Modelling water needs; from past to present. Case study: The Municipality of Western Mani

G.-Fivos Sargentis, Ilias Taygetos Meletopoulos, Theano Iliopoulou, Panayiotis Dimitriadis, Efthimis Chardavellas, Dimitra Dimitrakopoulou, Aimilia Siganou, David Markantonis, Konstantina Moraiti, Konstantinos Kouros, Maria Nikolinakou, and Demetris Koutsoyiannis

National Technical University of Athens
School of Civil Engineering

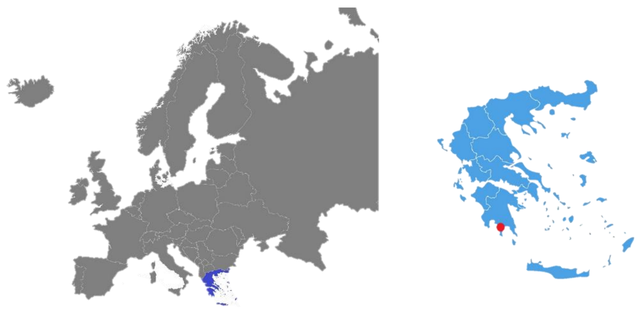
International Association of Hydrological Sciences (IAHS 2022) Montpellier (France) 29 May -3 June 2022.

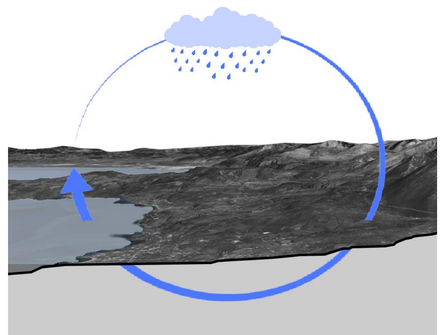
1. Introduction

The Municipality of Western Mani is located in the southern part of Greece in Peloponnese. The region has a high rate of rainfalls mainly in the mountainous areas.

Rainfall is mainly observed during the autumn and winter months, from October to March, while there is a significant decrease in the summer[1].

The problems that arise mainly focus on the quantitative aspect [2-5]. The geological background is extremely permeable as it consists mainly of karstic limestone. Therefore, there are limited surfaces water resources with limited water supply.





2. Stochastic simulation of hydrological timeseries for data scarce regions using Hurst-Kolmogorov dynamics (Siganou et al., 2022)

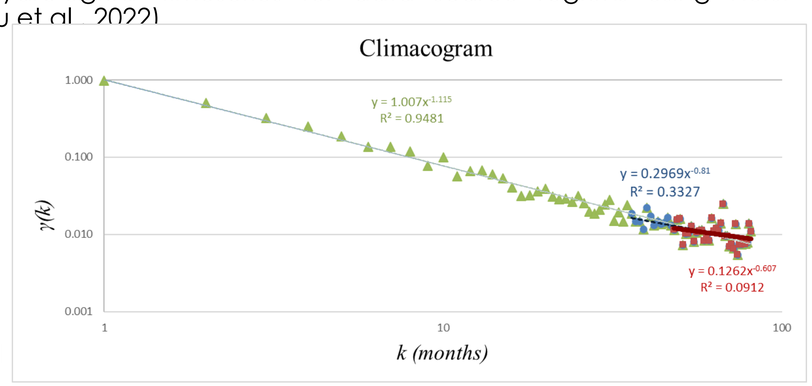
Kalamata's station 1951-2018 (68 yrs)

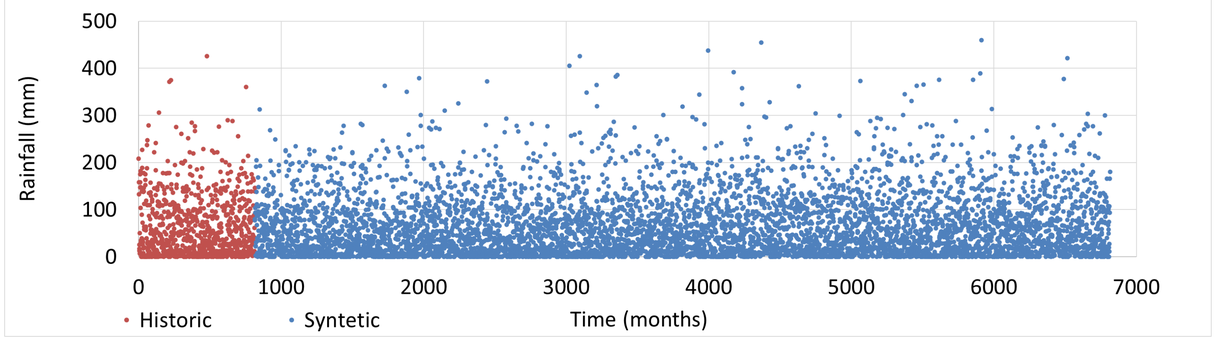
Kadamylis' station (in WM), 2014-2021 (8 yrs)

