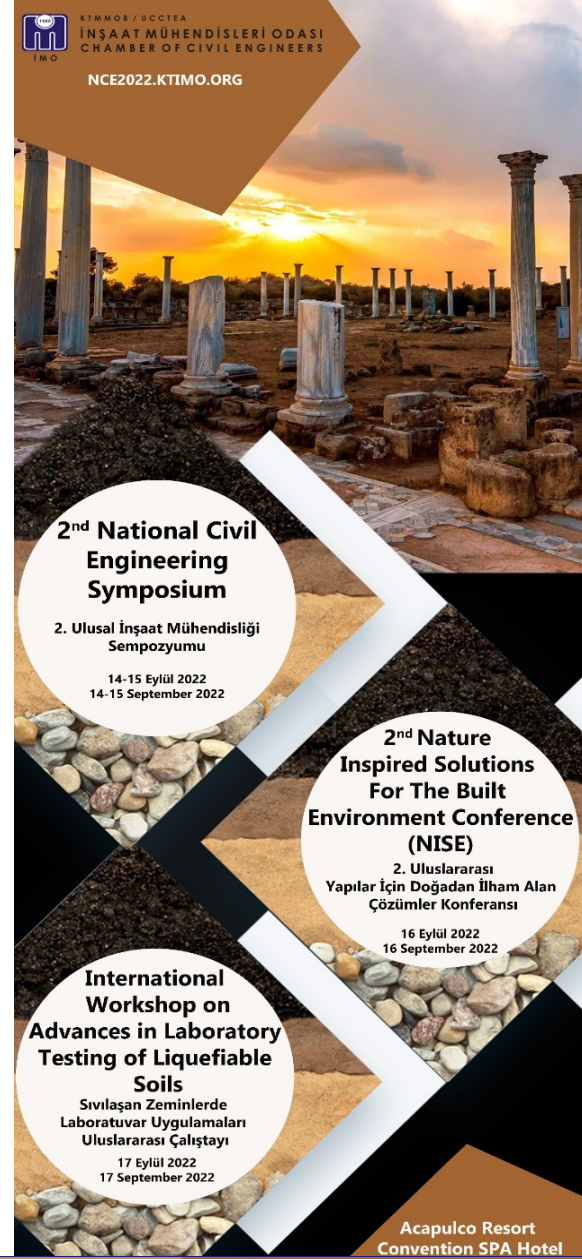


Sustainable Stormwater Management Practices for Middle East Technical University, Northern Cyprus Campus

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2. Ulusal İnşaat Mühendisliği Sempozyumu
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North Cyprus

14 -17 Eylül 2022
14 - 17 September 2022

Outline

- **Climate change and Water Crisis**
- **Climate change effects in Cyprus**
- **Sustainable Stormwater Management**
- **SWMM Software**
- **SWMM Software Operations**
- **Research Area**
- **Methodology**
- **Results**
- **Conclusions**

