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"Monitoring the environmental conditions in landfill sites: a case study of Fyli - Ano Liosia, Attica Region, Greece"

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ESSI – Earth & Space Science Informatics ESSI4 – Advanced Technologies and Informatics Enabling Transdisciplinary Science GI6.3 Remote sensing for environmental monitoring

Introduction

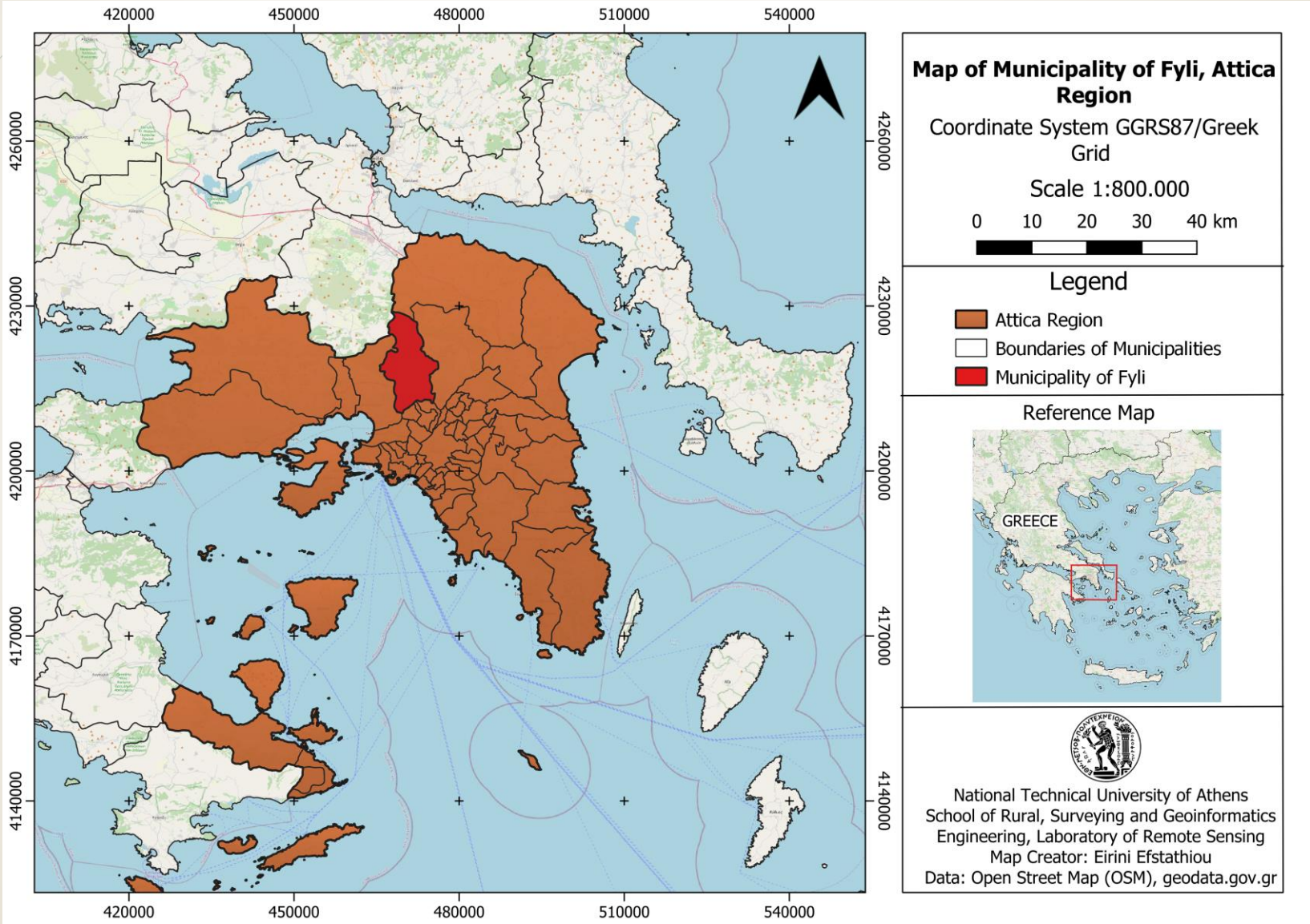
- **The aim** of this work is to confirm that the use of remote sensing in combination with GIS can produce very good results in waste management decision-making.
- **The purpose** is to study and monitor the environmental conditions through the Land Surface Temperature (LST) in the landfill of Fyli – Ano Liosia region. The use of satellite images for such an application is a pioneering step, but there are many studies that prove the usefulness of remote sensing in this particular field of research. Therefore, based on previous studies, we have the monitoring of the Land Surface Temperature (LST) in the landfill Fyli – Ano Liosia through remote sensing tools for the period January 2021 to December 2022.

