DECISION SUPPORT FOR INVESTMENTS ON ROOFTOP RAINWATER HARVESTING TANKS IN TURKEY

Climate Adaptation Days 2022

«Klimatilpasningsdagene 2022»

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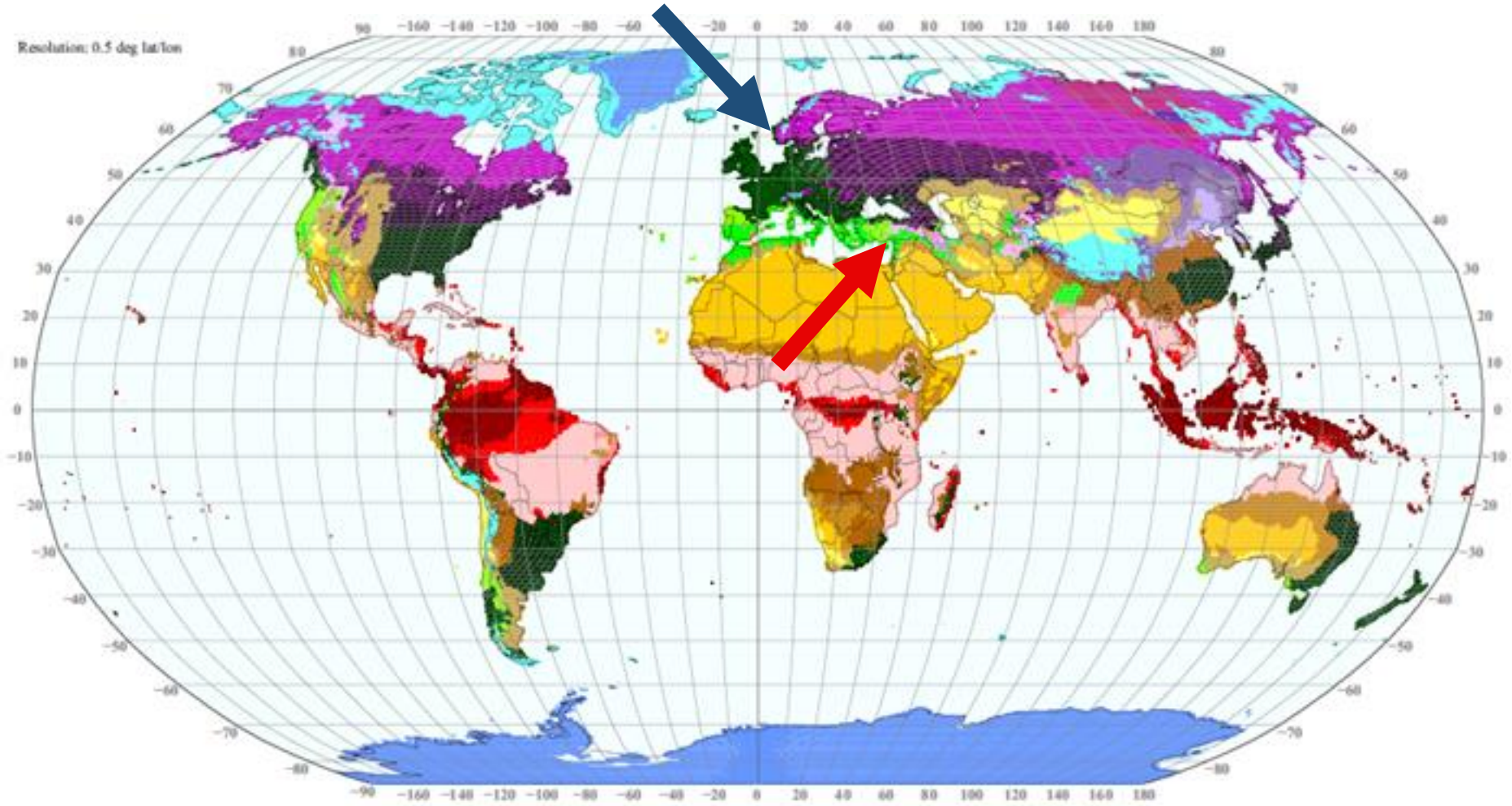
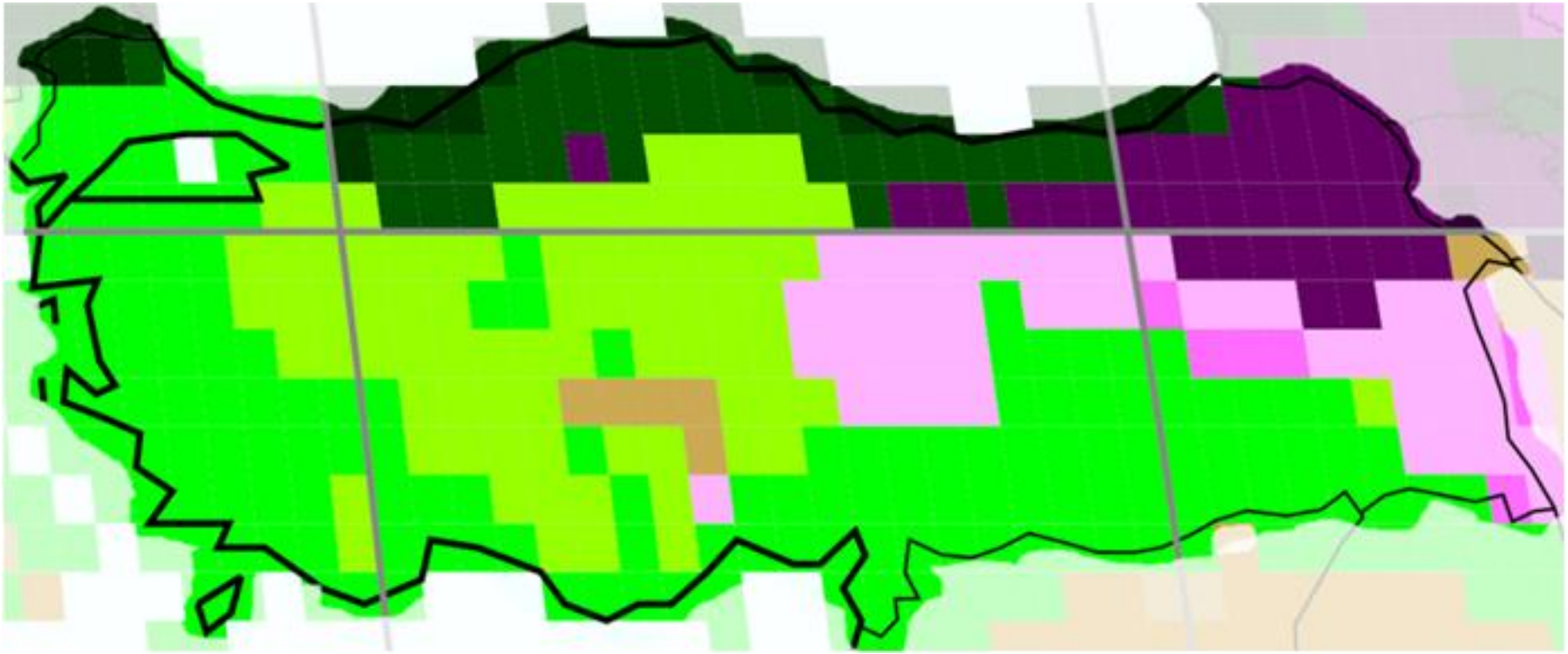
21 September 2022