The length of the timeseries is insufficient for the estimation of stochastic properties.

Both stations are in the same altitude (13 m).

Moving Average(SMA) method





3. Traditional rainwater harvesting techniques. Cisterns (Nikolinakou et al., 2022)

Constitute an integral part of local tradition

Enrich the cultural heritage

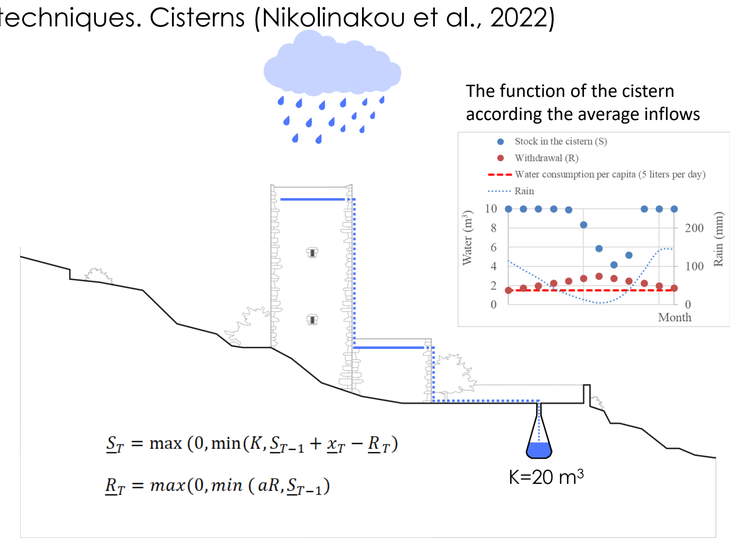
Attract great architectural interest

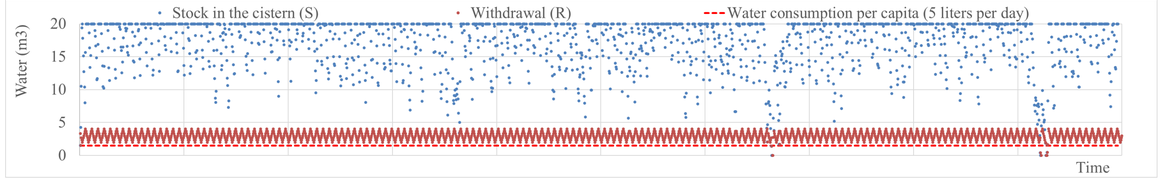
Water Quality:

- Past → suitable for drinking
- Present → suitable for water supply

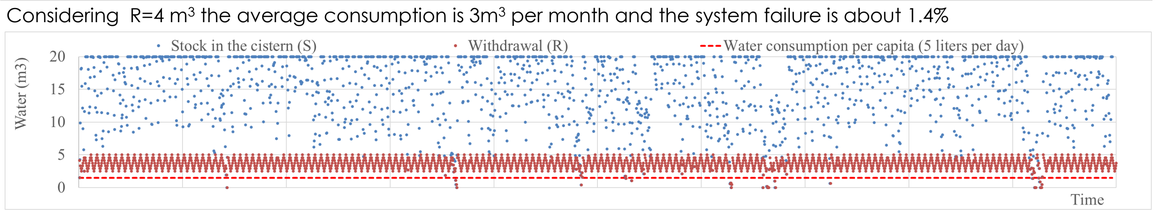
The cistern volume depends on:

- Water demand of the residents
- Potential rainwater yield
- Amount of possible concentration of water from rainfall