Study Area

- The study area is the landfill site of Fyli – Ano Liosia which is located in the Municipality of Fyli.
- The Municipality of Fyli (Map 1.) is a municipality of the Attica region that was established within the context of the Kallikratis program. It arose from the union of the pre-existing municipalities of Fyli, Ano Liosia and Zephyri. The area of the new Municipality is 105,128 sq.km. with 45,965 inhabitants according to the 2011 census. It consists of the Municipal Unit of Ano Liosia (Headquarters of the Municipality), the Municipal Unit of Zephyri and the Municipal Unit of Fyli.

Study Area

Map 1. Municipality of Fyli

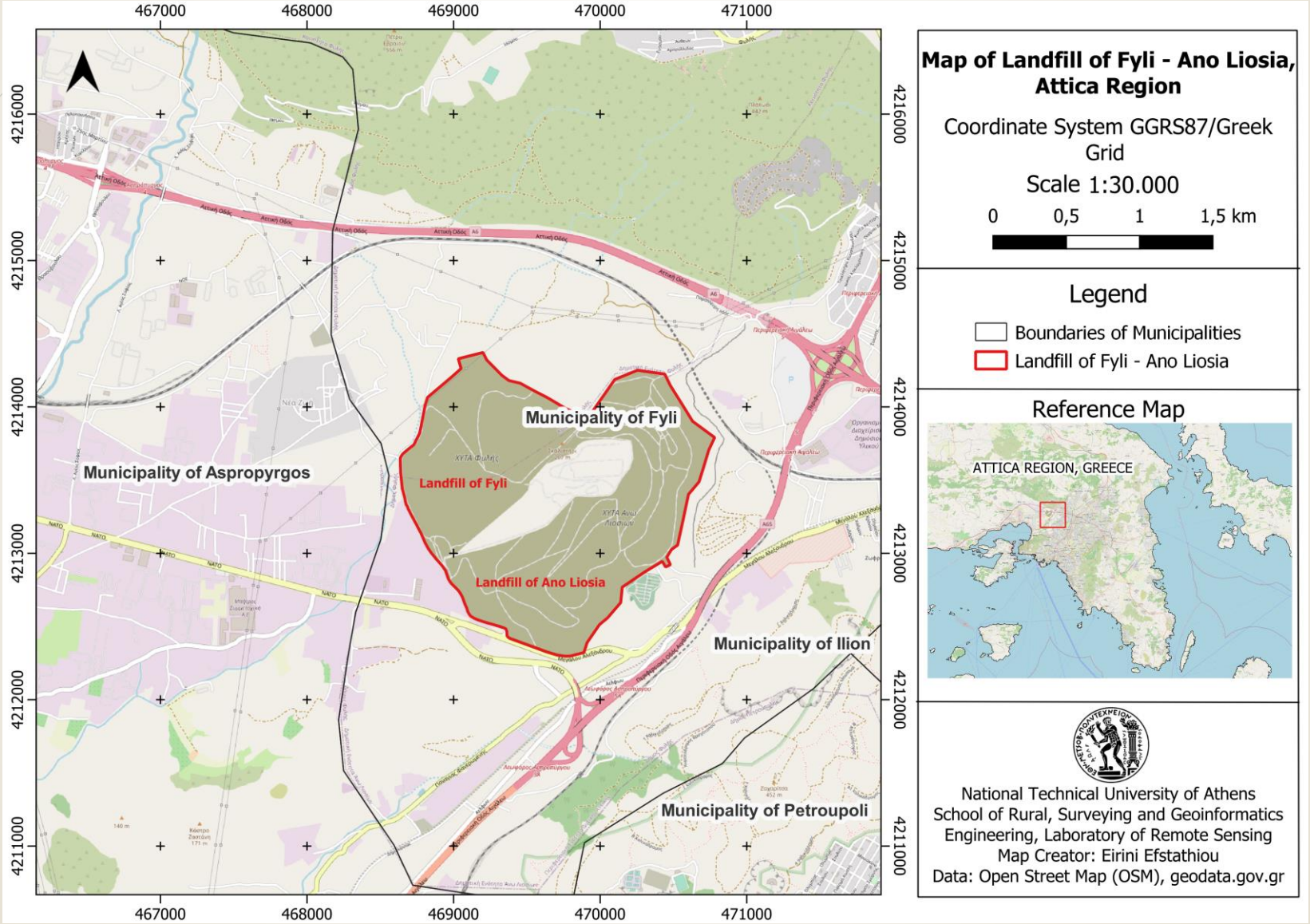


Study Area

- The management and the final disposal of Attica Region's wastes is carried out in the Landfill of Fyli, approved by the national legislation, at the location "Skalistiri", an area of approximately 1,000 acres, located between the Parnitha and Aigaleo mountains. The landfill of Fyli (Map 2.) is adjacent to the no longer active landfill I and II of Ano Liosia and the Waste Disposal Area of Ano Liosia. Fyli's landfill has been operating since 2004, while the landfill I was restored in 2009, and the landfill II, in 2010. The biogas produced from the restored landfills I and II and the older Waste Disposal Area of Ano Liosia, is led to exploitation for energy production in a unit located within the boundaries of the Complete Waste Disposal Facility of Attica.

