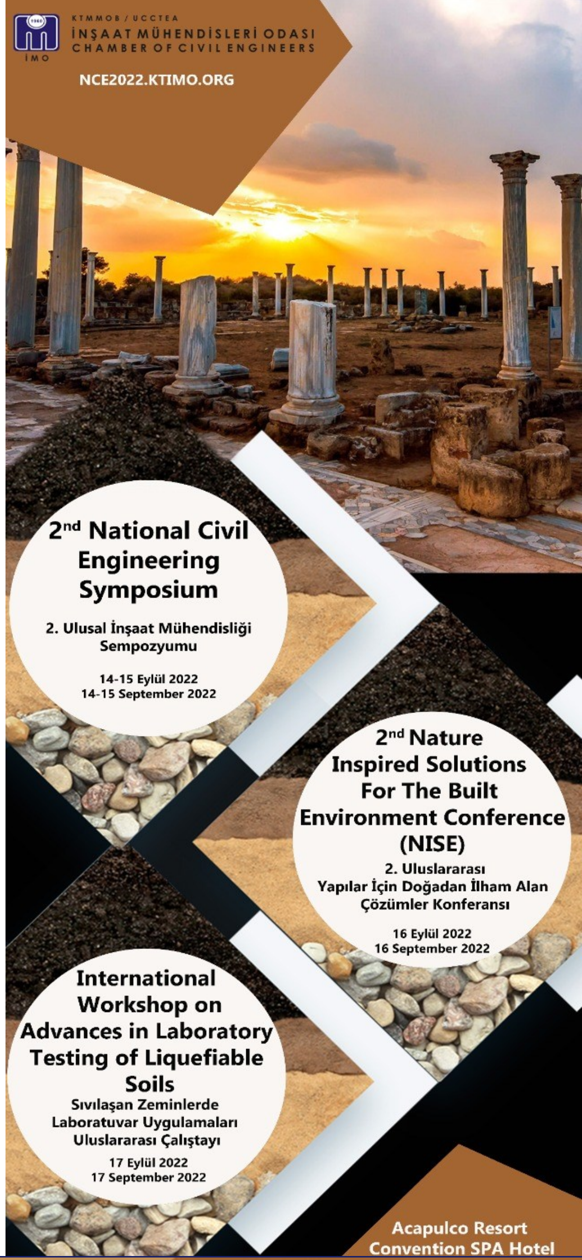

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ULUSLARARASI KIBRIS ÜNİVERSİTESİ

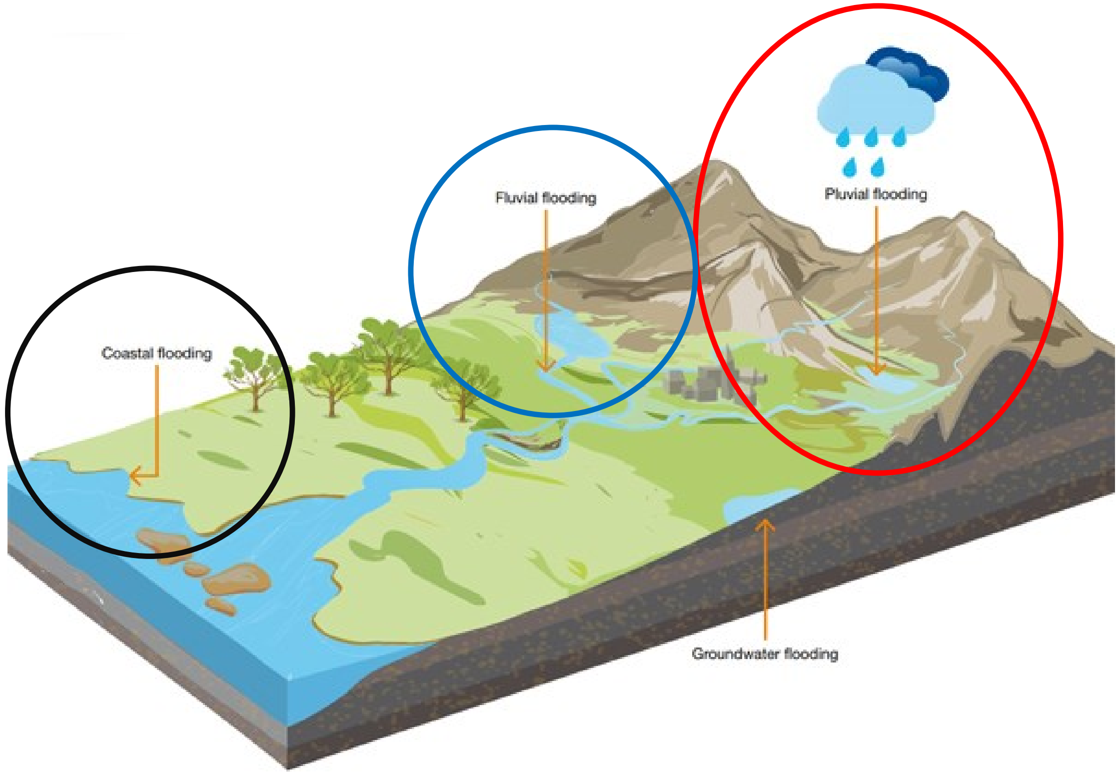
North Cyprus
14 -17 Eylül 2022
14 - 17 September 2022

Outline

Floodings

❖ Main Causes of increases in Floodings [2]

1. Increase in urbanizations (changes LC)
2. Insufficient flood control infrastructure
3. Climate change



Https://Blog.Wavin.Co.Uk/Urban-flooding-affect-us/Flooding-diagram/

Flood Risk Management -

❑ Prevention and Mitigation

- Developing Floodplain Mapping
- Identification of the flood vulnerable areas
- Identifying and Implementation of the Remedial measures

❑ Preparedness

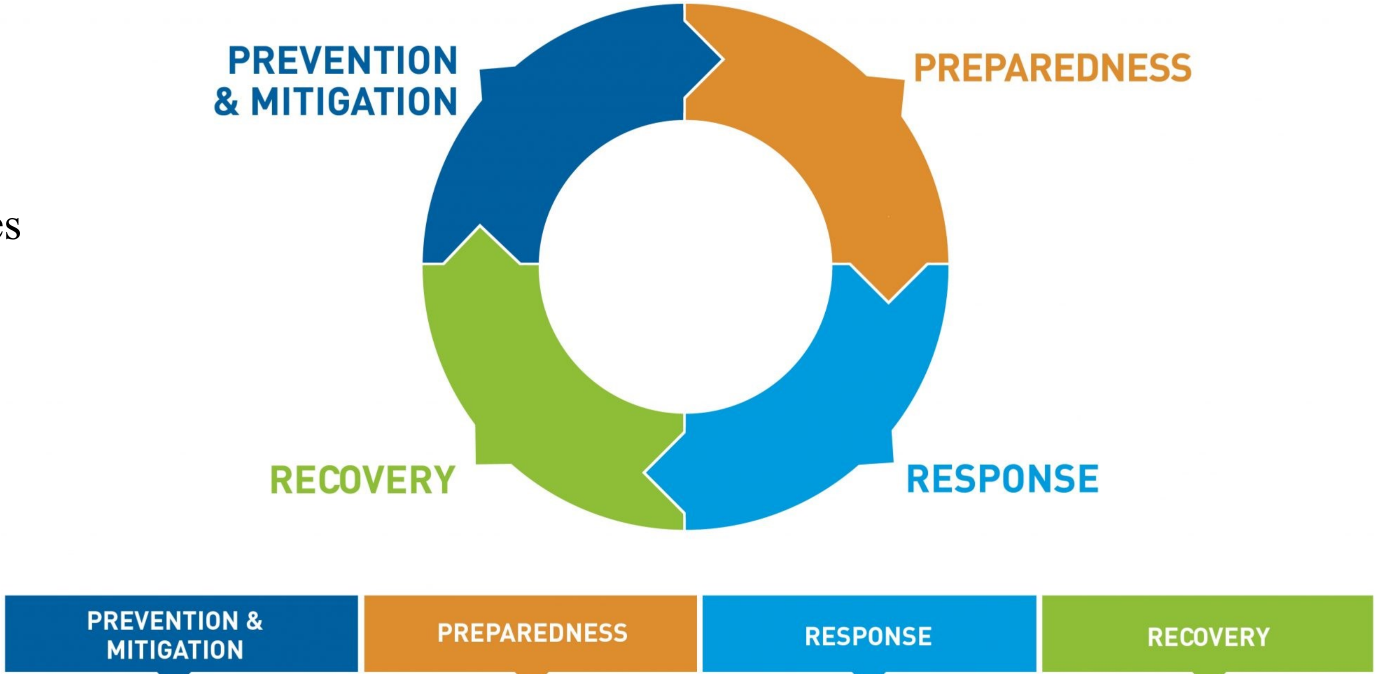
- Emergency operation center and plan

❑ Response

- Operate flood control infrastructures

❑ Recovery

- Flood Event documentation and lessons learned



https://trca.ca/conservation/flood-risk-management/

❖ Flood in Cyprus [3]

- 18th Jan 2010 flash flood in Morphou (Güzelyurt) .

  (2013) Caused 5 million TL damages.