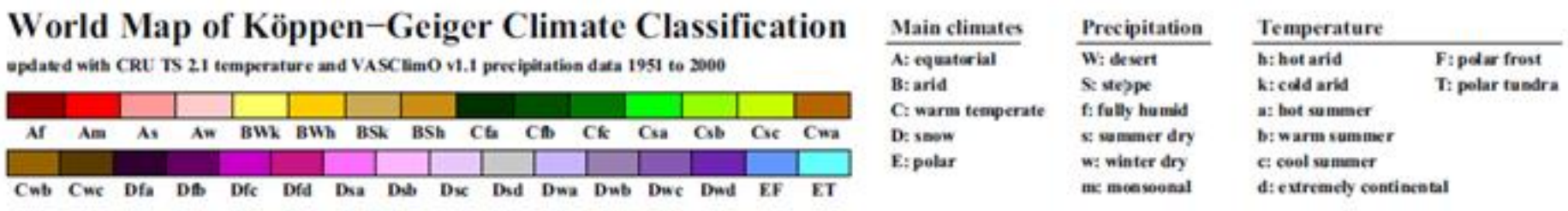
INTRODUCTION



KONYA
TEKNİK ÜNİVERSİTESİ

INTRODUCTION





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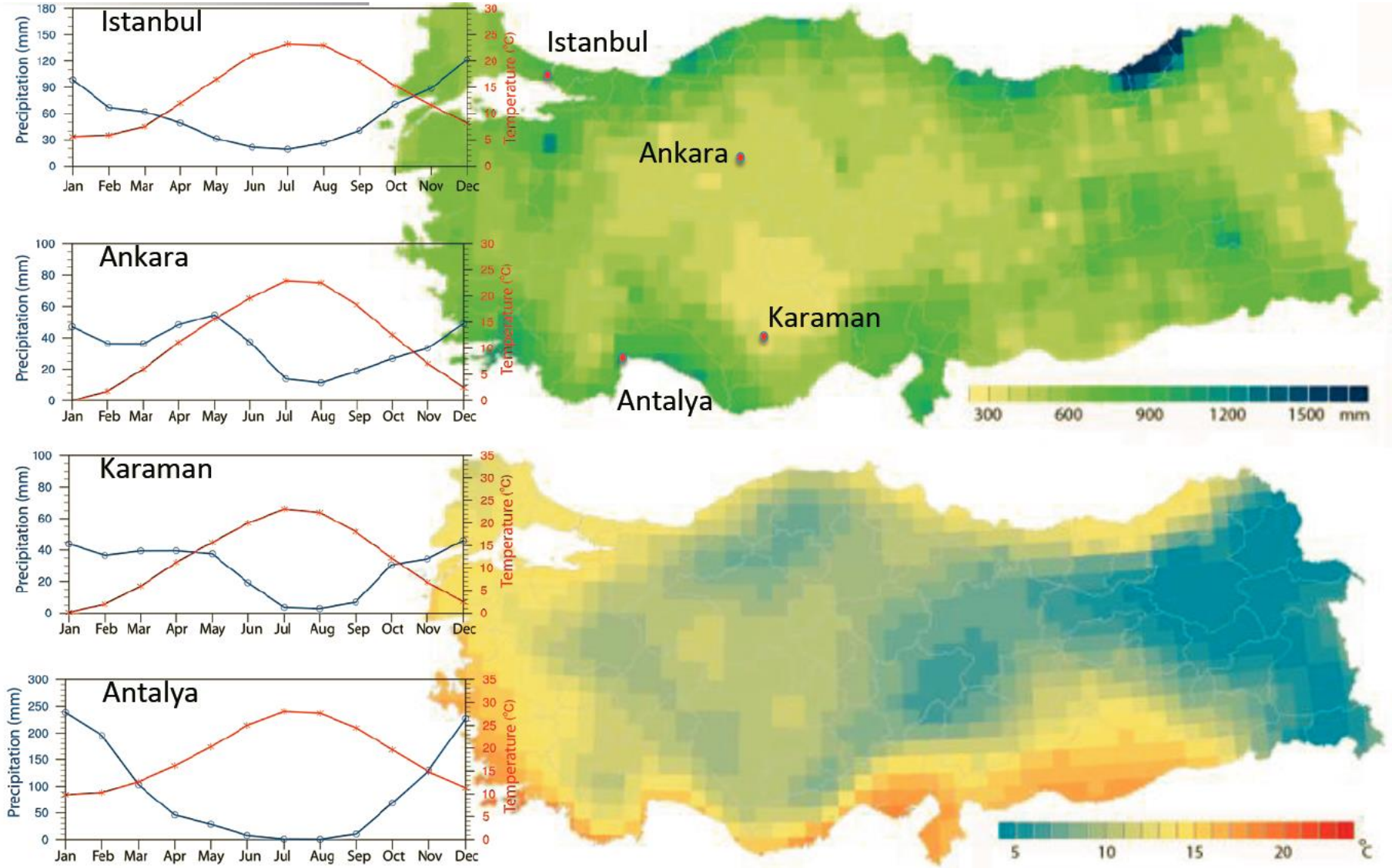

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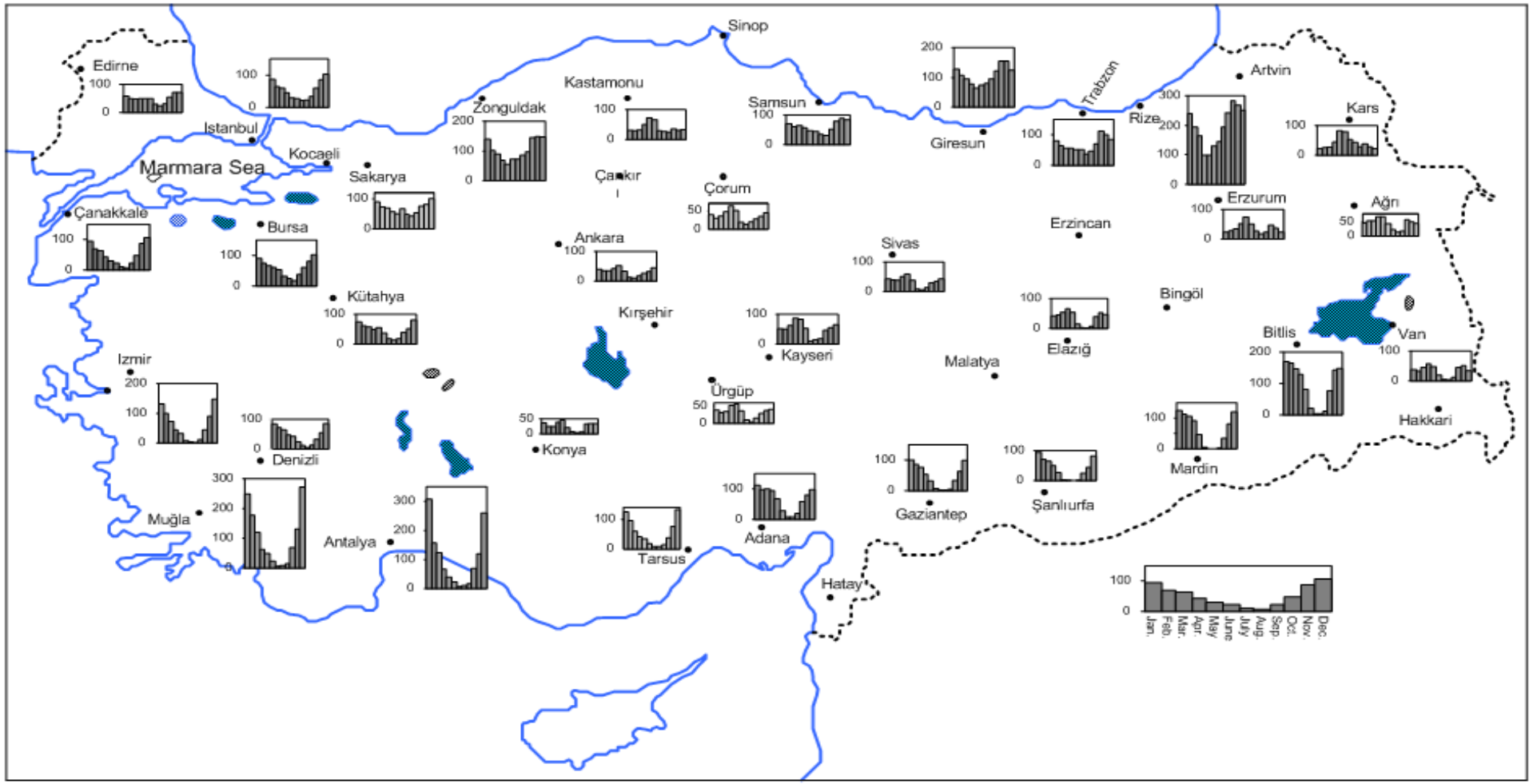

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INTRODUCTION

Turkey is not a water rich country in terms of existing water potential. Approximately **1400 m³ fresh water per capita** is available.

Turkish Statistical Institute has estimated that the population will reach 100 million and water availability in Turkey will fall **1100 m³ per capita by 2030**.

The water availability per capita is **1/5 of the world average** for Turkey.

In 2018, internal renewable water resources per capita for Norway was **71,563 cubic meters**. Internal renewable water resources per capita of Norway fell gradually from 94,453 cubic meters in 1977 to 71,563 cubic meters in 2018.

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INTRODUCTION

Rainwater harvesting has become a worldwide popular application recently for water resources management in sustainability context.

Water resources have been becoming scarce due to the climate change driven disasters, especially by the effects of prolonged droughts.

Significant water conservation especially in public/commercial buildings with larger roof areas can be achieved by rainwater harvesting and using it in flushing reservoirs where most of the water is used.

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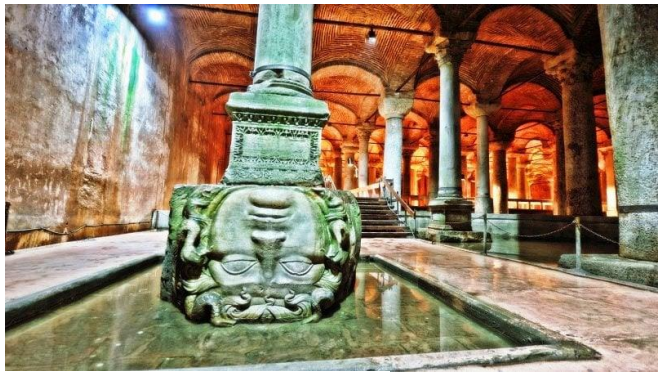
INTRODUCTION

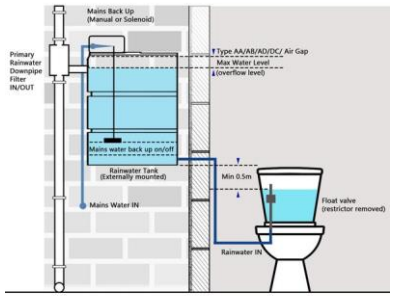
Rainwater harvesting is an ancient method and many civilizations have used rainwater to supply water.

In ancient times, rooftop rainwater harvesting was applied throughout the Mediterranean region and Asia. The collected rainwater was usually stored in underground cisterns.

Yerebatan Saray in Istanbul is known as the largest cistern in the Mediterranean region with a storage potential of approximately 80000 m^3.

Discharge of rainwater to sewerage can be avoided and collected instead and used for domestic (toilet flushing) and non-domestic (recreational irrigation and industrial uses).