Climate Change and Water Crisis

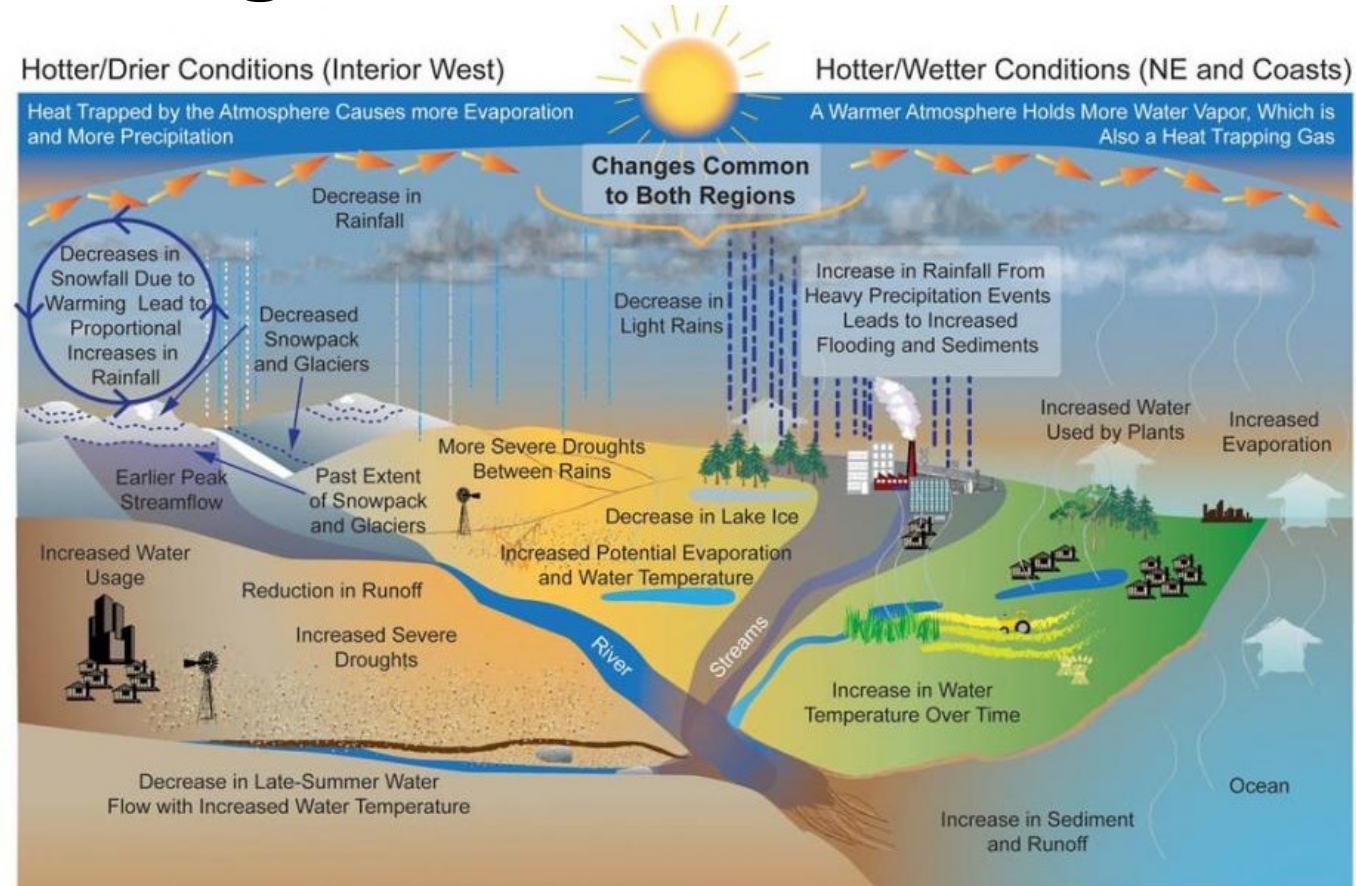


Figure 1. Projected changes in the water cycle [1].

Climate Change Effects in Cyprus

1. Increasing trend in annual mean temperatures with a rate of 0.01 °C per year [2].
2. There is an increase in the length and number of heatwaves by a factor of 6 to 8 since the 1960s in Eastern Mediterranean region [2].
3. Mean annual precipitation decreased during the last century by 1mm/year on average [2].
4. The groundwater is being depleted and the quality of groundwater has reduced due to over-pumping of the aquifers leading to the entry of salt water [3].
5. Unequal rainfall distribution may result in Urban flooding.

Sustainable Stormwater Management

- **Green Roof**

1. Reduce Heat Island effect.
2. Control the Effects of Atmospheric pollution.
3. Controls Urban runoff.



Sustainable Stormwater Management

- **Permeable Pavements**

1. Allows water to infiltrate in the soil.
2. The gaps/ pores are filled with Sand or Gravel.



Sustainable Stormwater Management

- **Bioretention Areas**

1. Shallow, Landscaped depressions which allows runoff to pond in a designated area.
2. Allows water to infiltrate through soil and Vegetation.



Sustainable Stormwater Management

- **Rainwater Harvesting (RWH)**

1. Allows storage of rain rather than allowing it to runoff.
2. Reduces the peak discharge.
3. Water collected can later be used in non-potable applications.