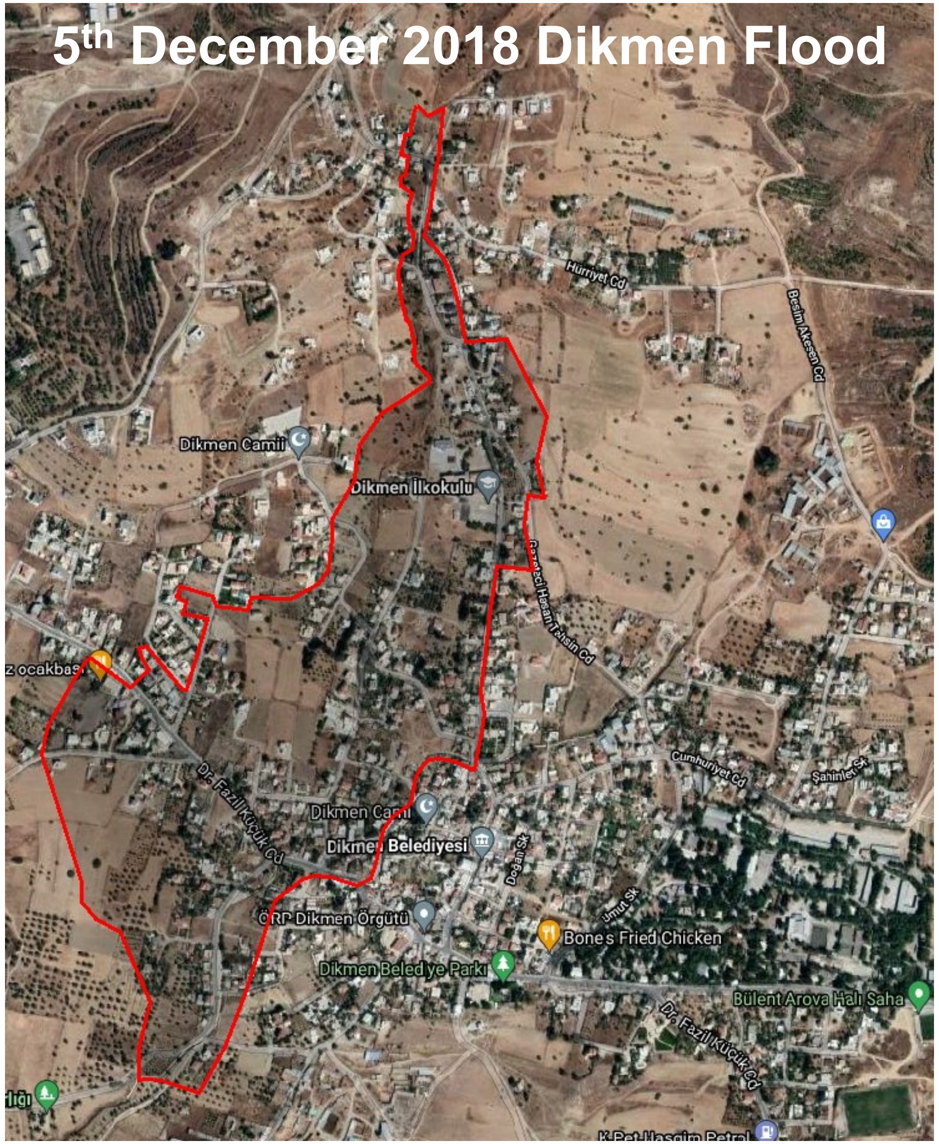
- 26th Feb 2010 Flood in Nicosia [2]

  - Nicosia Turkish Municipality paid around 215,000 TL for compensation to people.

E.Şahin (et.al 2013)

5th December 2018 Dikmen flood

http://www.haberatorkibris.com/dikmende-sel-felaketi-26563h.htm



❖ Objective of the study

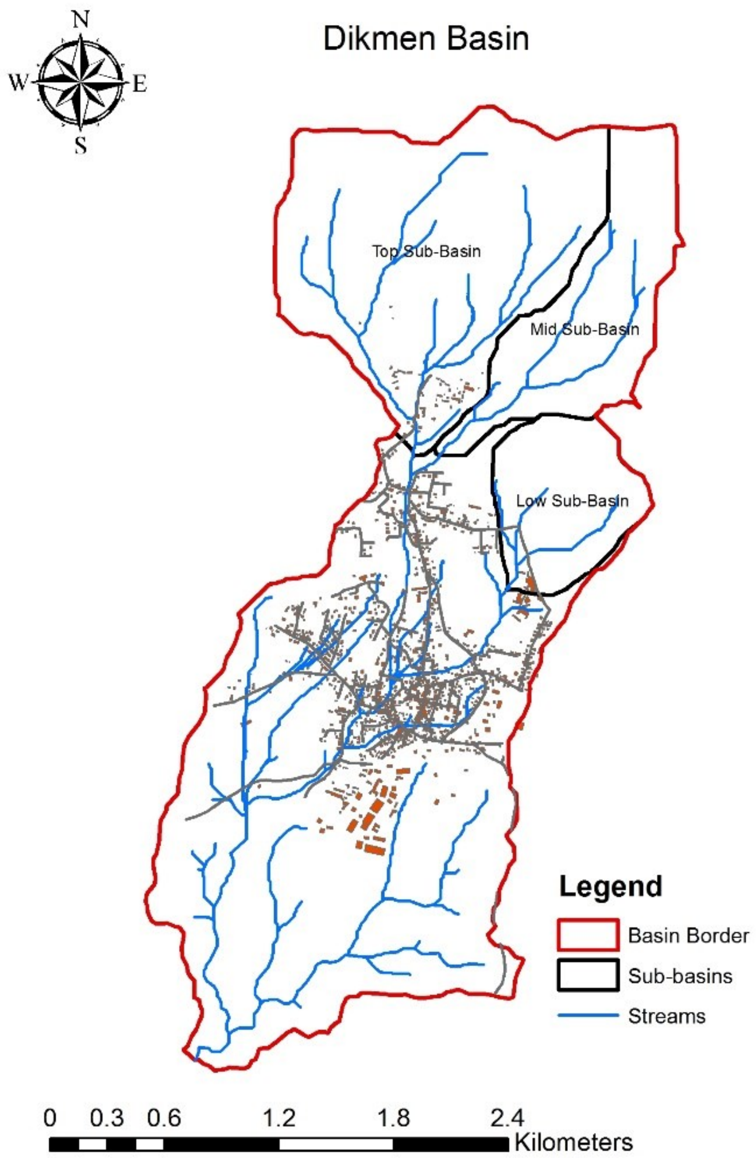
➢ Develop flood management plan for the flooding issue of Dikmen town in Northern Cyprus to:-

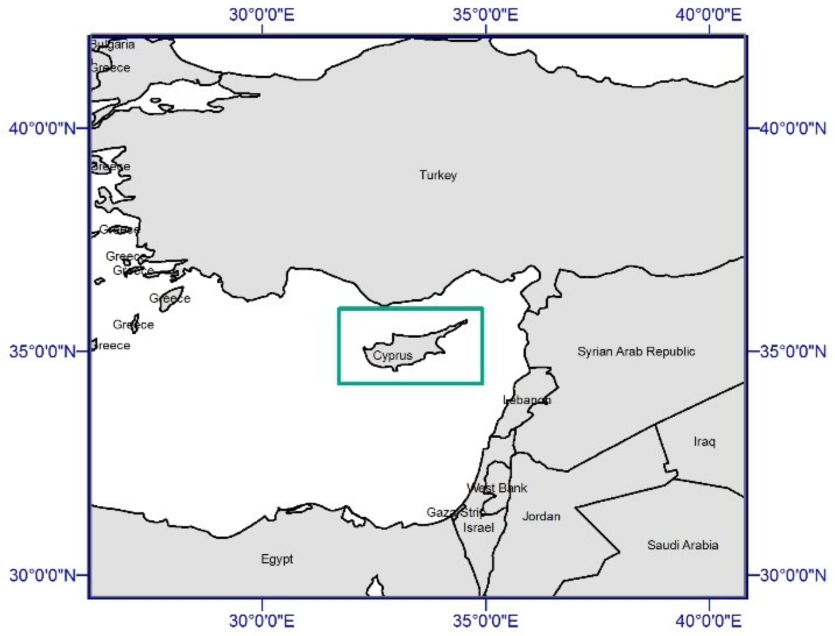
- Model the 2018 Flood event and Calibrate based on the Observed Flood Extend Map
- Detect regions with high risk of flooding For Future flood scenarios (50-, 100-, 500-year) return period flood event.
- Identify best possible solutions to mitigate risk of flooding on that area against the extreme future flood scenarios.
- Analyze economic aspect of each solution alternative to determine most feasible option.

