Micro-climate assessment of pilot areas through an installed meteorological network on Andros Island, Greece

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Introduction

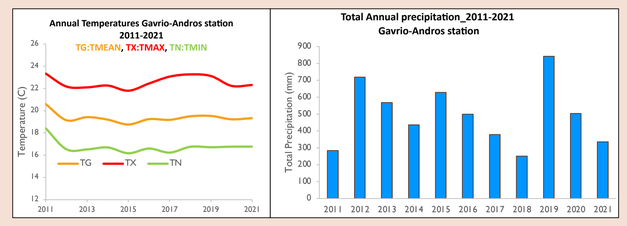
Climate is changing in the Mediterranean Basin, faster than global trends, both historically and as projected by climate models (Cherif et al., 2020, MedECC). Heat waves will intensify in duration and peak temperatures, while summer rainfall (despite strong regional variations) will likely be reduced by 10 to 30% in some regions, increasing existing water shortages, desertification and decreasing agricultural productivity (MedECC 2020). The Aegean islands, characterized by strong relief and low vegetation cover, are listed as a region of high desertification risk (Giorgi 2006; Zanis et al. 2008; Varotsos et al., 2021). The future vegetation cover and composition is likely to change under influence of the projected declining annual precipitation, rising temperatures and the increasing length of dry spells in Aegean islands (Kitsara et al., 2021). The Terracescape project aims to demonstrate, at the Aegean island of Andros (Greece), the use of drystone terraces(a prominent element of the Mediterranean landscape) as Green infrastructures resilient to climate change impacts.

The main objective of this study is to assess, at the demonstration areas that experienced Terracescape's project interventions (renewed cultivation of abandoned terraces), if the anticipated improvement of air humidity (i.e. increase compared to non-intervention sites) and air temperature (i.e. decrease compared to non-intervention sites) is detectable. To this end, changes in temperature and humidity between weather sensors at locations that did (not) experience project interventions were examined, using the observational meteorological data collected from the installed meteorological stations, an in-depth time-series analysis for the study areas.

Climate of Andros Island and the installed meteorological network

The climate of Andros, as an Aegean Island, is displaying the basic characteristics of the Mediterranean climate such as winter rainfall, summer drought, large inter-annual variations in total rainfall, hot summers (with intense sunlight), relatively cool winters and strong northerly winds. Climate change poses significant challenges to the islands and is expected to worsen already acute situations such as the environmental problems that have arisen from the abandonment of traditional uses of land (terrace farming)/ erosion leading to loss of fertile soils and increasing fire risk.

In the framework of the LIFE Terracescape project, the climate situation in Andros was analyzed, based on the 10 years records of the Gavrio station
https://www.meteo.gr/Gmap.cfm
This is the only available station with a longer-term meteorological record that may be used to evaluate local climate.



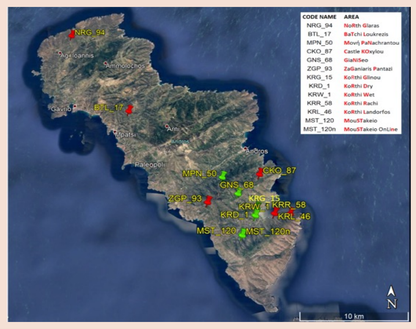
METEOROLOGICAL NETWORK INSTALLED ON THE ISLAND OF ANDROS

To record the meteorological conditions in the selected study areas (terraces /plots)

12 small autonomous
(measurements of air temperature, relative humidity)

2 automatic meteorological stations
(measurements of air temperature, relative humidity, precipitation, air pressure, wind speed / direction and solar radiation)
'Moustakeio': 2018-2022, 'Panachrantou': July 2022-today