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MOTIVATION OF STUDY

- ✓ In a new regulation in Turkey under the title of "Regulation on the Amendment of the Planned Areas" prepared by the Ministry of Environment and Urbanization and enacted on 11 July 2021 (Official Gazette, 2021), is mentioned that a rainwater collection system needs to be installed on new buildings.
- ✓ With this regulation, considering the increasing drought problems, it is obligatory to construct a rainwater collection system to collect the rainwater from the roofs of all buildings to be built on parcels larger than 2000 m2.
- ✓ It is stated in the regulation that the collected rainwater should be filtered and stored in the tank for the use of toilet flushing primarily. Excessive collected water can be used for garden irrigation.
- ✓ However, the calculation of the volumes of the storage tanks in the regulation is not very clear, only mentioning that the storage tank volume should be calculated based on the maximum average monthly precipitation of the province and the roof area of the building.
- ✓ By the effectiveness of this regulation, it has been announced that there will be many incentives on RHS in Turkey. Hence, by the enforcement of this regulation, there will be an increase on RHS applications in Turkey.

SUMMARY OF STUDY

- ✓ Rooftop rainwater harvesting potential has been assessed for all 81 provinces of Turkey.
- ✓ Precipitation Concentration Index (PCI) was used for rainfall regime analysis and Rippl method (RM) for optimal storage tank estimation.
- ✓ The influence of PCI on the storage tank sizing has been investigated.
- ✓ Two scenarios have been assessed using RM for;
  - I) Individual houses (6-member family toilet flushing water demand), and
  - II) Public/commercial buildings (20 employees toilet flushing water demand).
- ✓ Optimal storage tank for scenario I and II has been estimated by the assessment of sufficient roof areas to supply the demand of toilet flushing water with 90-100% volumetric reliability.
- ✓ ArcGIS has been used to illustrate nationwide results of the assessment of payback period for storage tanks.

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MATERIAL AND METHODS

- The monthly rainfall data of recent 58 years was used in this study.

- The data from 81 stations were used to represent all the provinces of Turkey geographically.

Historical rainfall data was obtained from the Turkish State Meteorological Services.

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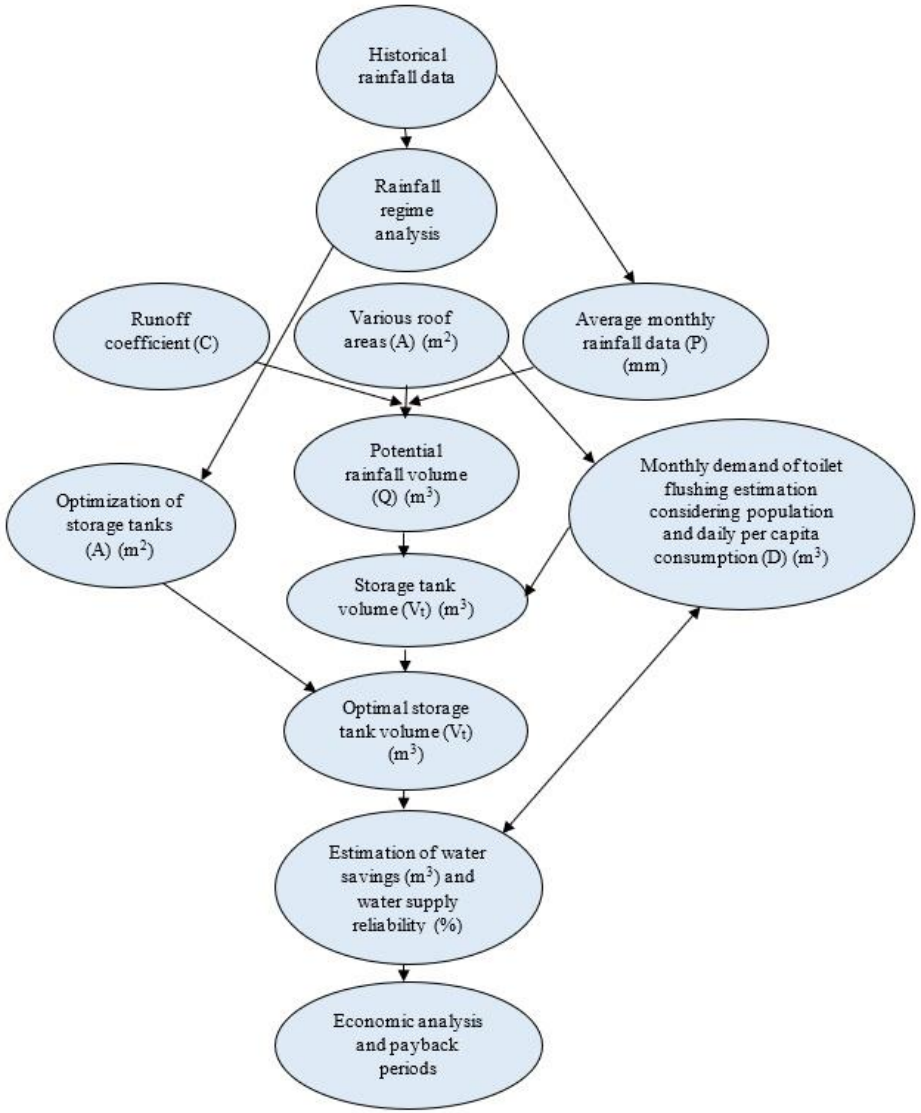
MATERIAL AND METHODS

- ✓ Rainfall regime analysis was conducted using PCI to reflect precipitation concentration in all provinces.
- ✓ Various roof areas were selected for the estimation of potential rainfall volume.
- ✓ RM with average monthly rainfall data was used for optimal storage tank estimation.
- ✓ PCI was used as a decision tool for determining regularization needs for designing optimal storage tanks.
- ✓ Rainfall regime analysis and optimization studies were conducted for system reliability and cost-effectiveness.



Conceptual model of the study

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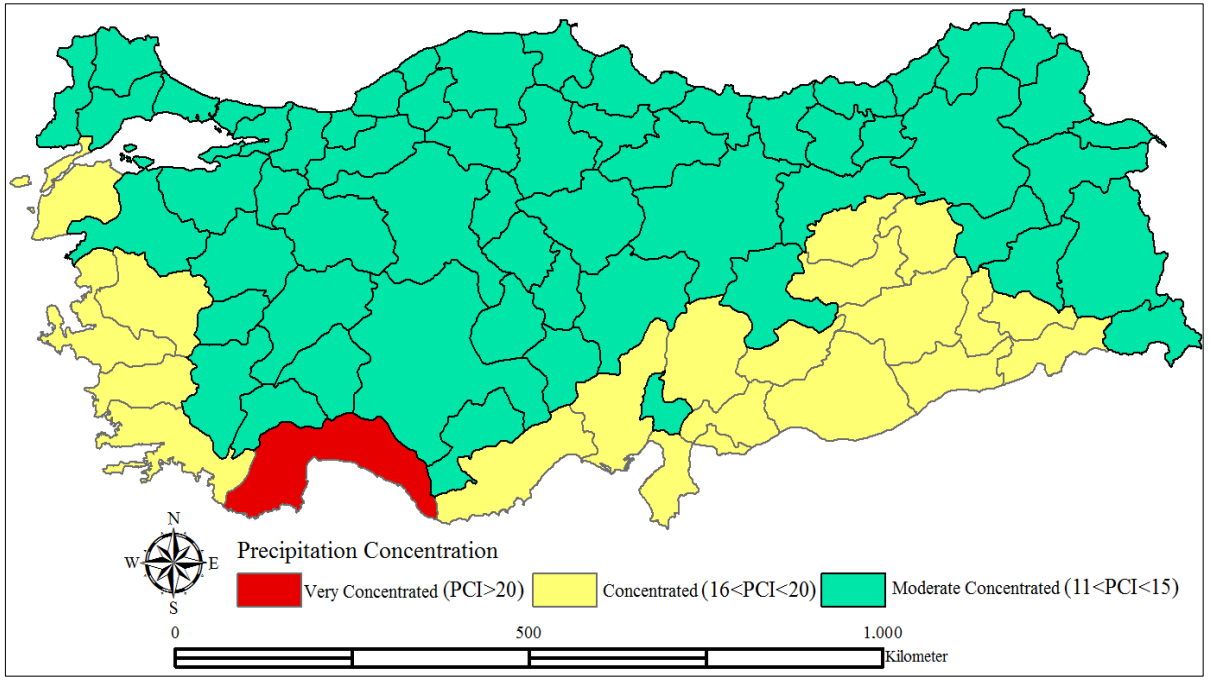
RESULTS Temporal Variability of Precipitation in Turkey

- ✓ As a result of the analysis; the provinces in Turkey were divided into three categories as moderate, concentrated and very concentrated precipitation.
- ✓ Any temporally uniform series of precipitation was not observed in all provinces of Turkey.
- ✓ Black Sea, Central Anatolia, Eastern Anatolia and Marmara Region have moderate concentrated precipitation.



- ✓ Southeast Anatolia, Mediterranean and Aegean Region have concentrated precipitation.
- ✓ Among 81 provinces of Turkey, Antalya which is located in the Mediterranean Region is considered as the sole province with very concentrated precipitation pattern.