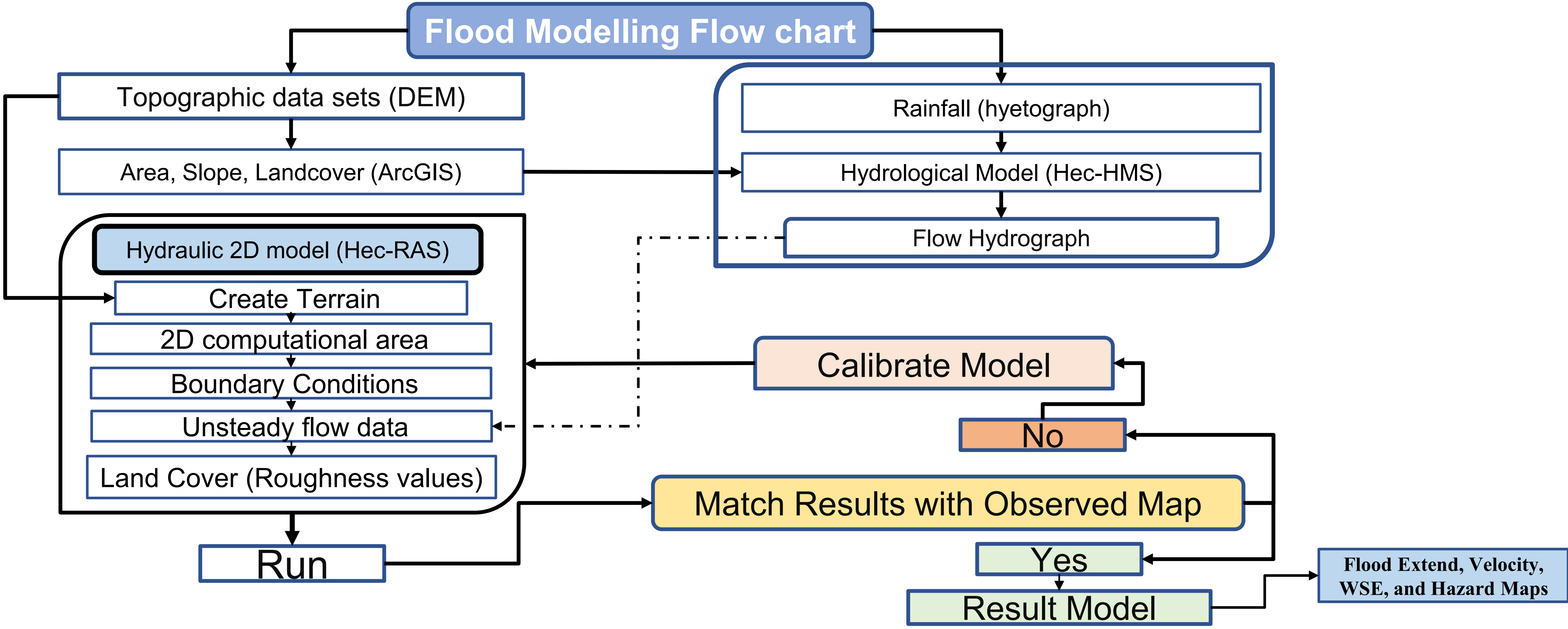
Study Area

Basin Area is 8 km^2

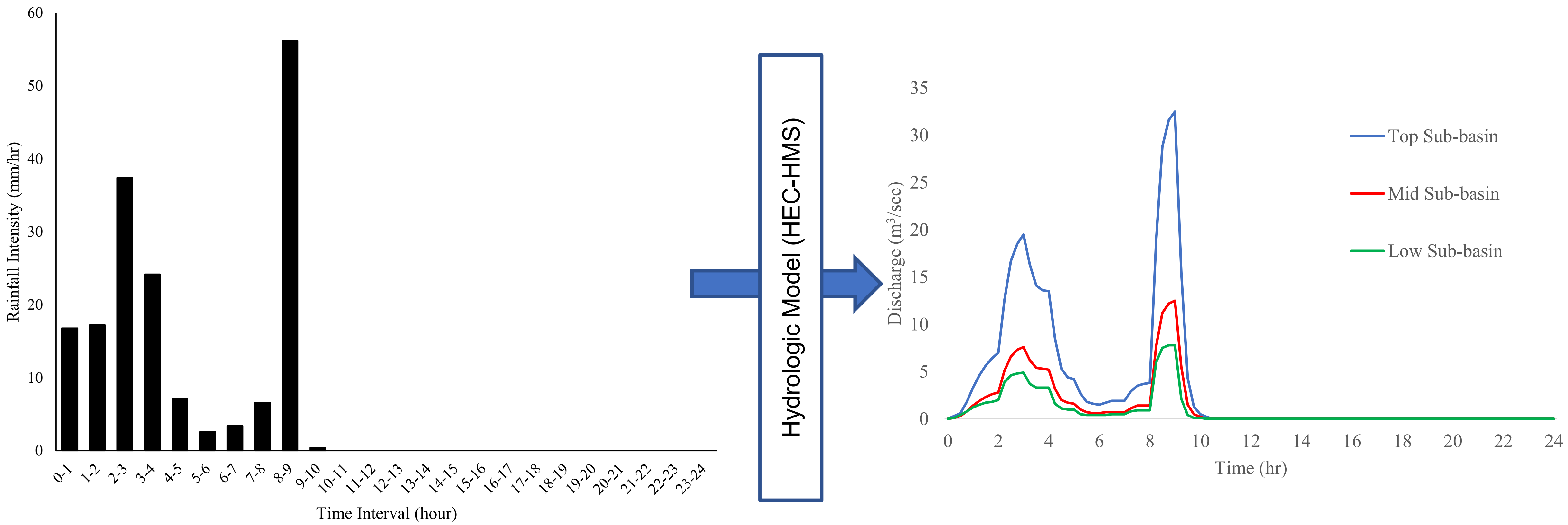
- Sub-Basin Areas
  - Top Sub-Basin $2.0\ km^2$
  - Mid Sub-Basin $0.9\ km^2$
  - Low Sub-Basin $0.6\ km^2$






Flood Modelling Flow chart
Topographic data sets (DEM)
Area, Slope, Landcover (ArcGIS)
Rainfall (hyetograph)
Hydrological Model (Hec-HMS)
Flow Hydrograph
Hydraulic 2D model (Hec-RAS)
Create Terrain
2D computational area
Boundary Conditions
Unsteady flow data
Land Cover (Roughness values)
Run
Calibrate Model
No
Match Results with Observed Map
Yes
Result Model
Flood Extend, Velocity, WSE, and Hazard Maps

Rainfall Data sets (Boğaz Station) of 2018 – Flood Event Rainfall Records.



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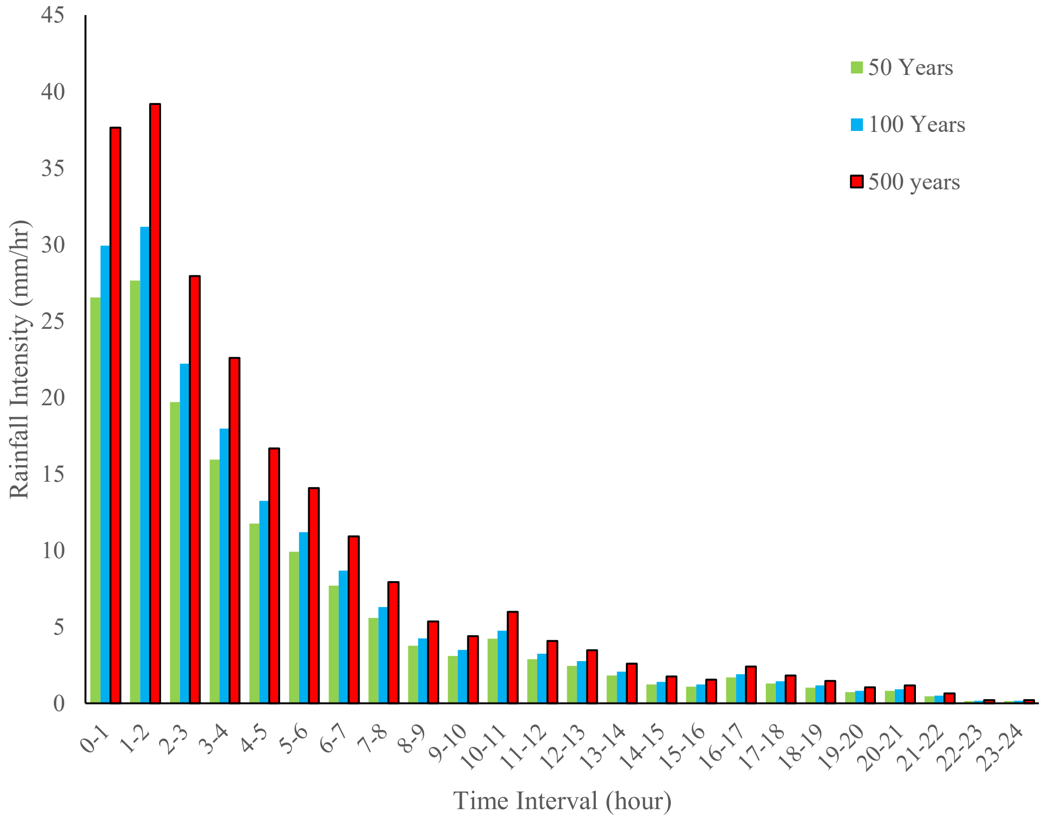
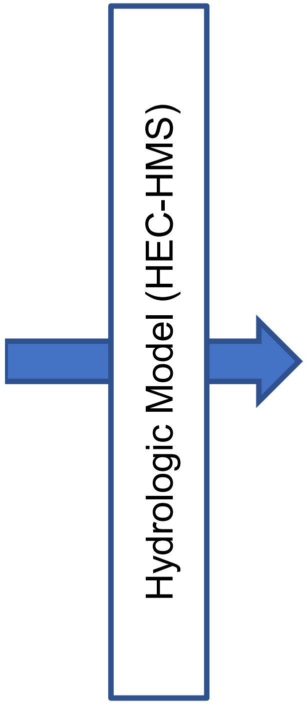
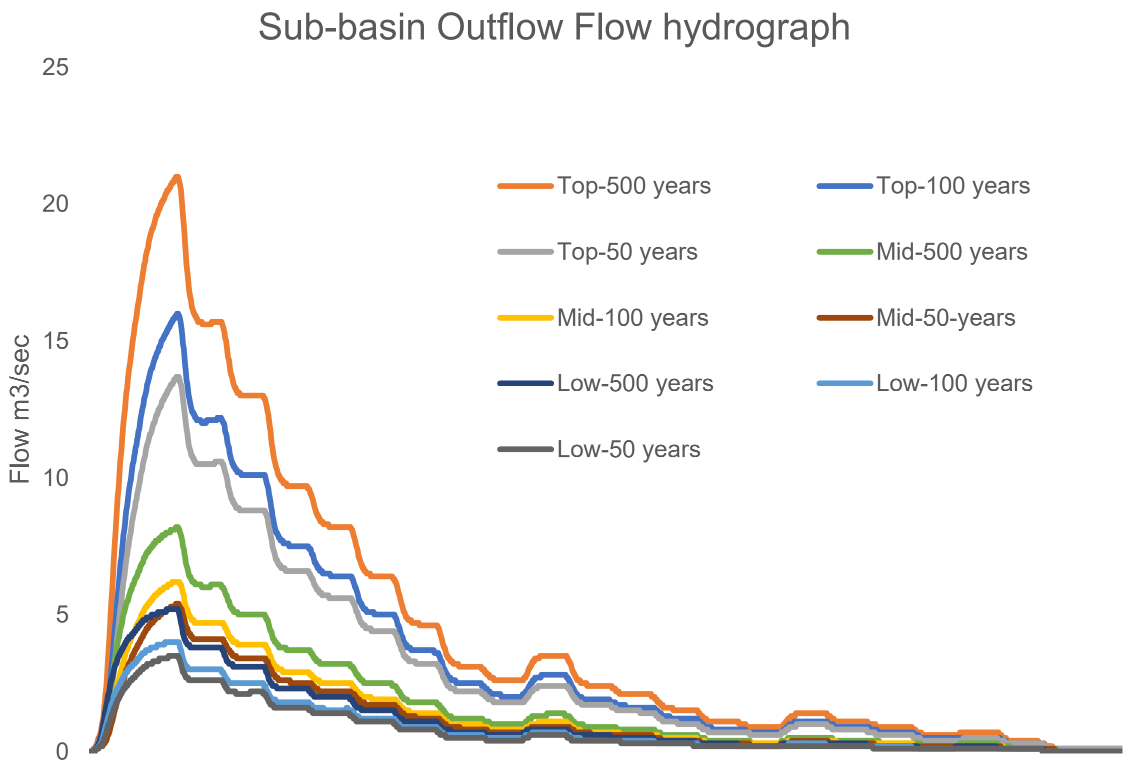
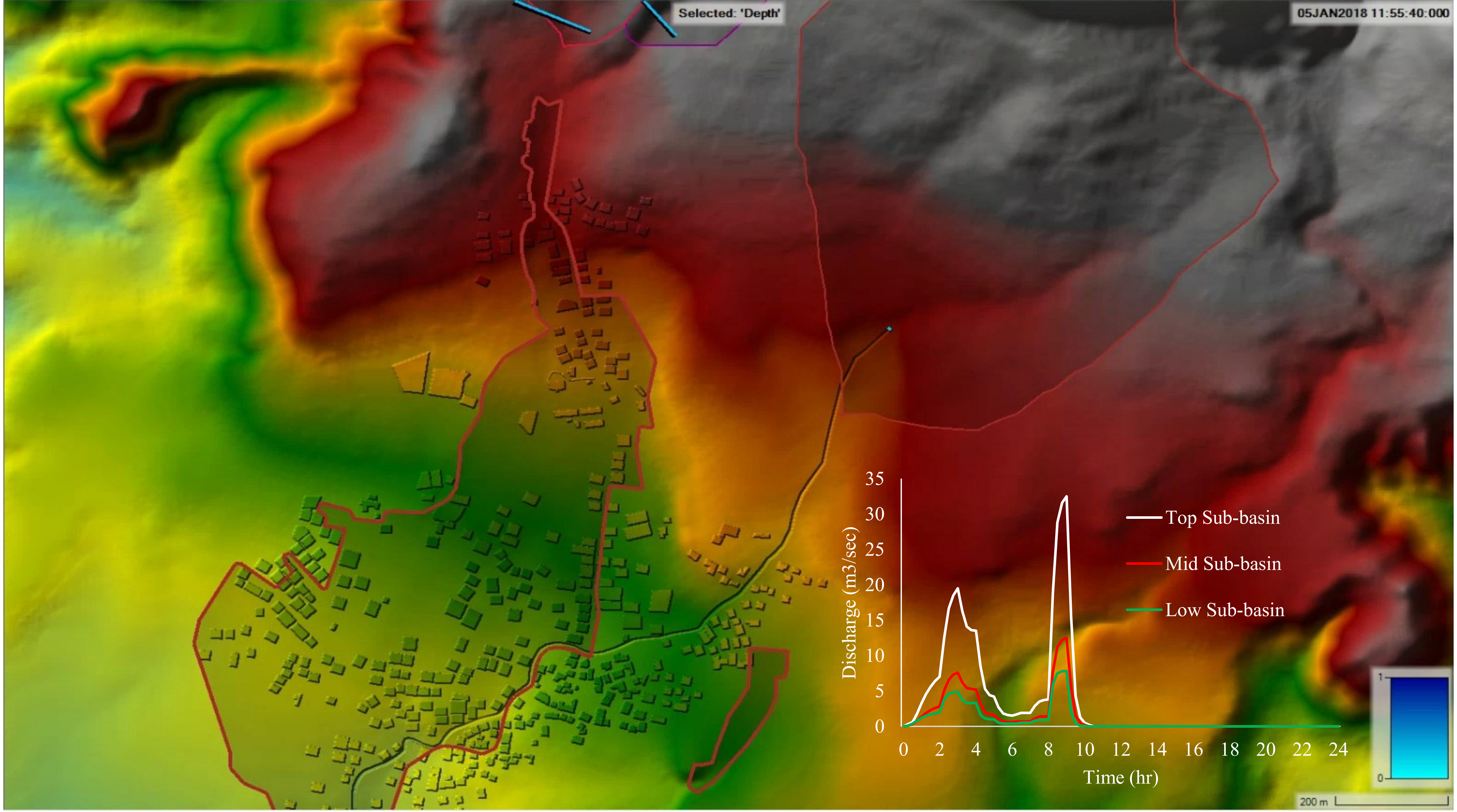
Rainfall Hyetographs