SWMM Software

LID Control Editor

Control Name:

LID Type: Bio-Retention Cell

- Bio-Retention Cell
- Rain Garden
- Green Roof
- Infiltration Trench
- Permeable Pavement
- Rain Barrel
- Rooftop Disconnection
- Vegetative Swale

*Optional

OK Cancel Help

Surface	Soil	Storage	Drain
Berm Height (in. or mm)			
Vegetation Volume Fraction			
Surface Roughness (Mannings n)			
Surface Slope (percent)			

Figure 2. LID Control Editor Options [4].

SWMM Software Operations

Subcatchment Basin2

Property	Value
Name	Basin2
X-Coordinate	1582.200
Y-Coordinate	739.200
Description	green
Tag	
Rain Gage	Gage1
Outlet	J18
Area	4.4691
Width	52.88
% Slope	2.31
% Imperv	64.52
N-Imperv	0.01
N-Perv	0.1
Dstore-Imperv	0.05

User-assigned name of subcatchment

Figure 3. Sub catchment options [4].

Time Series Editor

Time Series Name
Rainfall

Description

☐ Use external data file named below

☒ Enter time series data in the table below

No dates means times are relative to start of simulation.

Date (M/D/Y)	Time (H:M)	Value
	00:00	0
	00:10	18.48
	00:20	27.72
	00:30	46.2
	00:40	6.6
	00:50	21.12
	00:60	11.88

View

OK

Cancel

Help

Figure 4. Rainfall options [4].

Research Area – METU (Northern Cyprus Campus)



Figure 5. Aerial view of Middle East Technical University [5].

Research Area – METU (Northern Cyprus Campus)