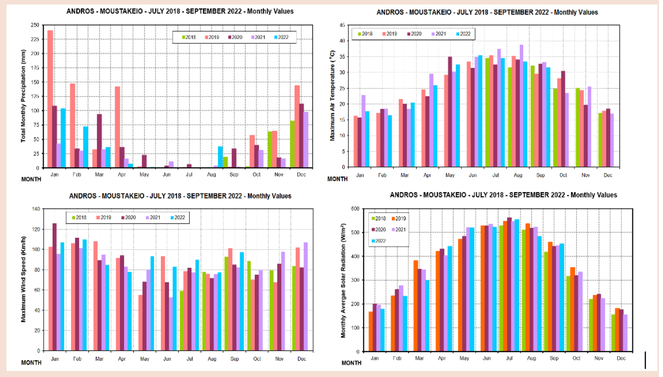
The plots for the installation of the stations were selected due to project interventions: renewed cultivation of abandoned terraces with barley



Data from the installed meteorological network on Andros island

Data from automatic online meteorological station

Meteorological data (2018-2022) from the automated 'Moustakeio' station in South East Andros available online through the link:
https://www.iersd.noa.gr/WeatherOnLine/s_Andros1/meteotableGR.html
are used for a full in-depth time series analysis of : air temperature (T), relative humidity (RH), precipitation (PR), wind speed (WS)/direction (WD), air pressure and solar radiation , based on daily values, monthly and growing season estimations.

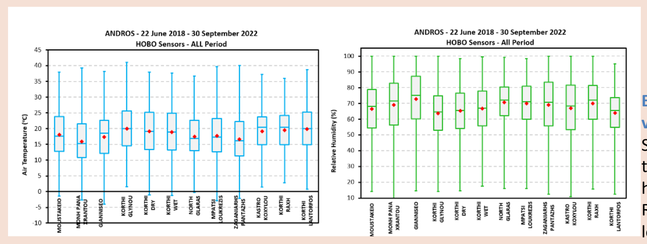


Meteorological sensor data from the 12 small autonomous stations

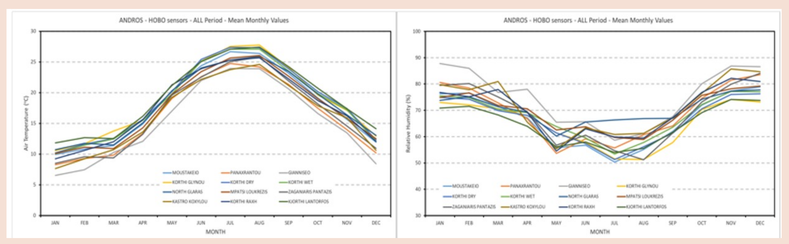
Table 1. List of the installed meteorological stations on Andros, providing the cultivated crop type for those plotsnchosen for land-use modifications

α/α	Station	Cultivated Crop type
1	NRG_94	
2	BLT_17	
3	MNP_50	
4	CKO_87	Barley
5	GNS_68	Barley/lupin
6	ZGP_93	Peas/Barley
7	KRL_46	Barley
8	KRG_15	Barley
9	KRD_1	
10	KRW_1	
11	KRR_58	Barley
12	MST120	
13	MST120n	
14	Panachrantou_n	

The network of 12 small autonomous stations, recording air temperature and relative humidity, on Andros island were used in this micro-climate assessment of pilot areas, with and without project interventions.

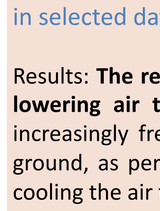


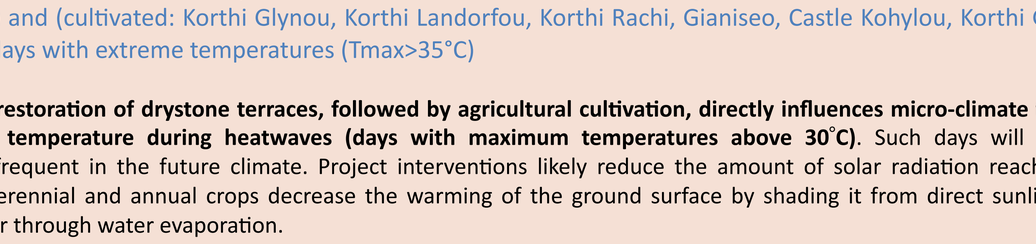
Extreme maximum and minimum values are marked by the bars; the average value is noted with a red diamond; the rectangle contains 50% of the values.
Stations in higher altitude areas of the island exhibit the lowest average annual air temperature (15°C), as opposed to the stations in Korthi bay that display the highest annual air temperature of around 20°C (Korthi-Landorfos, Korthi-Glynou) Relative humidity, Gianiseo has the highest annual mean value 72.7%, while the lowest value of 63.7% is registered in Korthi-Glynou.