Mean Annual Maximum Daily Precipitation of Bogaz Station (Zaifoglu et al. 2018)

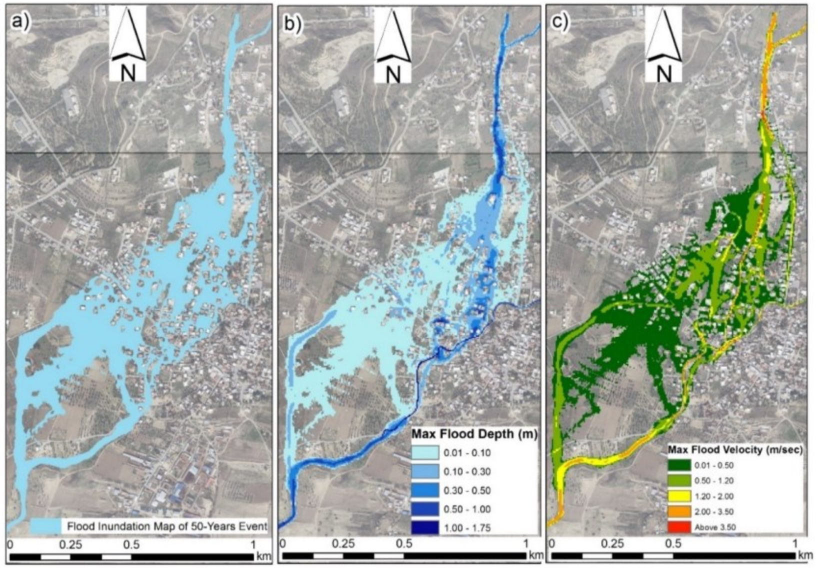




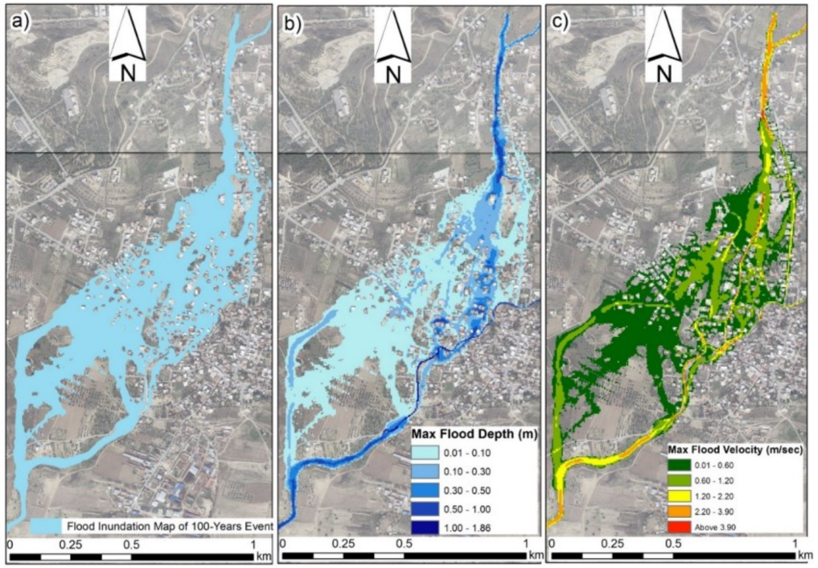



Selected: 'Depth'
05JAN2018 11:55:40:000
Discharge (m3/sec)
Time (hr)
Top Sub-basin
Mid Sub-basin
Low Sub-basin
200 m

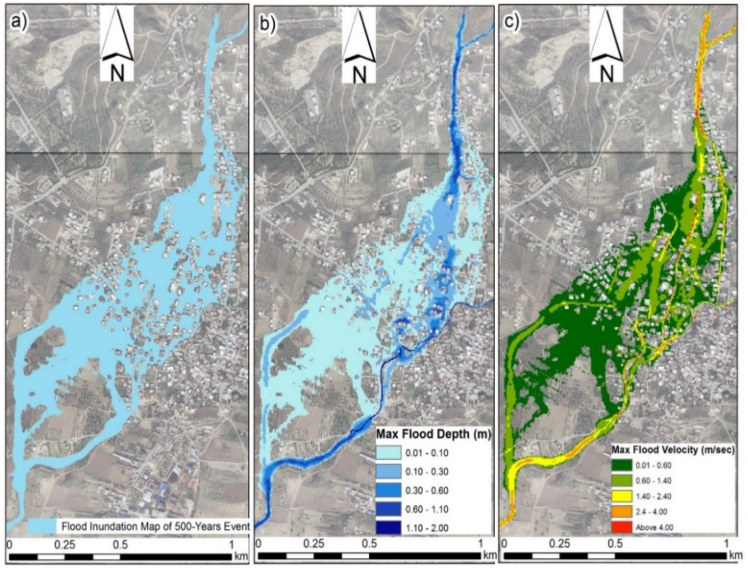
2D-Hydraulic Results 50, 100, 500-year Return Period Flood Events