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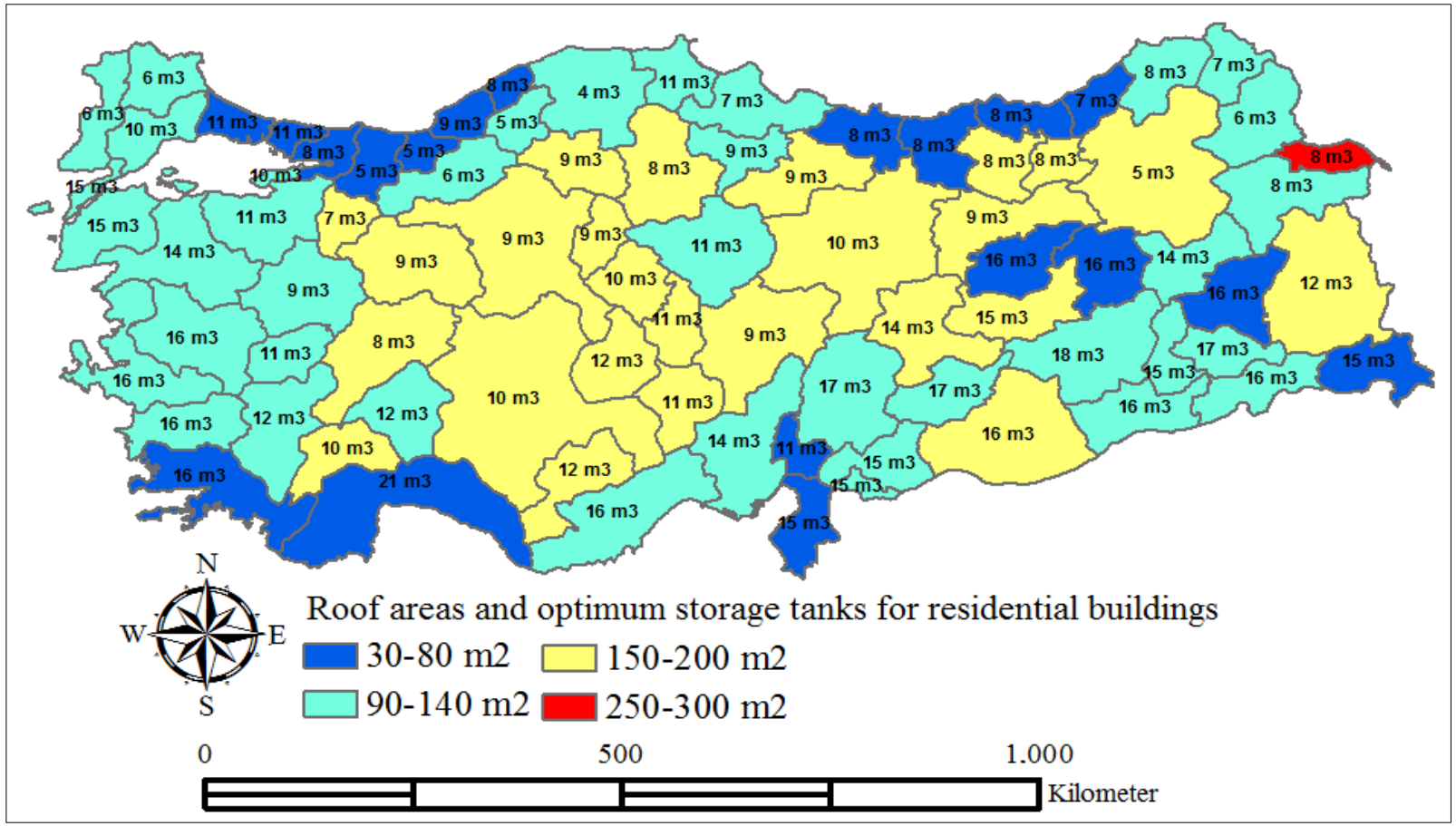
RESULTS Roof Areas and Optimum Volume of Storage Tanks (1/2)

Residential buildings with 6 people

(water demand of 144 L/day for toilet flush)

for 90-100% volumetric reliability



Required roof areas

(m^2, as shown in legend)

and

Volume of storage tanks

(m^3, shown in each province on the map)

- The amount of water that used for toilet flushing in residential buildings is about 30% of all water use (Şahin, 2010).

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RESULTS Roof Areas and Optimum Volume of Storage Tanks (2/2)

Public/commercial buildings with 20 employees

(water demand of 360 L/day for toilet flush)

for 90-100% volumetric reliability

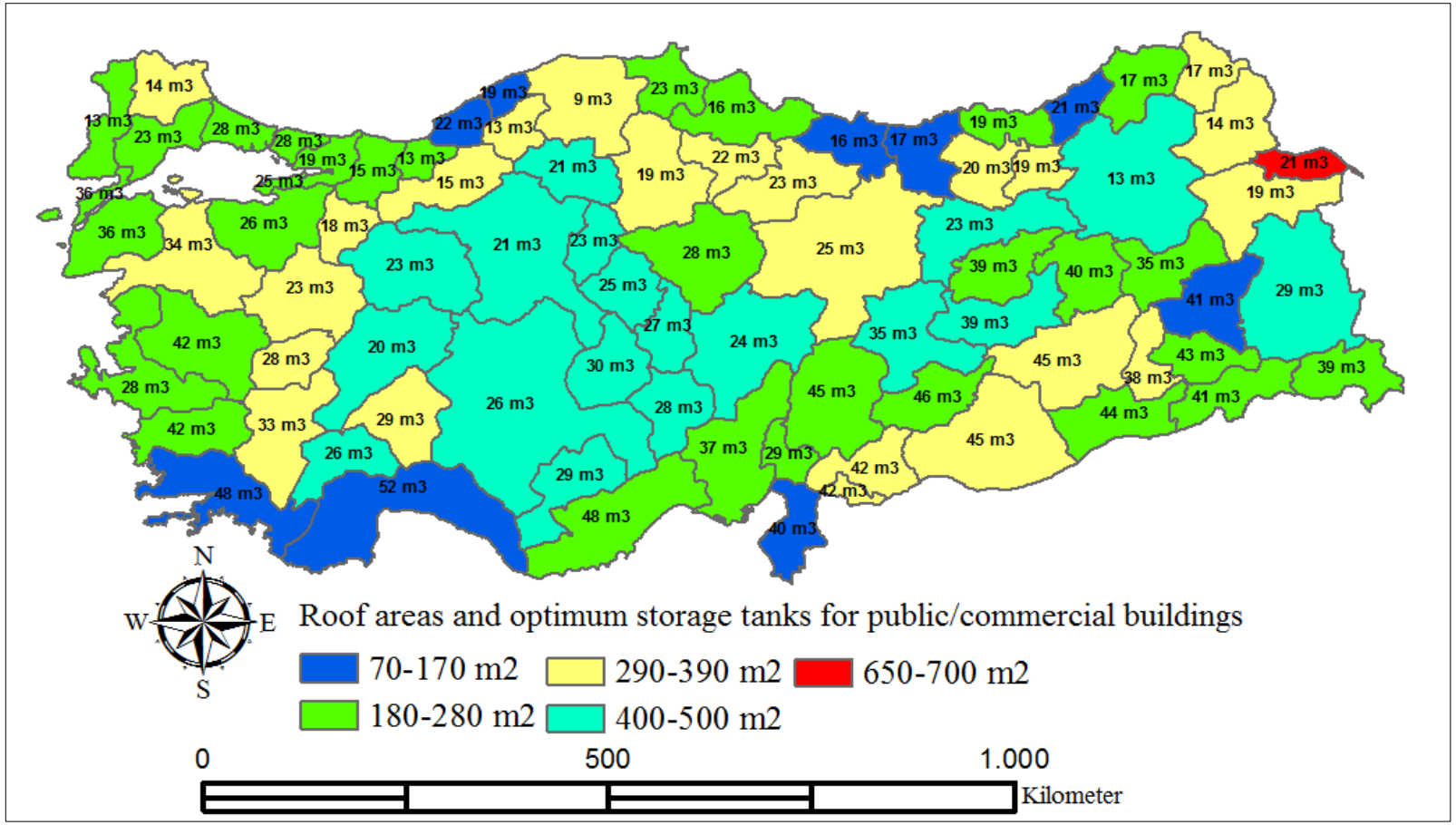
Required roof areas

(m^2, as shown in legend)

and

Volume of storage tanks

(m^3, shown in each province on the map)



- In public/commercial buildings, 74% of supplied water is used in toilet flushing (Sousa et al., 2018).