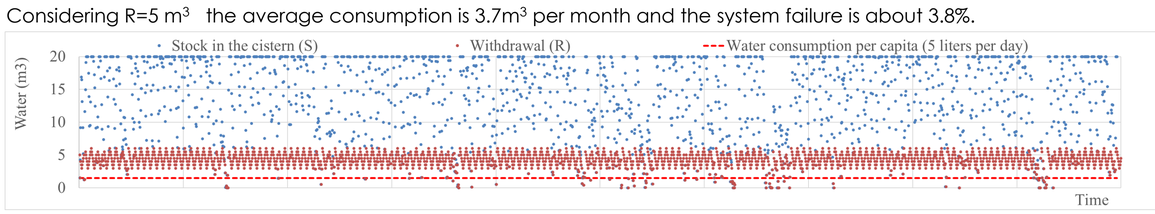




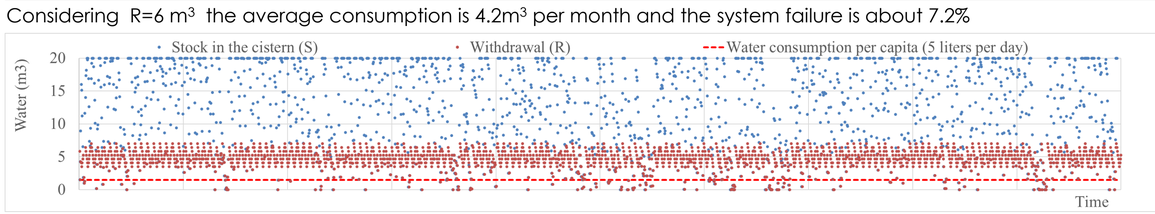
Considering R=4 m³ the average consumption is 3m³ per month and the system failure is about 1.4%



Considering R=5 m³ the average consumption is 3.7m³ per month and the system failure is about 3.8%.



Considering R=6 m³ the average consumption is 4.2m³ per month and the system failure is about 7.2%



Considering R=7 m³ the average consumption is 4.6m³ per month and the system failure is about 15%

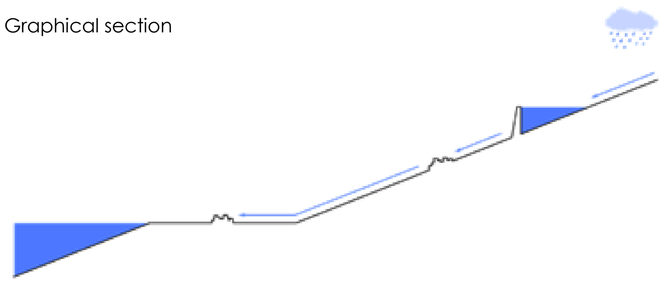
4. Determining optimal scale for modern water infrastructure (Markantonis et al., 2022)

Dam: Nedontas river

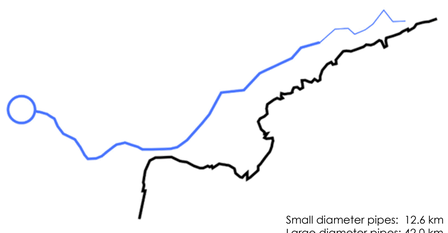
An appropriate position for a dam has been chosen, such that the catchment area is adequate to service the needs of our area.

The water is stored for up to a few years and then transported via pipe when needed to our area. The whole system is gravity operated.

Graphical section



Graphical top view



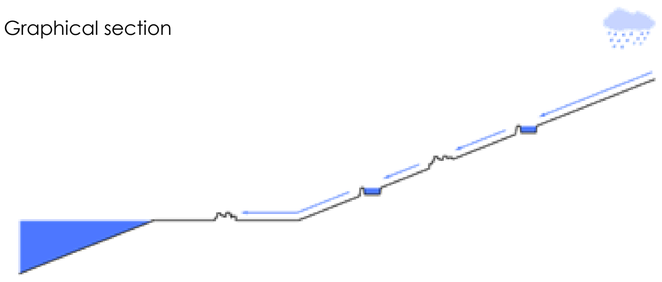
Small diameter pipes: 12.6 km
Large diameter pipes: 42.0 km

Water ponds: local streams

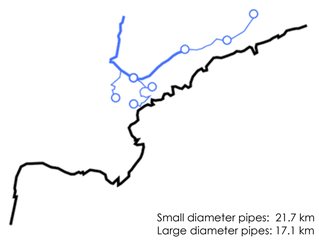
Water is captured at appropriate positions from local streams.