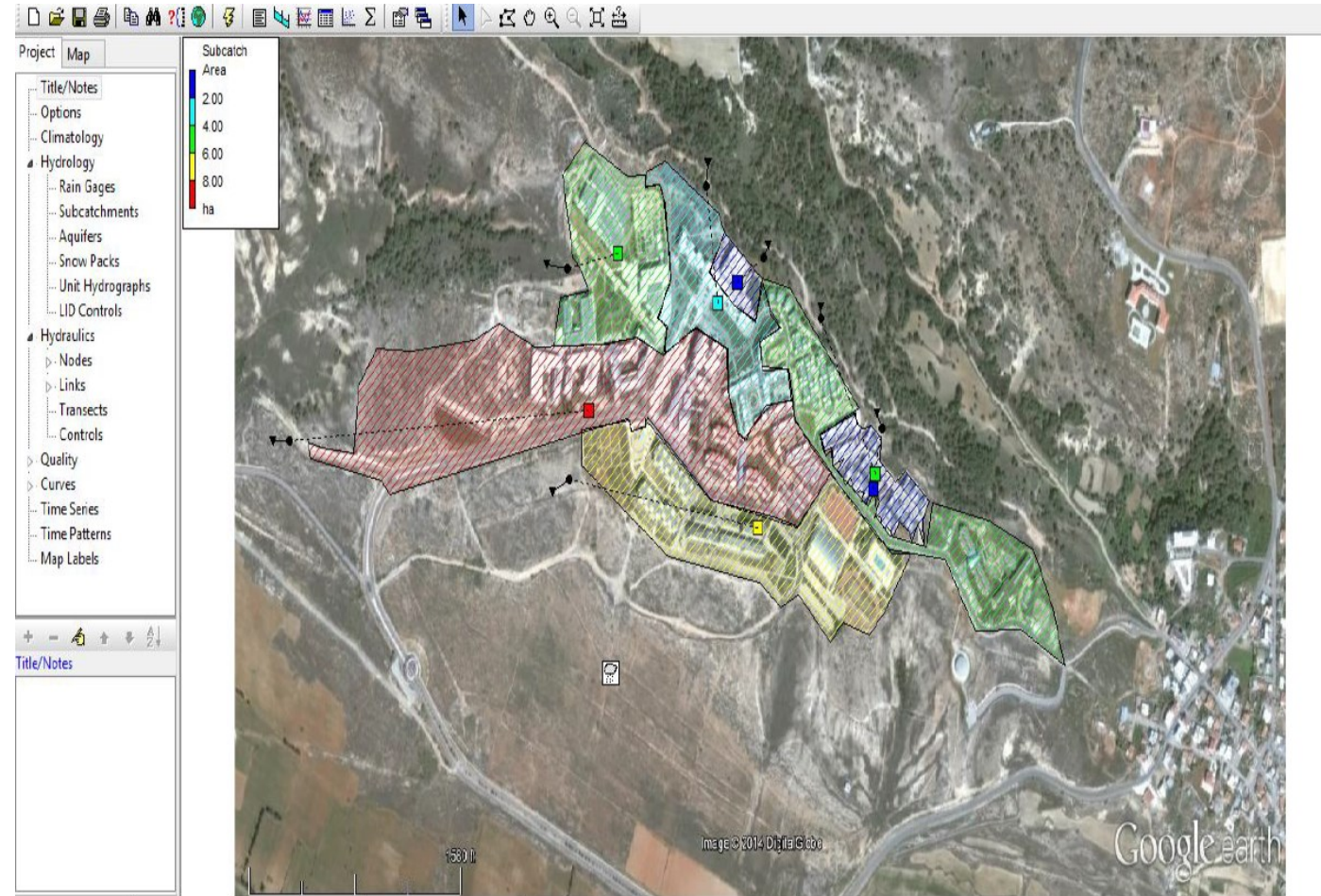


Figure 6. Basins of the research area [5].

Methodology

Sub catchments
are designed in
SWMM

Rainfall event of
22mm/hr is used
as an input

The rainfall event
is simulated
without applying
SSWMP

Rainwater
Harvesting is
employed at
every building

The rainfall event
is simulated again
with applying
SSWMP

The changes in
the Total runoff
and Peak
discharge is
observed by
changing the
RWH tank sizes

Results

- Without application of Sustainable stormwater management practices the total runoff is 280 m^3 and the Peak Discharge is 0.14 CMS.
- Total water stored is 120 m^3 .

Table 1. Results after simulation for Basin 1.

Tank Size (m^3)	Total volume of runoff (m^3)	Total reduction of runoff (%)	Peak Discharge (CMS)	Total reduction in peak discharge (%)
1	250	10.7	0.14	0
2	220	21.4	0.14	0
3	190	32.1	0.11	21.4
4	160	42.8	0.07	50



Figure 7. Basin 1.

Results

- Without application of Sustainable stormwater management practices the total runoff is 750 m^3 and the Peak Discharge is 0.29 CMS.
- Total water stored is 180 m^3 .

Table 2. Results after simulation for Basin 2.

Tank Size (m^3)	Total volume of runoff (m^3)	Total reduction of runoff (%)	Peak Discharge (CMS)	Total reduction in peak discharge (%)
1	720	4	0.29	0
2	690	8	0.29	0
3	660	12	0.29	0
4	630	16	0.23	20.6
5	600	20	0.20	31.1
6	570	24	0.17	41.4

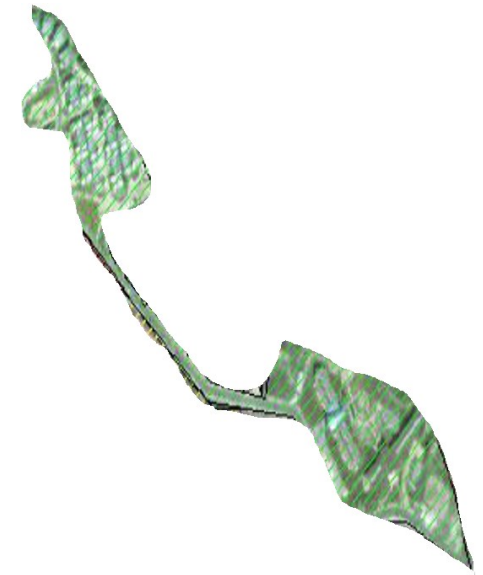


Figure 8. Basin 2.