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RESULTS

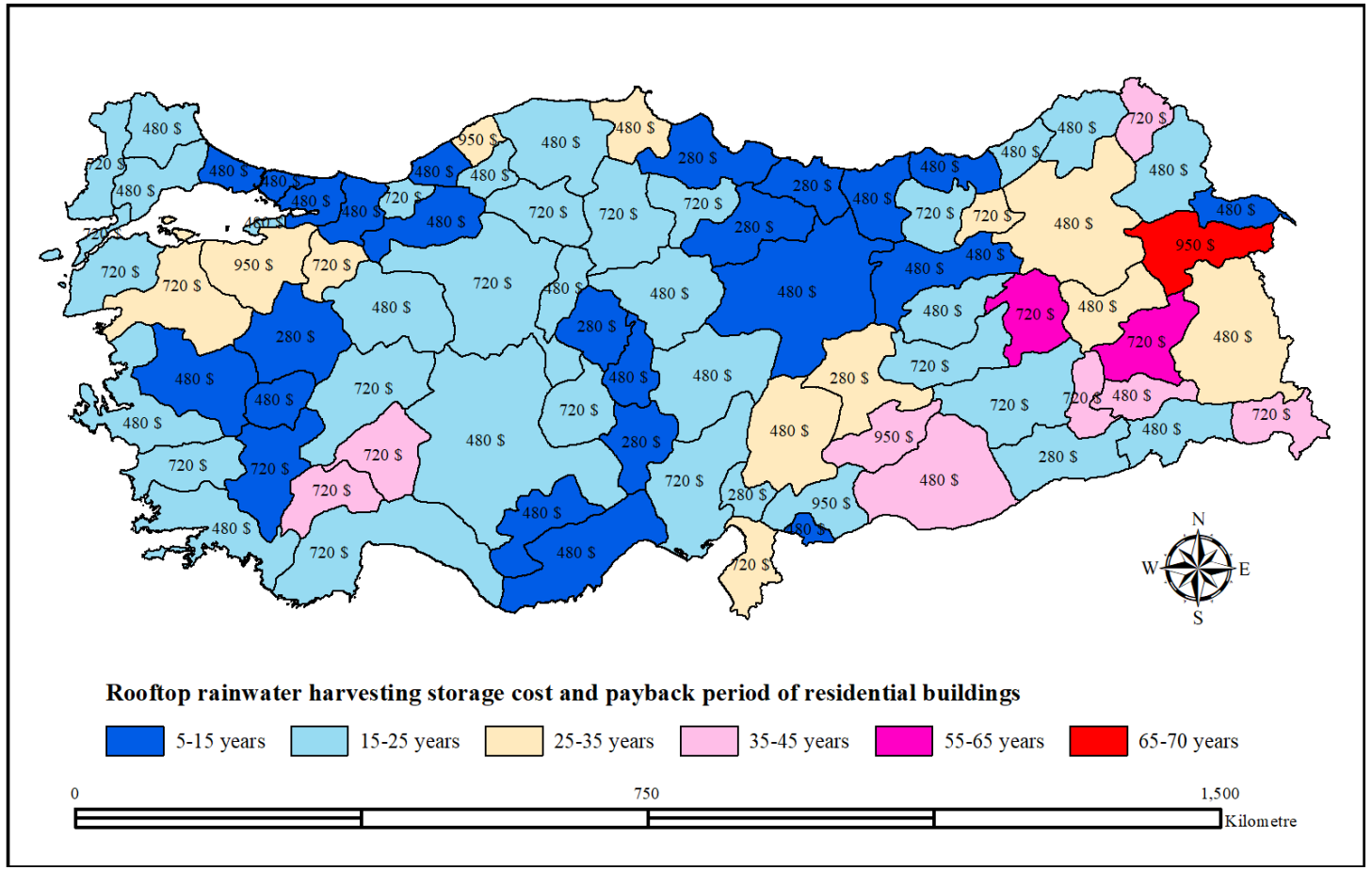
Storage Tank Cost and Payback Period (1/2)

Residential buildings with 6 people

By using rooftop rainwater harvesting in the toilet flushing of a 6-member family,

water conservation of 53 m^3 of water/year and
between 10-80 USD savings/year (due to the water tariff for each province) can be obtained.

Storage tank costs of rainwater harvesting for residential buildings vary between 280-950 USD and the payback periods vary between 6-70 years.



Payback period
(year, as shown in legend)
and
Cost of storage tanks
(TRY, shown in each province on the map)

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RESULTS

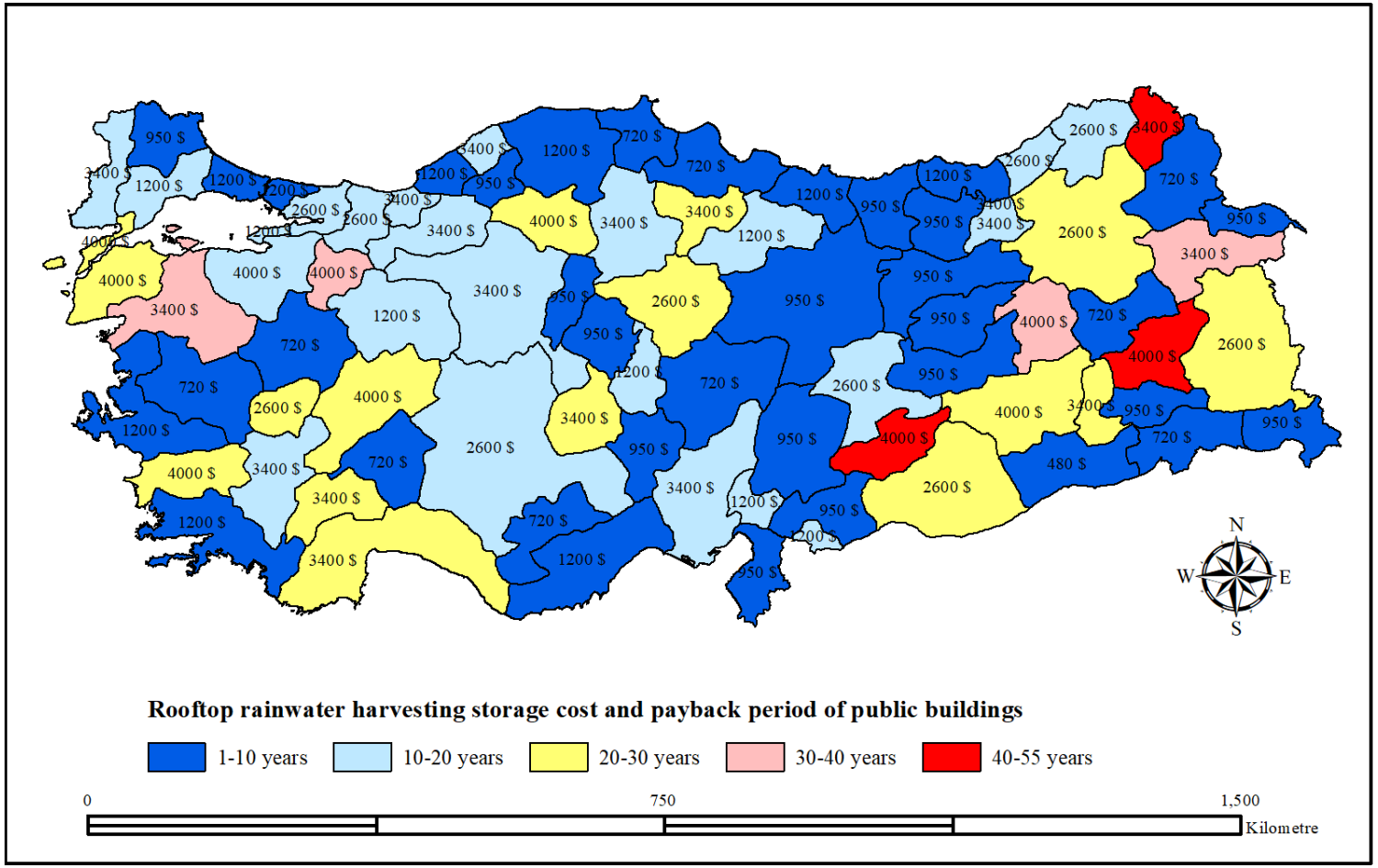
Storage Tank Cost and Payback Period (2/2)

Public/commercial buildings with 20 employees

By using rooftop rainwater system for supplying the toilet flushing of a public/commercial building with 20 employees,

water conservation of 131 m^3 of water/year and
between 64-306 USD savings/year can be obtained.

Storage tank costs of rainwater harvesting for public/commercial buildings vary between 480-4000 USD and the payback periods vary between 2-50 years.



Payback period
(year, as shown in legend)
and
Cost of storage tanks
(TRY, shown in each province on the map)

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RESULTS — Regularization for Provinces With High Variability

Storage tank costs were re-analyzed after making 8 months regularization for the provinces where larger storage tanks were required.

Use Only 8 Months for Rooftop Rainwater Harvesting,
Save 50% Money from Storage Tanks.

Is it Possible???