Flood inundation Map, Max Depth, and Max Velocity Map of 50-Year Event



Flood inundation Map, Max Depth, and Max Velocity Map of 100-Year Event

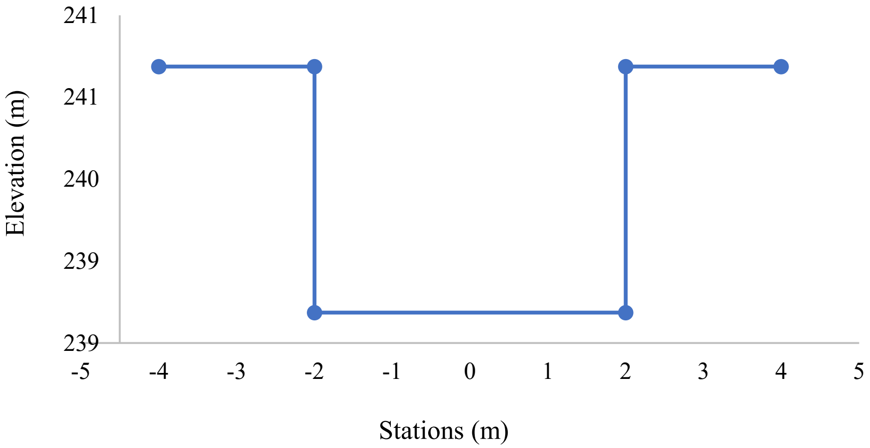


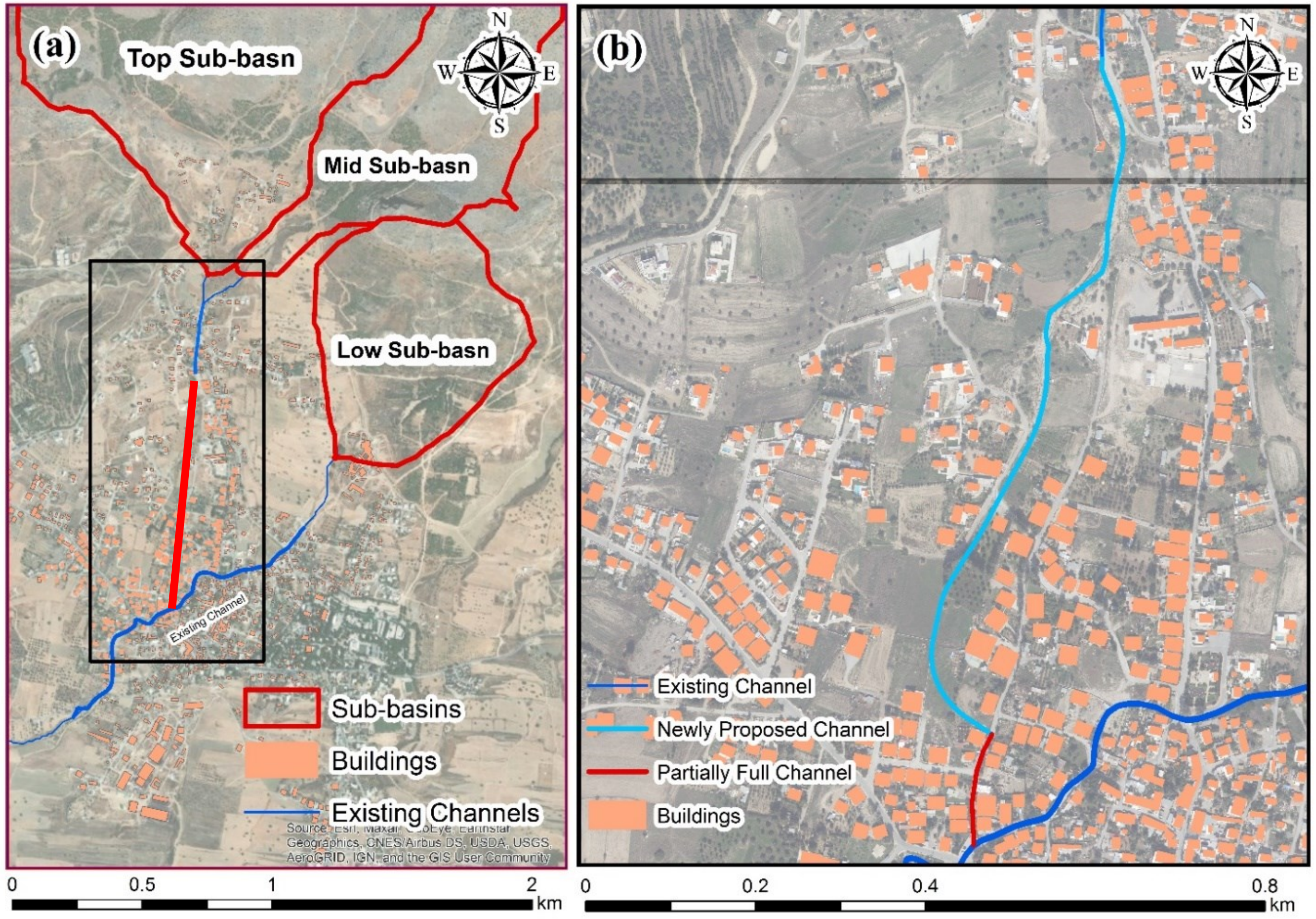
Flood inundation Map, Max Depth, and Max Velocity Map of 500-Year Event

Mitigation Measures – 1: Concrete Channel

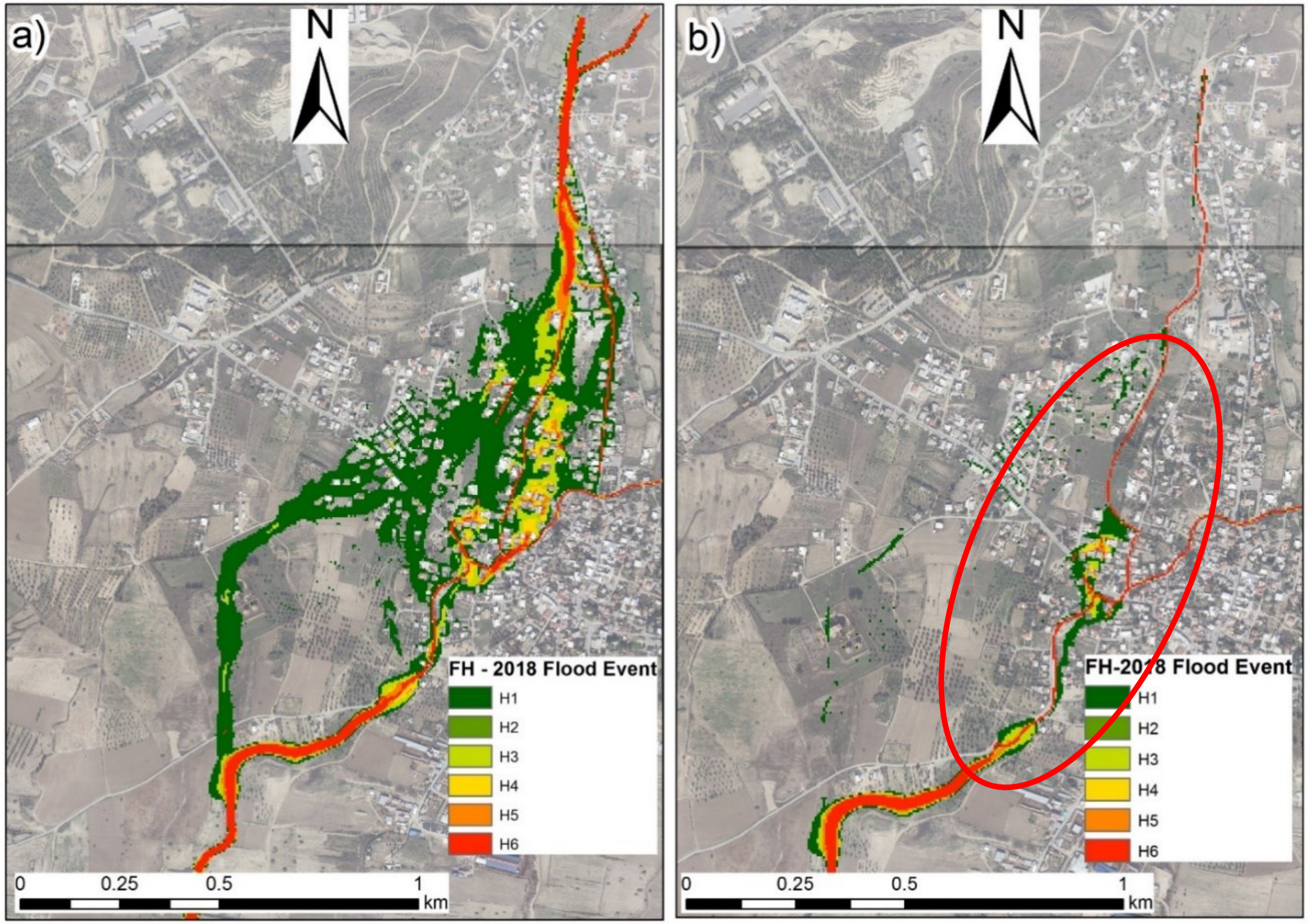
Channel Parameters	Values
n_1 stone wall	0.03
n_2 concrete walls	0.013
S_0(Varying)	0.012 - 0.033
W (m)	4.0
H (m)	1.8
Max Capacity (m^3/s)	26