It is then transported via pipe to a number o water ponds where it is stored for up to a few months until its use. The whole system is gravity operated.

Graphical section



Graphical top view



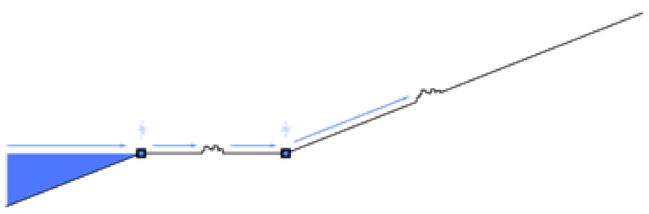
Small diameter pipes: 21.7 km
Large diameter pipes: 17.1 km

Desalination: sea

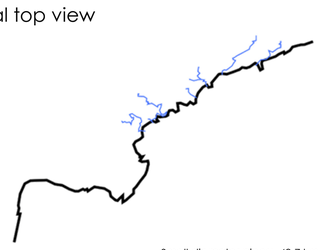
Sea water is desalinated via reverse osmosis in several coastal desalination plants.

Afterwards it is pumped uphill to the settlements where it is stored for up to a few hours before its consumption.

Graphical Section



Graphical top view



Small diameter pipes: 43.7 km
Large diameter pipes: 00.0 km

5. Conclusions (Moraiti et al., 2022)

	Dam (Nedodas River)	Water Ponds	Dam (Lagada)	Desalination	Wells/Boreholes	Cistern (traditional)
Environmental Impact	✗	✓	✗	✗	✗	✓
Political Difficulty	✗	○	✗	✓	✓	✓
Construction Feasibility	○	✓	✗	✓	✗	✓
Resilience of Supply	✓	✓	✗	✓	✗	○
Risk of Construction	✗	○	✗	✓	✓	✓
Adequacy	✓	✓	✗	✓	✗	✗
Pipe Network Length	✗	○	○	○	✓	✓
Construction Time	✗	✓	✗	✓	✓	○
Cost	✓	✓	✗	✗	○	○

	Dam (Νέδοντας river)	Water ponds	Desalination
Pipe Network Length (km) (sum)	59.1	38.8	43.7
Construction Time (years)	4	2	1
Energy Consumptions (kWh/m³)	0	0	5.631
Total Cost(€/m³)	1.478	0.479	1.969

The important role of traditional techniques in present

A cistern with 20 m³ capacity, can provide 100 L of drinking water per day with small probability of system failure.

This considers that could cover the drinking water needs for 20 people.

This way, avoiding to buy bottled water, the earnings are about 8 000€ per year.

References

Markantonis D., Siganou A., Moraiti K., Nikolinakou M., Sargentis G.-F. , Dimitriadis P., Chiotinis M., Iliopoulou T., Mamassis N. and Koutsoyiannis D. ,Determining optimal scale of water infrastructure considering economical aspects with stochastic evaluation – Case study at the Municipality of Western Mani

Moraiti K., Markantonis D., Nikolinakou M., Siganou A., Sargentis G.-F. , Iliopoulou T., Dimitriadis P., Meletopoulos I.-T., Mamassis N. and Koutsoyiannis D., Optimizing water infrastructure solutions for small-scale distributed settlements – A case study for the Municipality of Western Mani

Nikolinakou M., Moraiti K., Siganou A. ,Markantonis D., Sargentis G.-F. , Iliopoulou T., Dimitriadis P., Meletopoulos I.-T., Mamassis N. and Koutsoyiannis D. ,Investigating the water supply potential of traditional rainwater harvesting techniques used – A case study for the Municipality of Western Mani

Siganou A., Nikolinakou M., Markantonis D., Moraiti K., Sargentis G.-F. , Iliopoulou T., Dimitriadis P., Chiotinis M., Mamassis N. and Koutsoyiannis D. Stochastic simulation of hydrological timeseries for data scarce regions - Case study at the Municipality of Western Mani

Acknowledgment:
This research was supported by the Municipality of Western Mani