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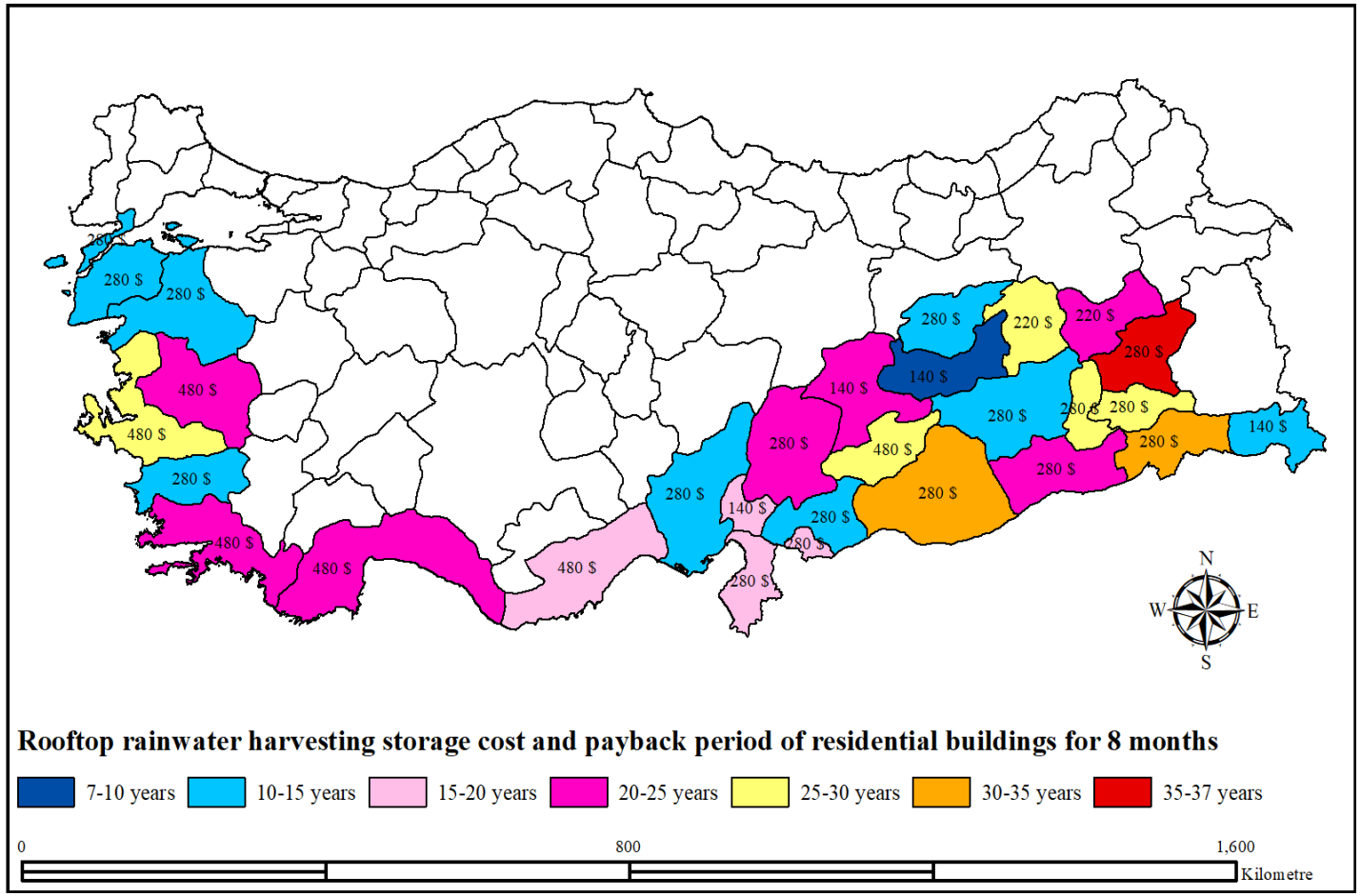
RESULTS Storage Tank Cost and Payback Period after Regularization (1/2)

Residential buildings with 6 people

With the use of rainwater in toilet flushing of a 6-member family, 35 m^3 of water conservation and 6-31 USD savings in 8 months can be achieved.

The storage tank cost of rainwater harvesting in the residential buildings varies between 140-480 USD and the payback period varies between 7 to 35 years.

By 8 months regularization, it is possible to decrease the storage tank costs about 50%.



Payback period
(year, as shown in legend)
and
Cost of storage tanks
(TRY, shown in each province on the map)

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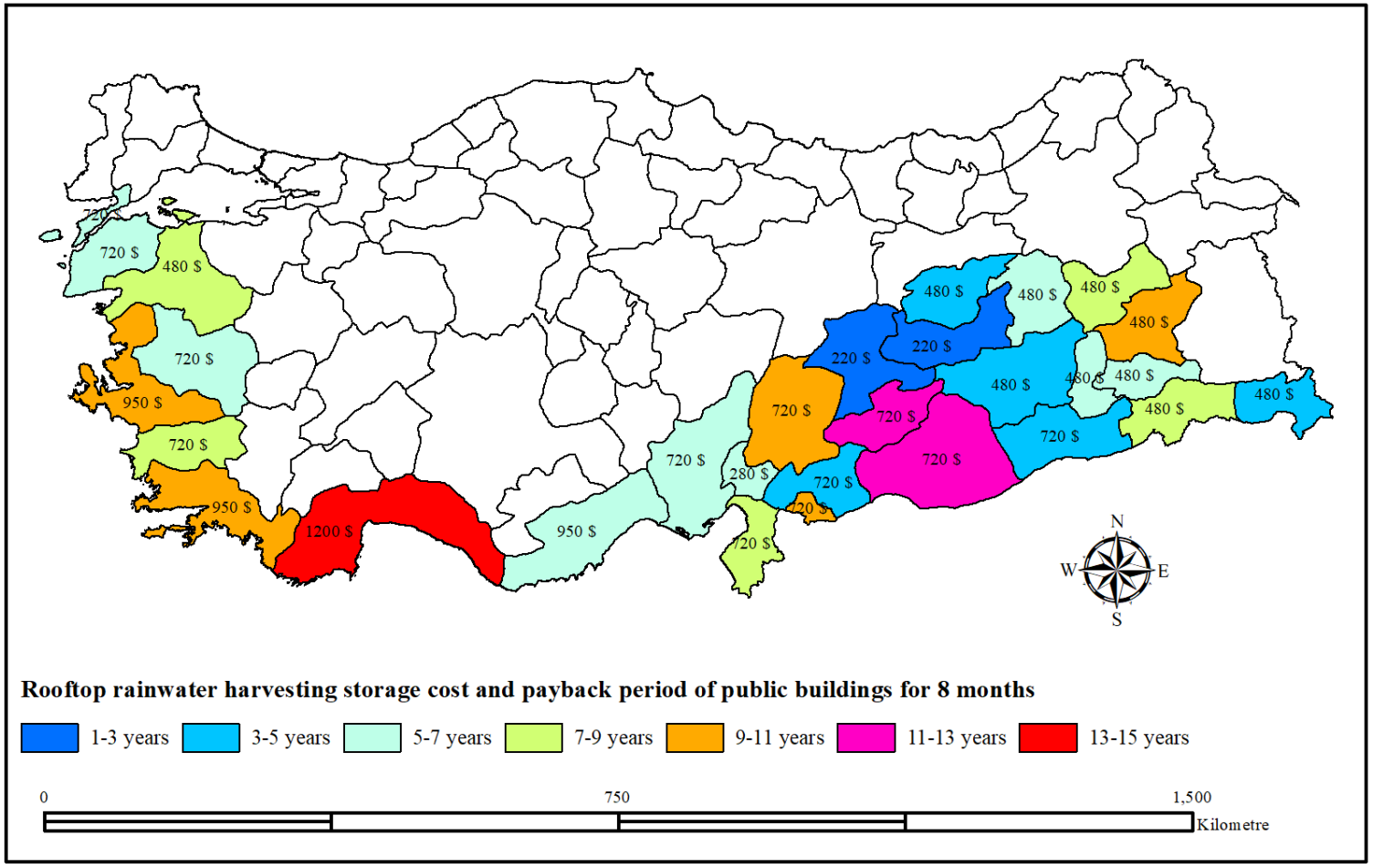
RESULTS Storage Tank Cost and Payback Period after Regularization (2/2)

Public/commercial buildings with 20 employees

With the use of rainwater in the toilet flushing of a public / commercial building with 20 employees; 88 m^3 of water conservation and 40-160 USD savings in 8 months can be achieved.

The storage tank costs of rainwater harvesting in the public/commercial buildings vary between 220-1200 USD and the payback period varies between 2-15 years.

In Public/commercial buildings, by 8 months regularization, it is possible to decrease the cost of storage tank cost about 60%.



Payback period
(year, as shown in legend)
and
Cost of storage tanks
(TRY, shown in each province on the map)

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CONCLUSIONS (1/2)

- A significant amount of water conservation and savings can be obtained effectively by using rainwater harvesting system in buildings with large roof areas such as public/commercial and residential buildings.

- The rainwater harvesting system efficiency is directly influenced by the precipitation concentration. Therefore, precipitation regime analysis should be done prior to the rainwater harvesting system design.

- In general, provinces with dry summer require larger storage tanks for rainwater harvesting. 90% of the total precipitation occurs only in 8 months of the year in most provinces of Turkey.

- For rainwater harvesting system in Turkey, larger storage tanks are required in Aegean, Mediterranean and Southeastern Anatolia Region compared to other regions due to high seasonality in the precipitation. Hence, in these provinces during June, July, August and September, rainwater harvesting is not applicable due to the deficiency of rainfall.

CONCLUSIONS (2/2)

- Priority might be given to the provinces which has moderate precipitation concentration for rooftop rainwater harvesting incentive projects.
- Rainwater harvesting is feasible for provinces which has moderate precipitation concentration.
- For rainwater harvesting optimal tank design, PCI can be used as a decision-support tool.
- Larger storage tanks are required in provinces with higher PCI values.
- Rainwater harvesting would be more economical due to the smaller storage tank requirements in provinces with moderate PCI.
- Moreover, there would be no need for any regularizations in provinces with moderate PCI.

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RECOMMENDATIONS (1/2)

- It is recommended to perform regularization studies to ensure that rainwater harvesting system is effective and economical in provinces where precipitation falls in a few certain months of the year.

- The implementation of large-scale rainwater harvesting projects instead of small-scale projects in the Aegean, Mediterranean and Southeastern Anatolia Region provides a beneficial use of water, while on the other hand, the effects of floods can be mitigated.

- Hence, in the aforementioned regions priority should be given to large-scale rainwater harvesting projects instead of small-scale rainwater harvesting projects.

- In Aegean, Mediterranean and Southeast Anatolia Region of Turkey, due to the seasonality in rainfall, rooftop rainwater harvesting system should be regularized.