Study Area

Map 2. Landfill of Fyli – Ano Liosia



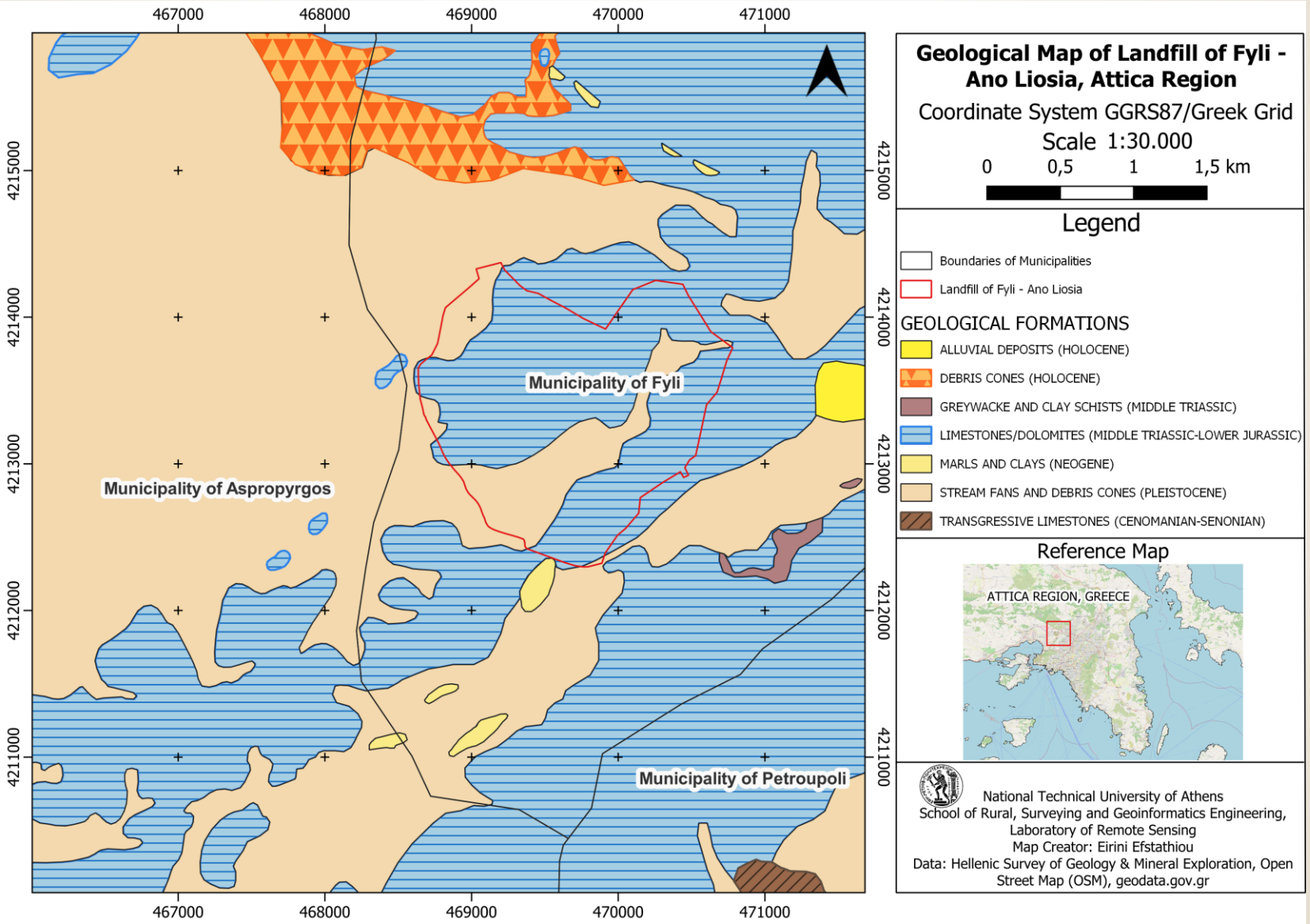
Study Area

- Geology

As can be seen on map 3, two geological formations are found in landfill, carbonate rocks and specifically limestones and dolomites of Middle Triassic-Lower Jurassic age (around 240 Ma), as well as stream fans and debris cones of Pleistocene age (around 2.5 Ma). According to the work of Lekkas (2001), the study area consists mainly of debris cones and unmetamorphosed alpine carbonate formations. Alluvial deposits of Holocene age (around 0.0117 Ma) can be observed in the wider area, as well as debris cones of the same age. Also, marls and clays of Neogene age (around 20 Ma), graywackes of Middle Triassic age (around 240 Ma) and also transgressive limestones of Cenomanian – Senonian age (around 100 Ma).