Channel Cross section

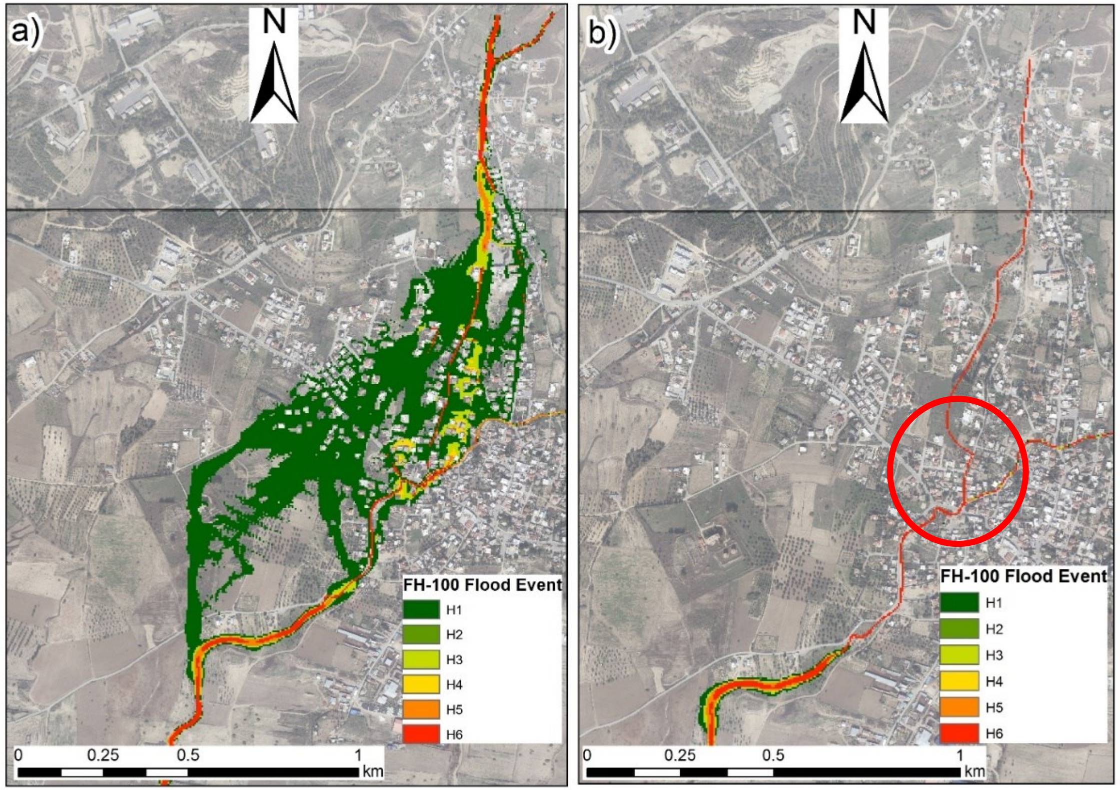




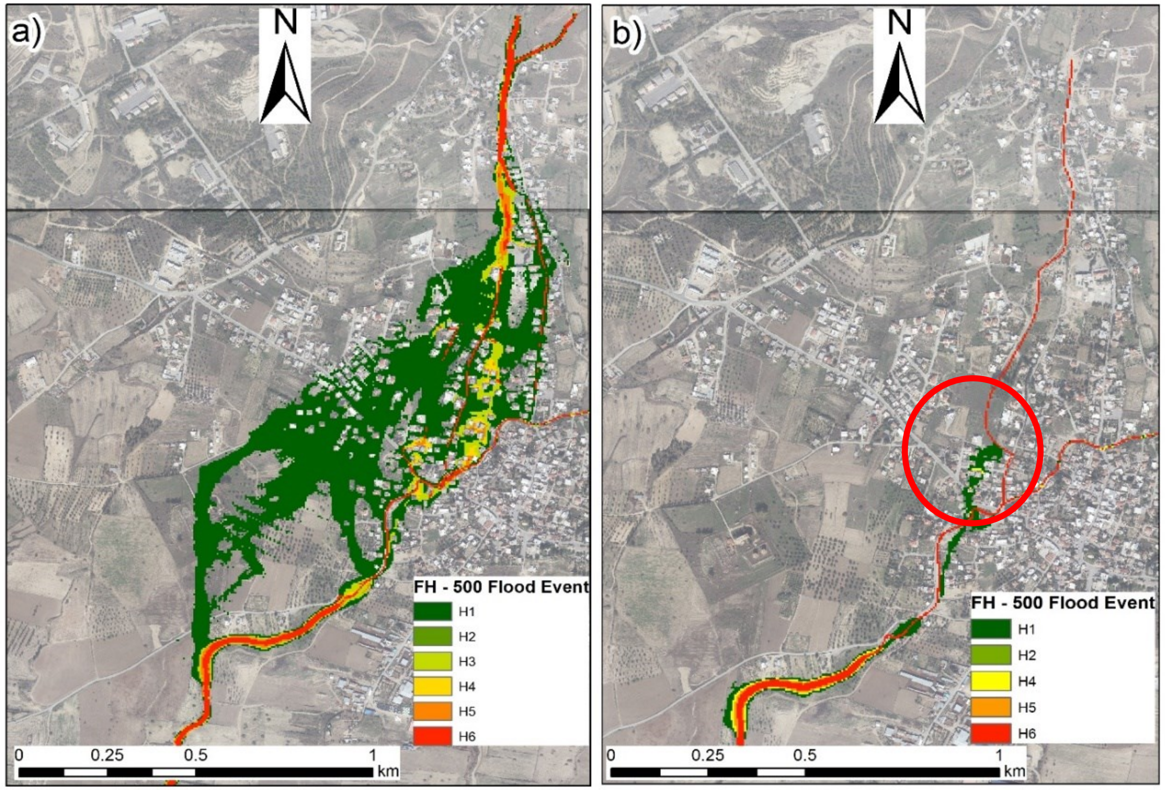
Changes in Flood Maps M-1: Concrete Channel



Flood Hazard of 2018 Flood Event. a) Before Channel, b) After Channel



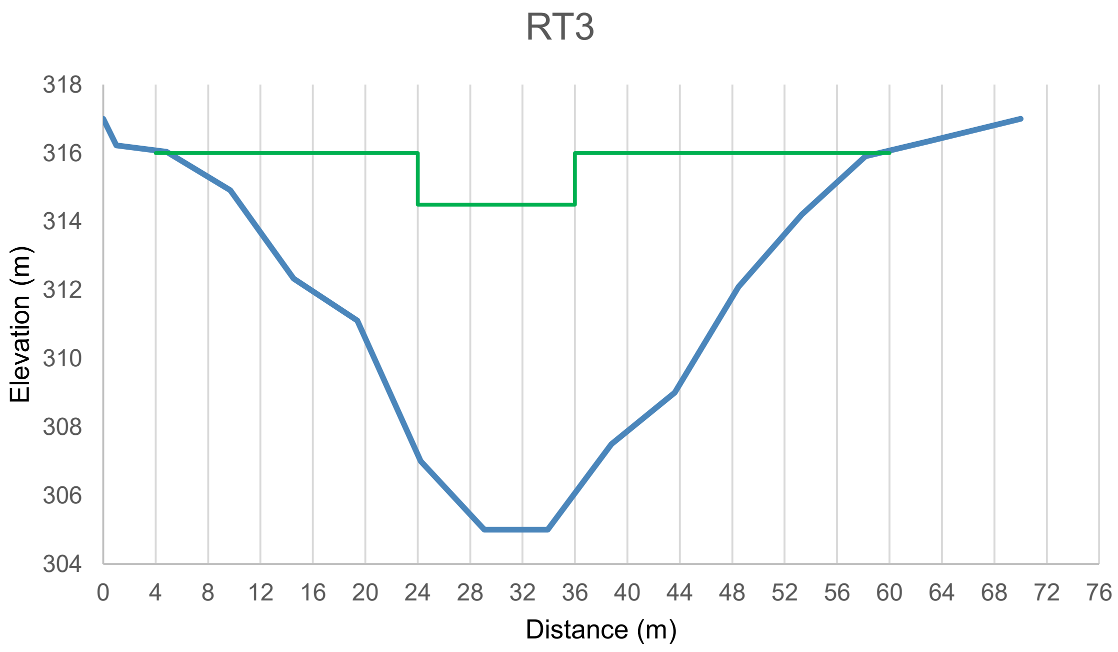
Flood Hazard of 100-Years Return Period Flood Event. a) Before Channel, b) After Channel



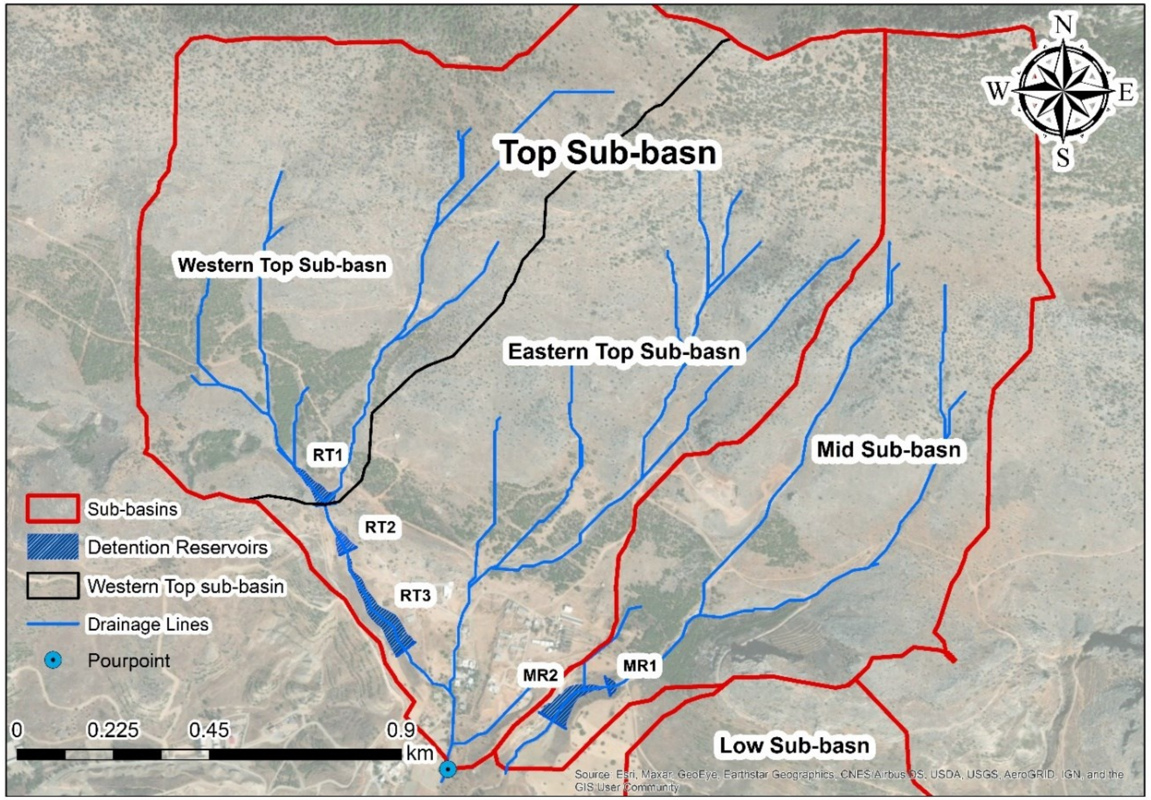
Flood Hazard of 500-Years Return Period Flood Event. a) Before Channel, b) After Channel