RECOMMENDATIONS (2/2)

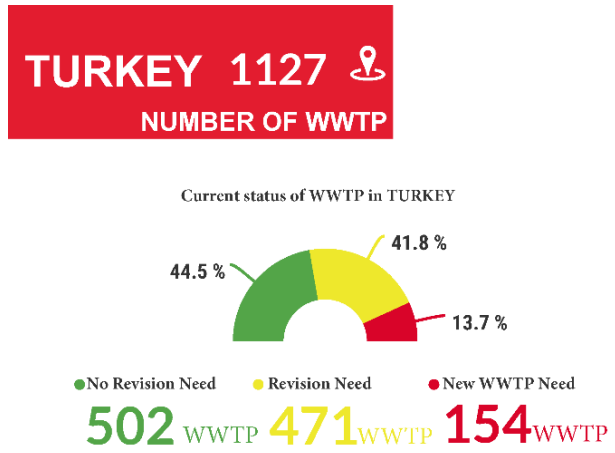
- More savings can be achieved when rainwater harvesting is used in public/commercial buildings compared to residential buildings.

- The large-scale rainwater harvesting projects should be given priority in regions where floods occur frequently, not only for water conservation and savings but also to mitigate flood.

- Application of rainwater harvesting system should become mandatory in the new constructed buildings of the country. Especially, in regions which suffer from water scarcity, it will decrease the stress on water resources and water supply demands.

PROJECTS

Within the scope of **"Determination of the Current Status of Urban Wastewater Treatment Plants and Determining the Need for Revision (TURAAT)" project,** it has been determined that **Turkey has 1127 domestic wastewater treatment plants either in operation or under construction and 10.5 million m^3/day wastewater is treated daily** (2016).



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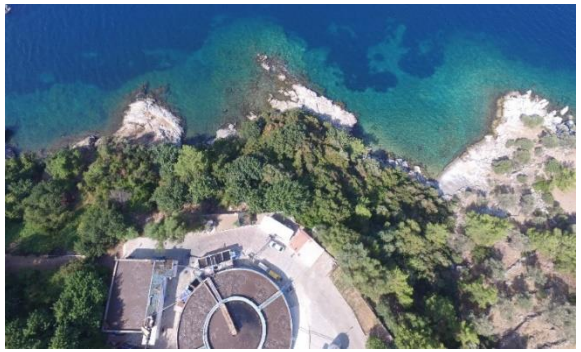
PROJECTS





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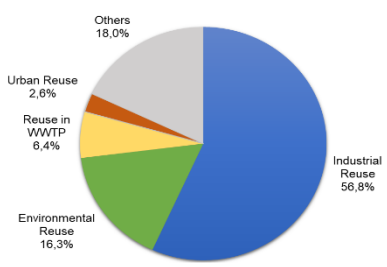
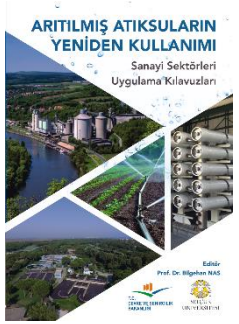
PROJECTS

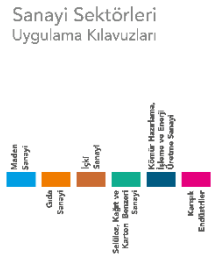
"Reuse of Reclaimed Wastewater Project" aimed to propose technical and administrative criteria for national and international practices and standards for investigating all kinds of urban and industrial treated wastewater reuse.

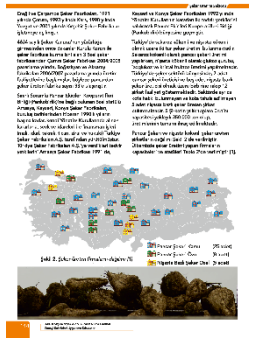
In the project; the initial investment and operating costs, operational problems, process efficiency and reuse categories of urban WWTP of Turkey are evaluated.

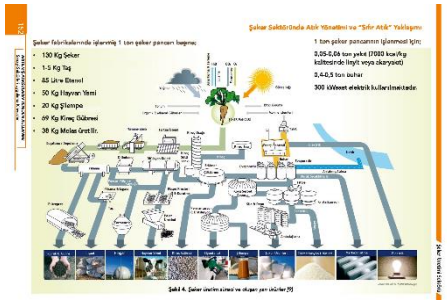
At the end, alternative treatment technologies, water quality criteria and monitoring frequencies that can be applied for each of the different reuse categories (urban, agricultural, environmental, industrial, aquifer feeding, etc.) have been proposed.











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PROJECTS

INVESTIGATION OF TRAINING AND CERTIFICATION PROGRAMS FOR TECHNICAL PERSONNEL WORKING IN WASTEWATER TREATMENT PLANTS AND DEVELOPMENT OF MODEL PROJECT




AATSer

2019-2020

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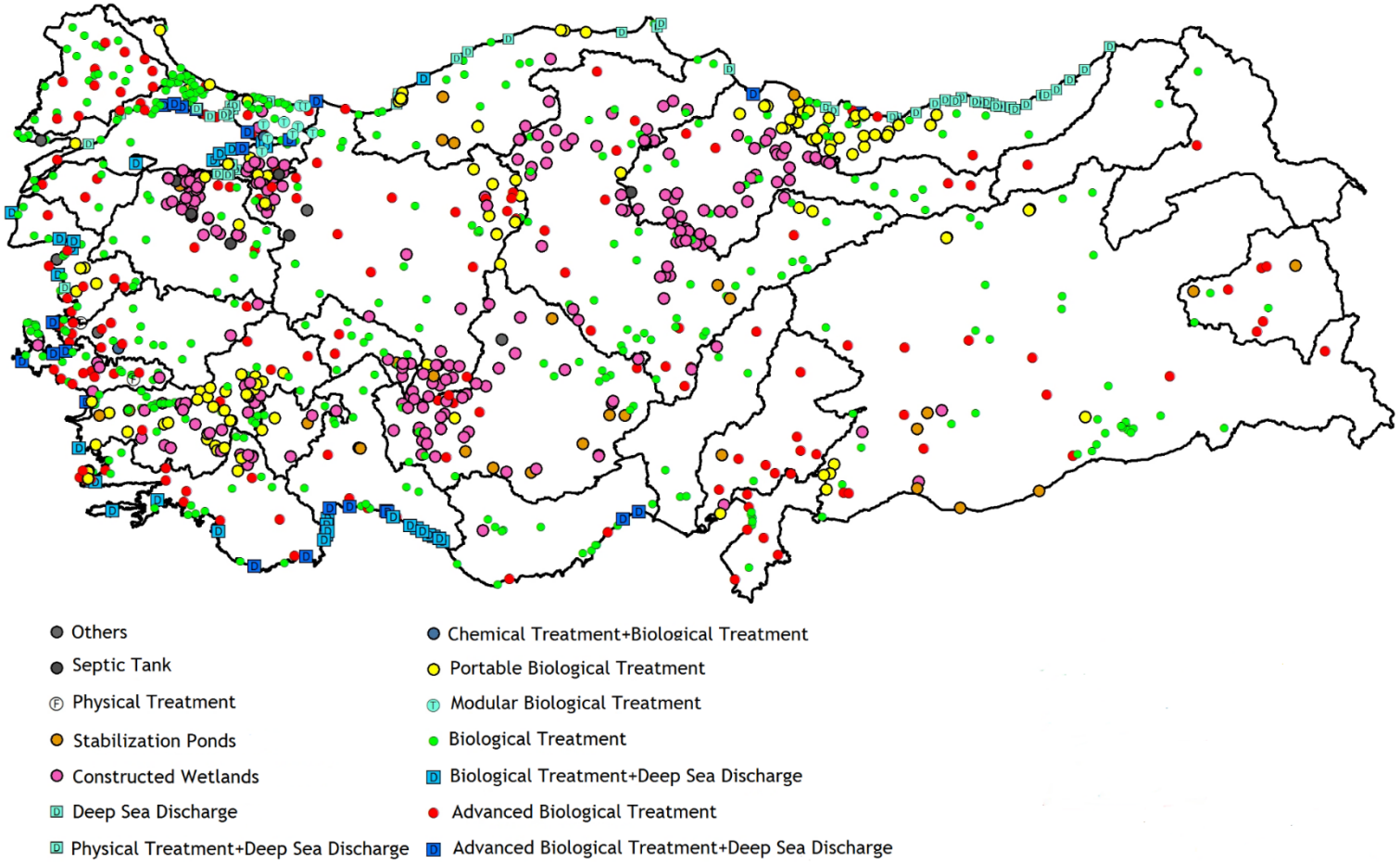
PROJECTS



Type of domestic / urban WWTP's throughout the country (TURAAT).