Results

- Without application of Sustainable stormwater management practices the total runoff is 600 m^3 and the Peak Discharge is 0.28 CMS.
- Total water stored is 150 m^3 .

Table 3. Results after simulation for Basin 3.

Tank Size (m^3)	Total volume of runoff (m^3)	Total reduction of runoff (%)	Peak Discharge (CMS)	Total reduction in peak discharge (%)
1	570	5	0.28	0
2	540	10	0.28	0
3	510	15	0.28	0
4	480	20	0.26	7.1
5	450	25	0.16	42.8



Figure 9. Basin 3.

Results

- Without application of Sustainable stormwater management practices the total runoff is 880 m^3 and the Peak Discharge is 0.42 CMS.
- Total water stored is 220 m^3 .

Table 4. Results after simulation for Basin 4.

Tank Size (m^3)	Total volume of runoff (m^3)	Total reduction of runoff (%)	Peak Discharge (CMS)	Total reduction in peak discharge (%)
12	700	20.4	0.42	0
13	690	21.5	0.41	2.3
14	670	23.9	0.36	14.2
15	660	25	0.31	26.1



Figure 10. Basin 4

Results

- Without application of Sustainable stormwater management practices the total runoff is 1930 m^3 and the Peak Discharge is 0.68 CMS.
- Total water stored is 270 m^3 .

Table 5. Results after simulation for Basin 5.

Tank Size (m^3)	Total volume of runoff (m^3)	Total reduction of runoff (%)	Peak Discharge (CMS)	Total reduction in peak discharge (%)
5	1760	8.8	0.68	0
6	1730	10.3	0.65	4.4
7	1690	12.5	0.53	22
8	1660	14	0.49	28

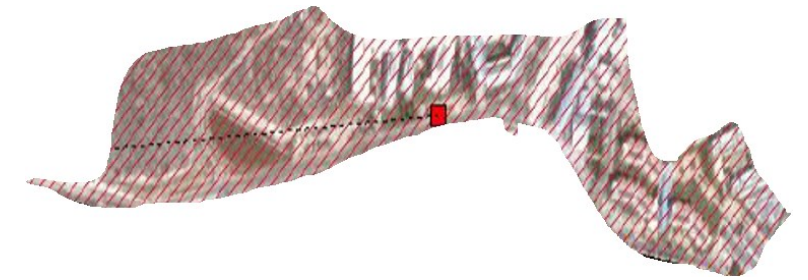


Figure 11. Basin 5

Results

- Without application of Sustainable stormwater management practices the total runoff is 1230 m^3 and the Peak Discharge is 0.49 CMS.
- Total water stored is 220 m^3 .

Table 6. Results after simulation for Basin 6.

Tank Size (m^3)	Total volume of runoff (m^3)	Total reduction of runoff (%)	Peak Discharge (CMS)	Total reduction in peak discharge (%)
8	1070	13	0.49	0
9	1050	14.6	0.45	8.1
10	1030	16.2	0.39	20.4
11	1010	17.9	0.33	32.6



Figure 12. Basin 6

Results

- Without application of Sustainable stormwater management practices the total runoff is 140 m^3 and the Peak Discharge is 0.08 CMS.
- Total water stored is 60 m^3 .

Table 7. Results after simulation for Basin 7.

Tank Size (m^3)	Total volume of runoff (m^3)	Total reduction of runoff (%)	Peak Discharge (CMS)	Total reduction in peak discharge (%)
12	100	28.5	0.08	0
13	90	35.7	0.07	12.5
14	90	35.7	0.06	25
15	80	43	0.04	50



Figure 13. Basin 7

Conclusion

1. With application of Sustainable stormwater management practices the total volume of 1220 m^3 is stored which is 21% of the total runoff produced.
2. The system is not only able to control the peak discharge from the rainfall event of 22mm/hr but will also control the peak discharge from events ranging from 28mm/hr to 30mm/hr.
3. Future work for this research would be finding an economically feasible solution by using other Sustainable Stormwater Management Practices like Green roof, Bioretention areas and permeable pavements.

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Thank you all for Listening



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