Mitigation Measures – 2: Reservoirs – Ignored Bottom Outlets Impacts

Proposed Detention Reservoirs Characteristics

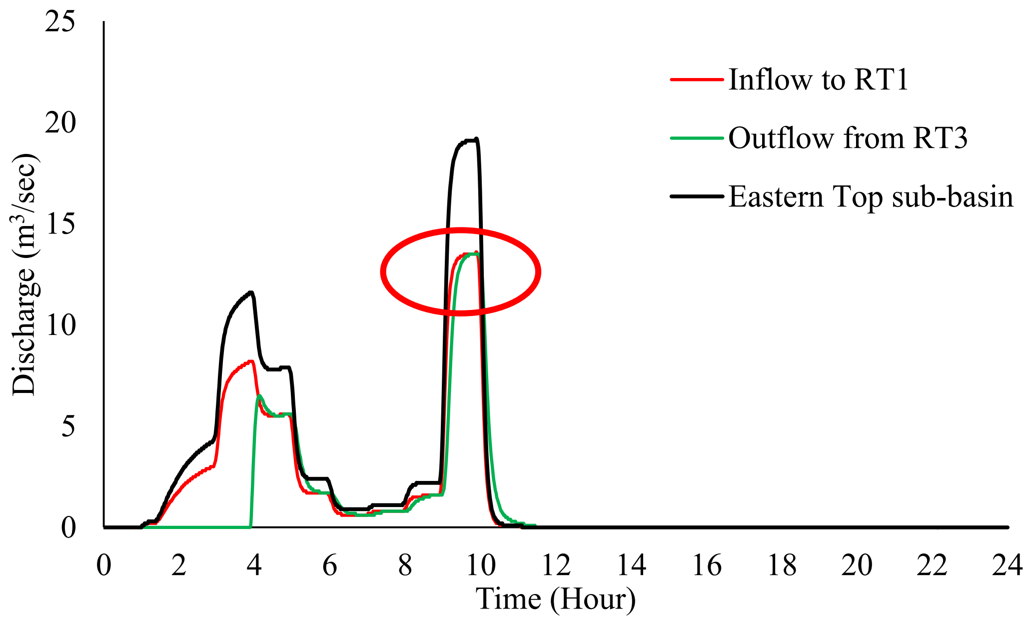


Reservoir Front View

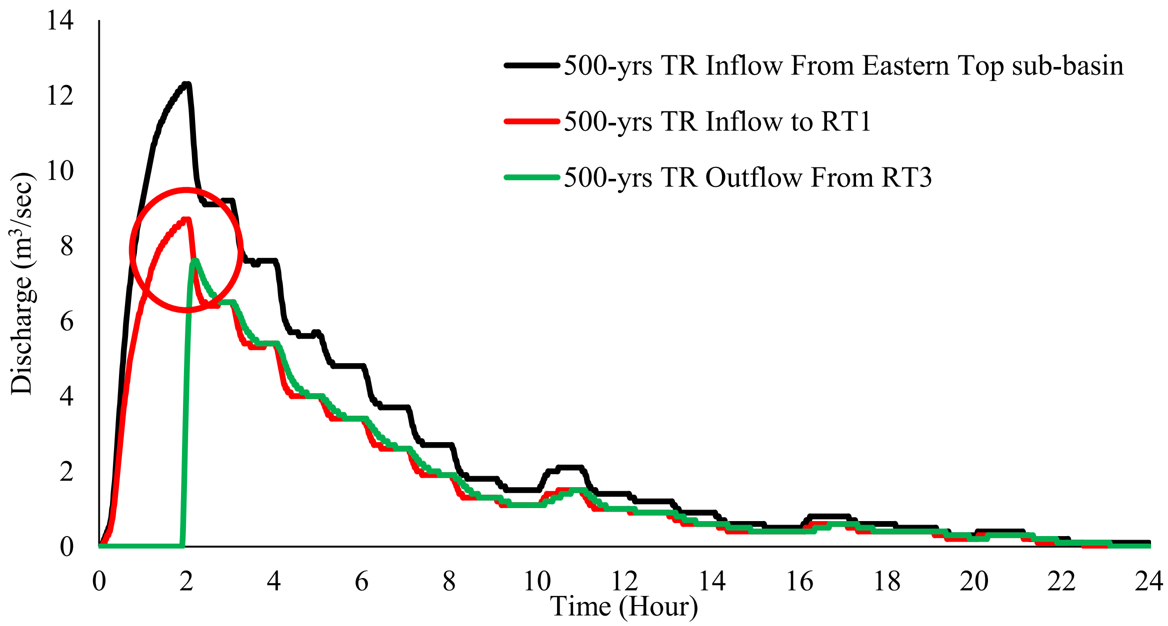


Selected Reservoirs Locations

Mitigation Measures – 2: Reservoirs – Ignored Bottom Outlets Impacts



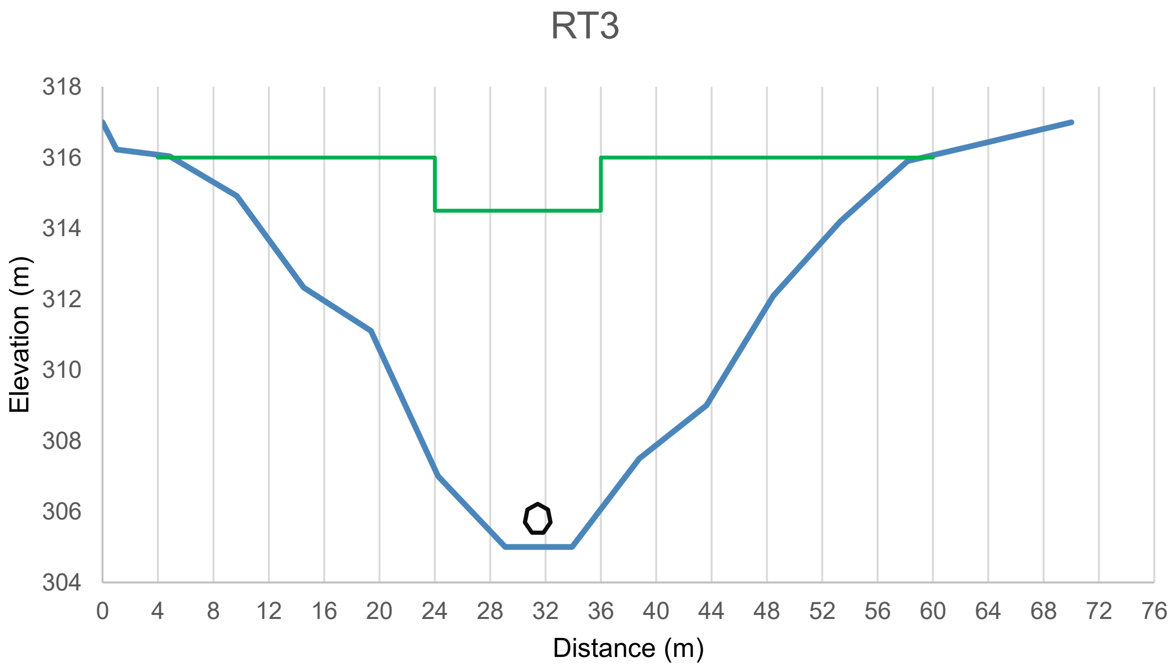
2018- Flood Routed Hydrograph After without bottom outlets Reservoirs in Top sub-basins



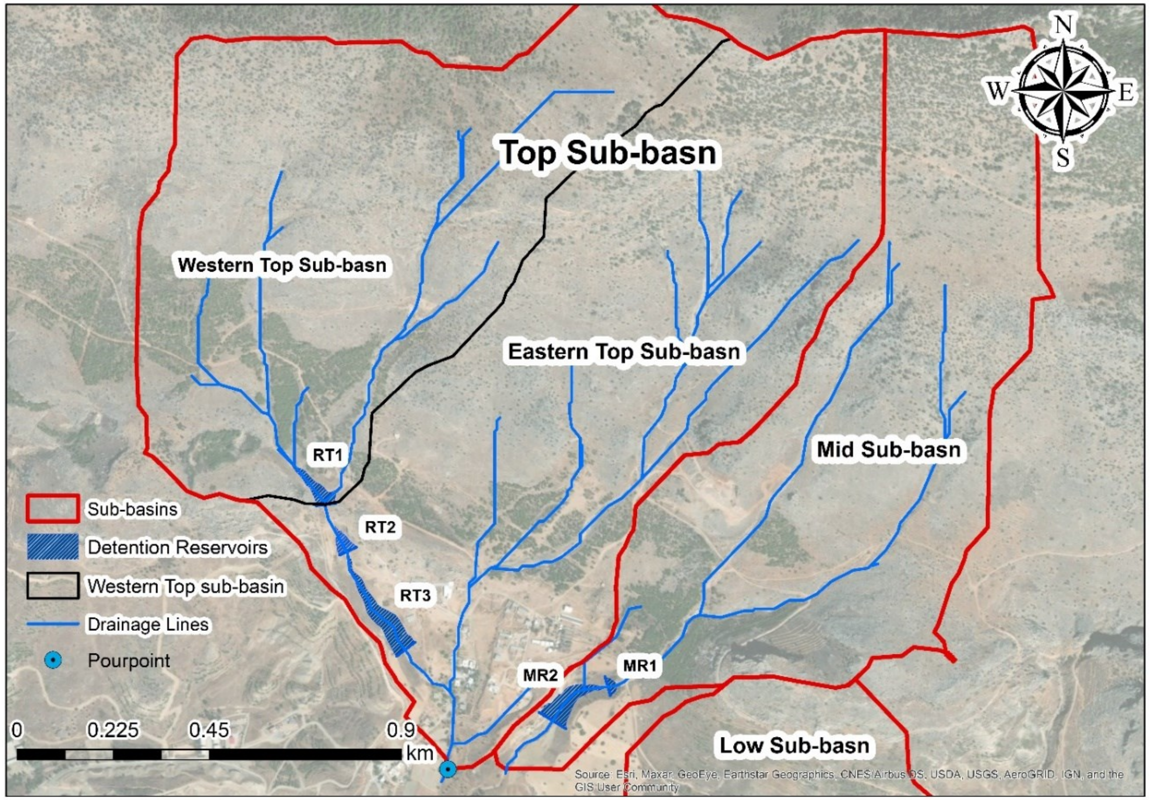
Reservoir W/O Bottom Outlet effects on 500-years Return Period Flood Hydrographs of Top sub-basin

Mitigation Measures – 2: Reservoirs With significant Bottom Outlets Impacts (0.5m, 1.0m, and 1.5m pipes)