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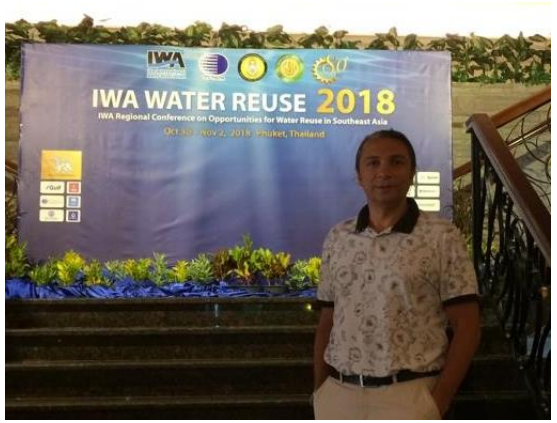
INVITATION TO IWA WATER REUSE CONFERENCE



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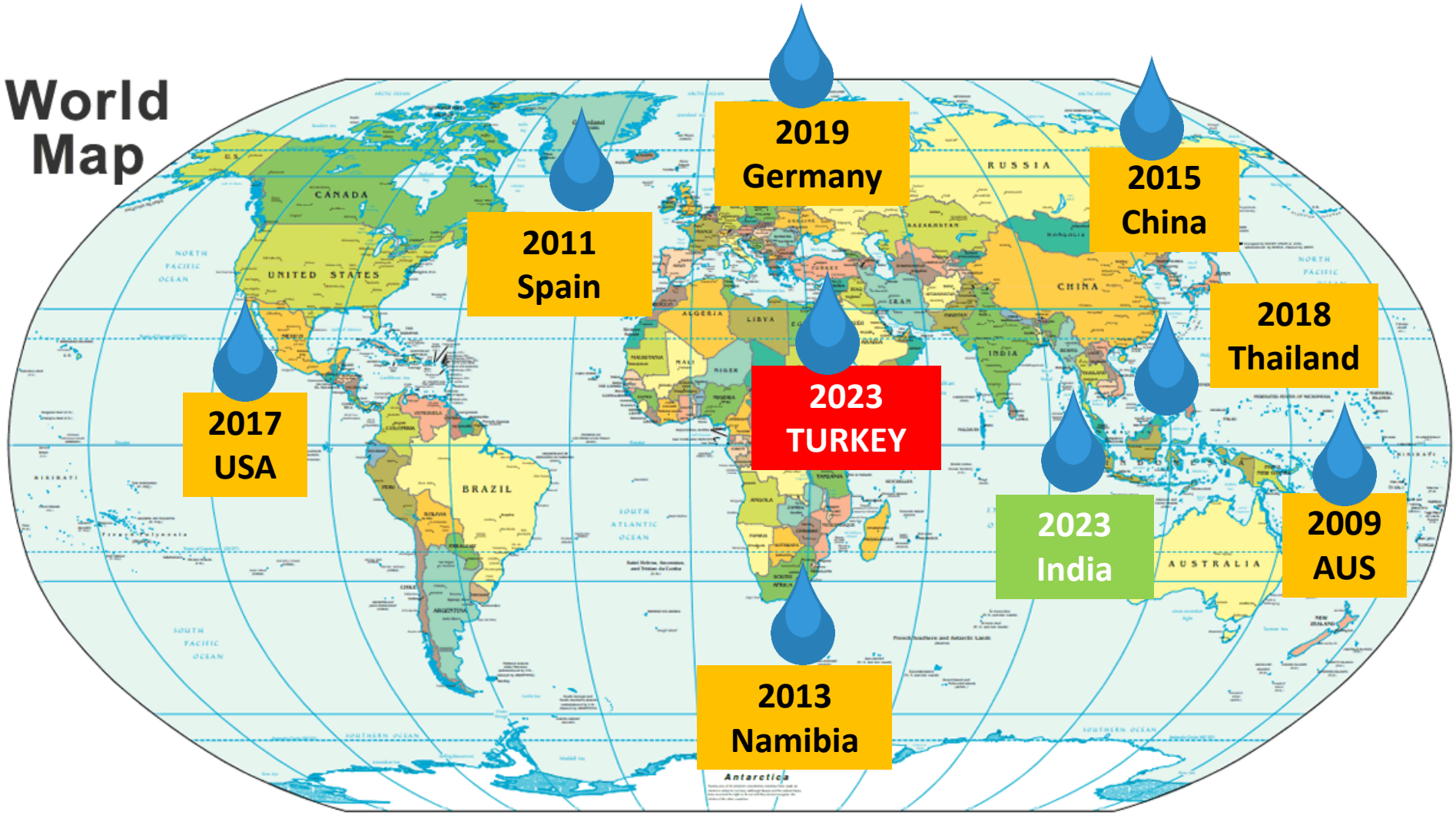

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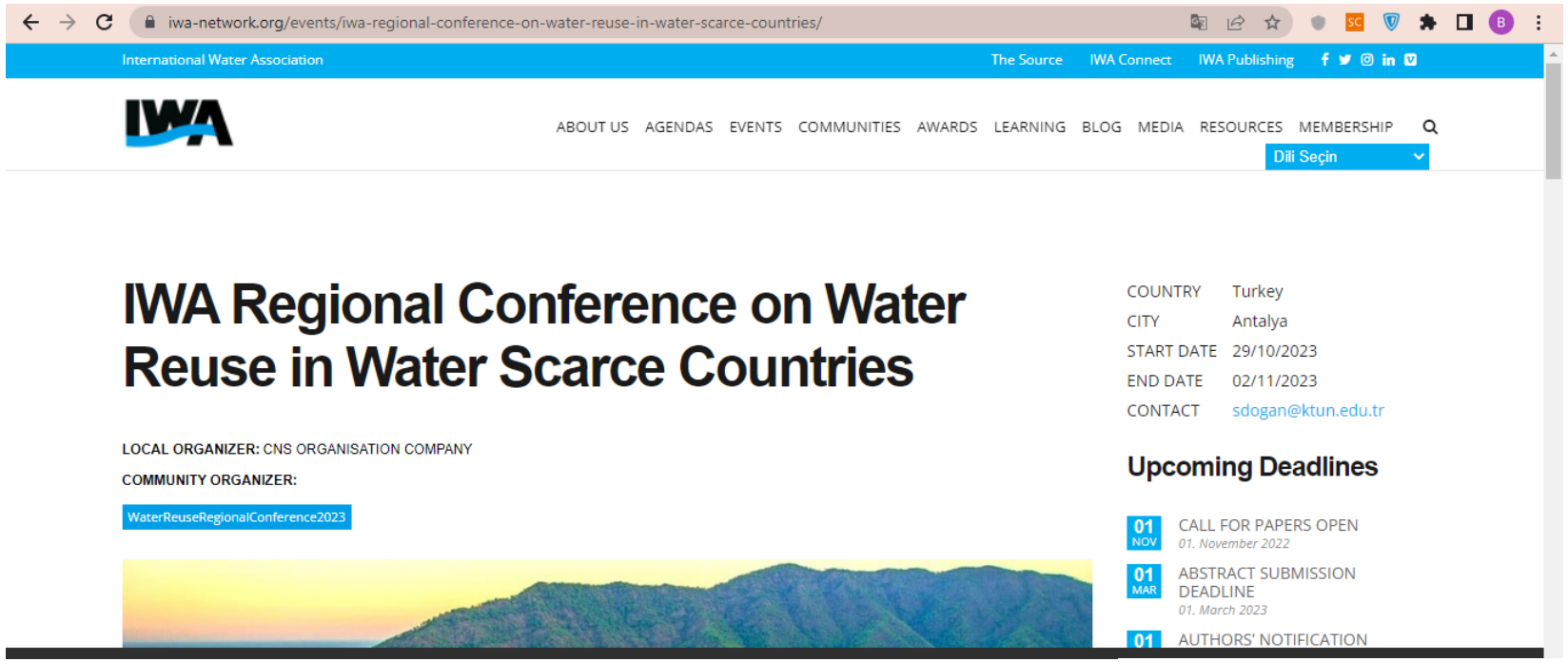
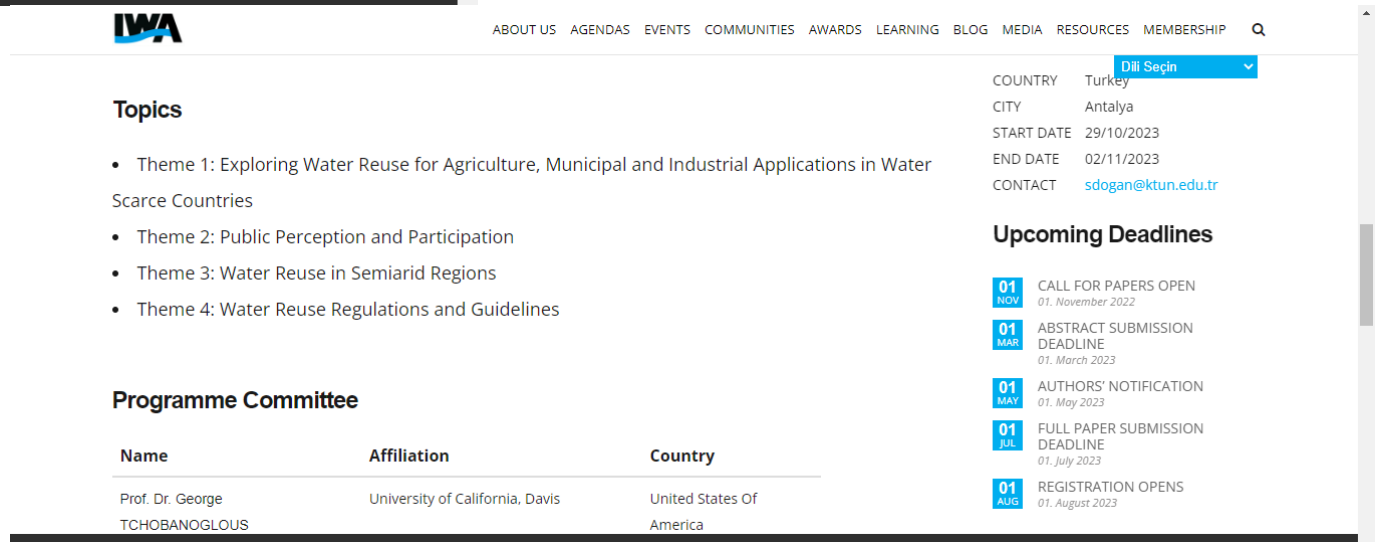


Oct 29-Nov 2, 2023

Antalya, Türkiye



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Climate Adaptation Days 2022

THANK YOU FOR LISTENING…

ANY QUESTIONS ???

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