Analyses of averaged mean-maximum-minimum temperatures (on annual, monthly and growth-seasonal basis) did not show any differences between cultivated- and uncultivated plots. On these timescales, factors dominating local temperature include altitude, proximity to the sea, topography and wind-exposure. Studies (e.g. Founda et al. 2019) show that heatwaves override such local factors

- Monthly mean air temperature is ranging from 12°C (winter months) -27°C (July, August), relative humidity is quite high, ranging from 55% (July) to 80% (November- February).
- Wind speed daily values are about 15-20 km/h for almost the whole 2018-2022 period, with maximum average WS being around 50 km/h, showing the high winds and wind gusts.
- There are only small differences in air temperature between the 4 growing seasons (October 2018 -June 2022)

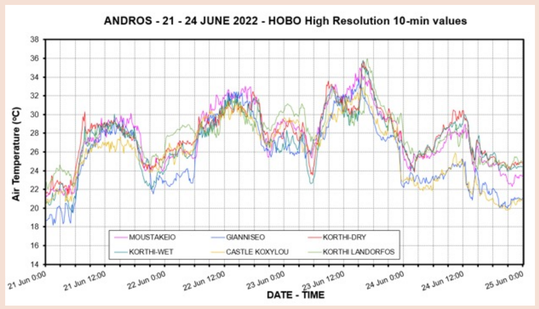


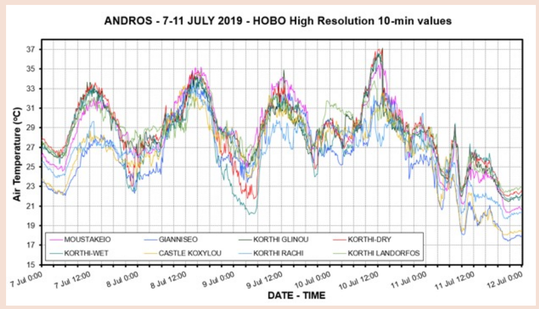


Analyses of meteorological station data

In order to assess the role of renewed drystone terrace cultivation in limiting extreme air temperatures and increasing humidity at selected demonstration sites of Andros Island:

- we examined **changes in temperature** and humidity between weather sensors at locations that did experience project interventions and nearby areas not experiencing any change.
- We focused **on warm to very hot days (T>35°C)**, to assess whether there are temperature differences between cultivated and uncultivated sites.





High resolution 10-minute air temperatures recorded in Korthi bay stations [(non cultivated:Korthi Wet, Korthi Dry, Moustakeio) and (cultivated: Korthi Glynou, Korthi Landorfou, Korthi Rachi, Gianiseo, Castle Kohylou, Korthi Glynou) in selected days with extreme temperatures (Tmax>35°C)

Results: **The restoration of drystone terraces, followed by agricultural cultivation, directly influences micro-climate through lowering air temperature during heatwaves (days with maximum temperatures above 30°C)**. Such days will become increasingly frequent in the future climate. Project interventions likely reduce the amount of solar radiation reaching the ground, as perennial and annual crops decrease the warming of the ground surface by shading it from direct sunlight and cooling the air through water evaporation.

Acknowledgement
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CONCLUSIONS

- The preliminary data from the installed meteorological network and their analyses suggest that terrace cultivation may help decrease the negative (direct) impacts of climate change, through decreasing local temperatures during heatwaves (days with very high temperature). Heatwaves will become more frequent in the future in the Aegean area, rendering this a key finding supporting the use of terraces as green infrastructure to combat the impacts of climate change.
- The benefits of terrace restoration are likely felt progressively over time, depending on the total extent of restored areas.
- The meteorological network will continue to provide base-line meteorological information that will be of crucial importance for future monitoring in the context of the "after-LIFE" program.

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