Proposed Detention Reservoirs Characteristics

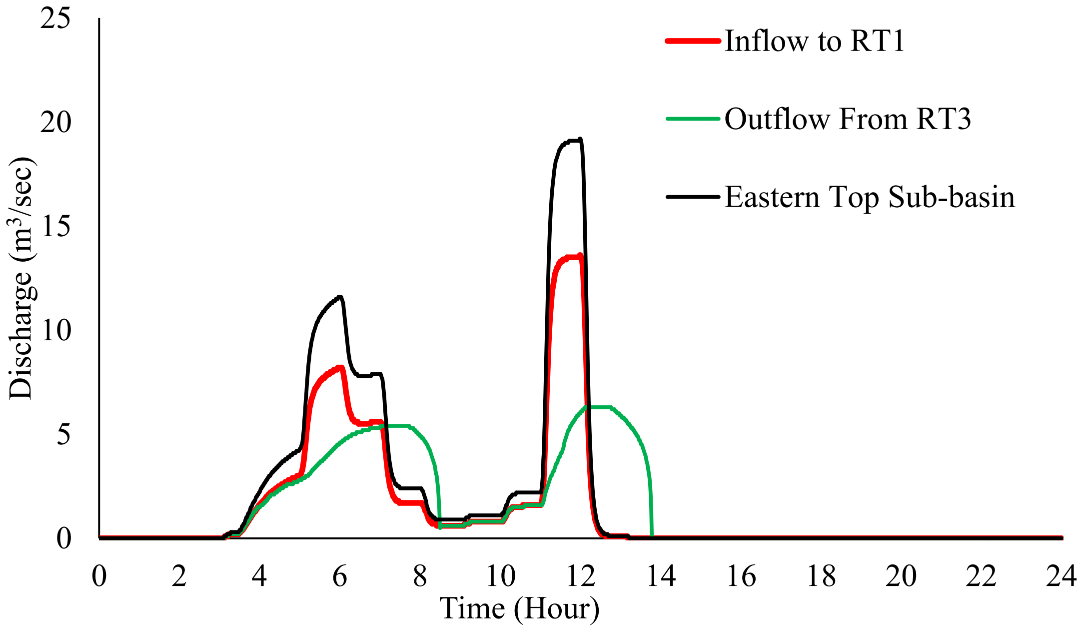


Reservoir Front View

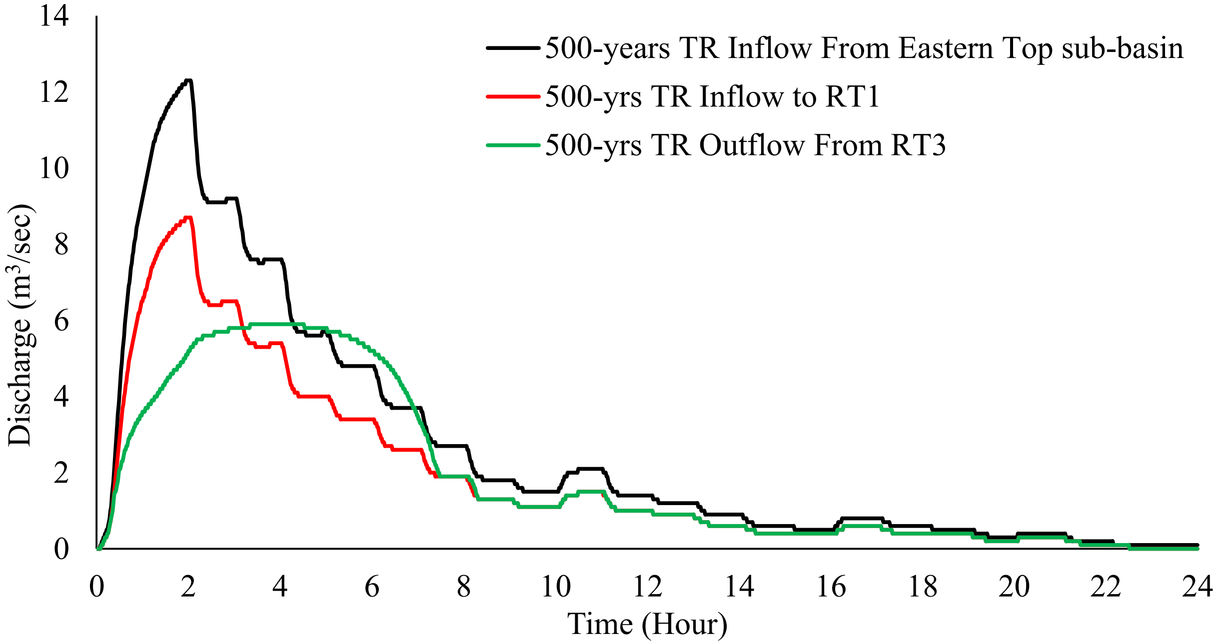


Selected Reservoirs Locations

Mitigation Measures – 2: Reservoirs – Optimum Bottom Outlets size - 1.0m



2018- Flood Routed Hydrographs after Reservoirs with 1.0 m Bottom Outlets in Top sub-basin



Effect of Reservoirs with 1.0 Diameter Bottom Outlets on 500-years Flood Hydrograph of Mid sub-basin

Mitigation Measures – 2: Reservoirs

Summary of the Flood Routing Analysis of Reservoirs 1.0 m Bottom Outlets

Flood Event	Sub-basins	Type	Name	Inflow		After Flood Routing			Discharges	
				Peak Time (H:m)	Peak value (m^3/sec)	Peak Time (H:m)	Peak value (m^3/sec)	ETS-B Inflow (m^3/sec)	W/O/R (m^3/sec)	W/R (m^3/sec)
2018 - Event	Top sub-basin	With 1.0 m Pipe Bottom Outlet	RT1	12:00	13.6	12:00	13.6	19.2	45.0	32.0
			RT3	12:00	13.6	12:25	6.3			
	Mid Sub-basin		MR1	12:00	12.6	12:00	12.6	-		
			MR2	12:00	12.6	12:00	7.[illegible]			
500-yrs TR	Top sub-basin		RT1	2:00	8.7	2:00	8.7	12.3	29.2	23.6
			RT3	2:00	8.7	4:00	5.9			
	Mid Sub-basin		MR1	2:00	8.2	2:00	8.2	-		
			MR2	2:00	8.2	3:00	6.2			
100-yrs TR	Top sub-basin		RT1	2:00	6.6	2:00	6.6	9.4	22.2	19.0
			RT3	2:00	6.6	3:25	5			
	Mid Sub-basin		MR1	2:00	6.2	2:00	6.2	-		
			MR2	2:00	6.2	2:15	5.3			
50-yrs TR	Top sub-basin		RT1	2:00	5.7	2:00	5.7	8.1	19.1	16.8
			RT3	2:00	5.7	3:40	4.6			
	Mid Sub-basin		MR1	2:00	5.4	2:00	5.4	-		
			MR2	2:00	5.4	2:10	4.8			

Mitigation Measures – 3: Integration of Concrete Channel and Reservoirs

Summary of the Flood Routing Analysis of Reservoirs 1.0 m Bottom Outlets

Flood Event	Sub-basins	Type	Name	Inflow		After Flood Routing			Discharges		
				Peak Time (H:m)	Peak value (m^3/sec)	Peak Time (H:m)	Peak value (m^3/sec)	ETS-B Inflow (m^3/sec)	W/O/R (m^3/sec)	W/R (m^3/sec)	Channel Capacity (m^3/s)
2018 - Event	Top sub-basin	With 1.0 m Pipe Bottom Outlet	RT1	12:00	13.6	12:00	13.6	19.2	45.0	32.0	26
			RT3	12:00	13.6	12:25	6.3				
	Mid Sub-basin		MR1	12:00	12.6	12:00	12.6	-			
			MR2	12:00	12.6	12:00	7.8				
500-yrs TR	Top sub-basin		RT1	2:00	8.7	2:00	8.7	12.3	29.2	23.6	26
			RT3	2:00	8.7	4:00	5.9				
	Mid Sub-basin		MR1	2:00	8.2	2:00	8.2	-			
			MR2	2:00	8.2	3:00	6.2				
100-yrs TR	Top sub-basin		RT1	2:00	6.6	2:00	6.6	9.4	22.2	19.0	26
			RT3	2:00	6.6	3:25	5				
	Mid Sub-basin		MR1	2:00	6.2	2:00	6.2	-			
			MR2	2:00	6.2	2:15	5.3				
50-yrs TR	Top sub-basin		RT1	2:00	5.7	2:00	5.7	8.1	19.1	16.8	26
			RT3	2:00	5.7	3:40	4.6				
	Mid Sub-basin		MR1	2:00	5.4	2:00	5.4	-			
			MR2	2:00	5.4	2:10	4.8				

Total 1035m Concrete Channel Approximate Cost

Description	Cost ($)
Excavation works	32,772
Open Channel works	168,562
Closed Channel Concrete works	29,160
Reinforcement steel work	77,760
Formwork	12,600
Total	320,854

Total cost of the Combined Mitigation Measures

Mitigation Measures	Cost ($)
Mitigation Measure – 1: Concrete Channel	320,854
Mitigation Measure – 2: Reservoirs	605,913
Mitigation Measure -3 : Channel + Reservoirs	926,767

Summary and Conclusion

- Topographic data are processed in ArcGIS, to obtain (Area, slope, stream networks, watershed boundaries, etc.)
- Hydrological Model of the ungauged catchments (Top, Mid, and Low sub-basins). (HEC-HMS)
- Developed a calibrated 2D - Hydraulic Model of the Dikmen urban area in HEC-RAS.
- The effects of concrete channel, five reservoirs, and integrated channel and reservoirs are investigated.
- The implementation of reservoir along with the channel can decrease the flood damages against rare extreme rainfall events. Also reservoirs can contribute to the recharging the groundwater resources. However, the cost is almost 3 times the cost of the channel only.
- At this stage the concrete channel with the given dimensions is the most applicable solution that needs to be considered.

Thank You

References

[1] https://www.usgs.gov/faqs/what-are-two-types-floods

[2] Zaifoglu, H., Yanmaz, A. M., & Akintug, B. (2019). Developing flood mitigation measures for the northern part of Nicosia. *Natural Hazards*, *98*(2), 535-557.

[3] ŞAHİN, E., AKINTUĞ, B., & Yanmaz, A. M. (2013). Modeling of Morphou (Güzelyurt) Flood and Remedial Measures. *Teknik Dergi*, *24*(120).

[4] Baltaci H (2017) Meteorological analysis of flash floods in Artvin (NE Turkey) on 24 August 2015. Nat Hazards Earth Syst Sci 17:1221–1230. https://doi.org/10.5194/nhess-17-1221-2017

[5] Kocaman S, Tavus B, Nefeslioglu HA, et al (2020) Evaluation of Floods and Landslides Triggered by a Meteorological Catastrophe (Ordu, Turkey, August 2018) Using Optical and Radar Data. Geofluids 2020:. https://doi.org/10.1155/2020/8830661