Study Area

Map 3. Geology of study area



Materials and Methods

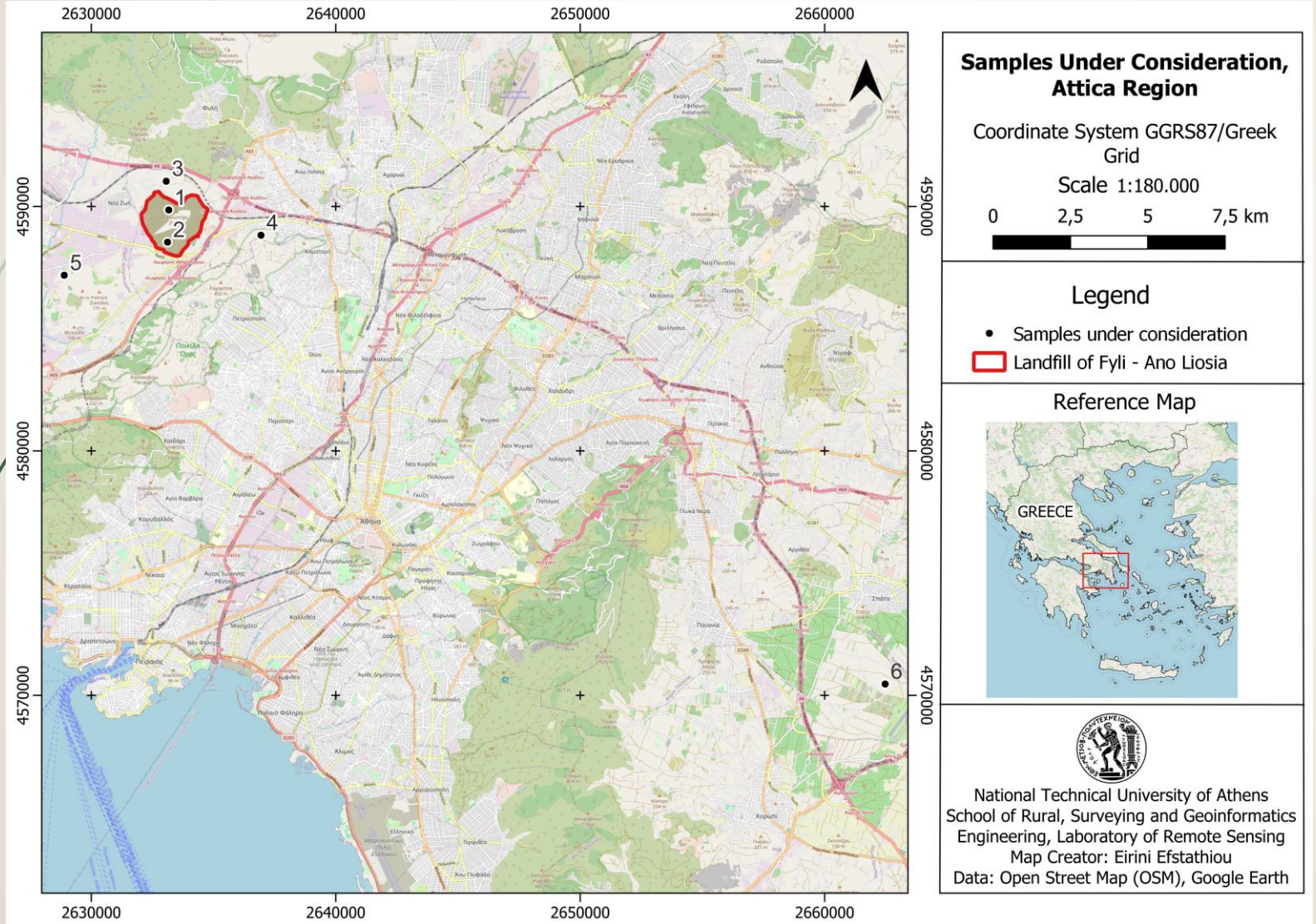
- Landsat 8-9 data from Sentinel EO Browser website are used to study Land Surface Temperature.
- **Landsat 8** : It carries two sensors, OLI (Operational Land Imager) and the thermal sensor TIRS (Thermal Infrared Sensor -TIRS).
- **Landsat 9** : It carries two sensors, OLI-2 (Operational Land Imager 2) and Thermal Infrared Sensor 2 (TIRS-2).
- The two thermal sensors, Landsat 8 's TIRS and Landsat 9 's TIRS -2 , measure the thermal radiation emitted by the Earth's surface in two thermal hyperspectral channels.
- Channel 10 TIRS 1 → 10.6μm - 11.19μm
- Channel 11 TIRS 2 → 11.5μm - 12.51μm
- Ground Sampling Interval (pixel size):100 m

Materials and Methods

- It is chosen to study different areas of the landfill in terms of their LST as well as parts of bare soil and cultivation outside the landfill. The areas under consideration are the following (Map 4.):
- Part of the Active area of landfill (site 1)
- Part of the Inactive area of landfill (site 2)
- Bare Soil at the same altitude as landfill (altitude 100 m) (site 3)
- Bare Soil at a higher altitude than landfill (altitude 250 m) (site 4)
- Cultivation in Aspropyrgos (site 5)
- Cultivation in Spata (site 6)

Materials and Methods

Map 4. Samples under consideration



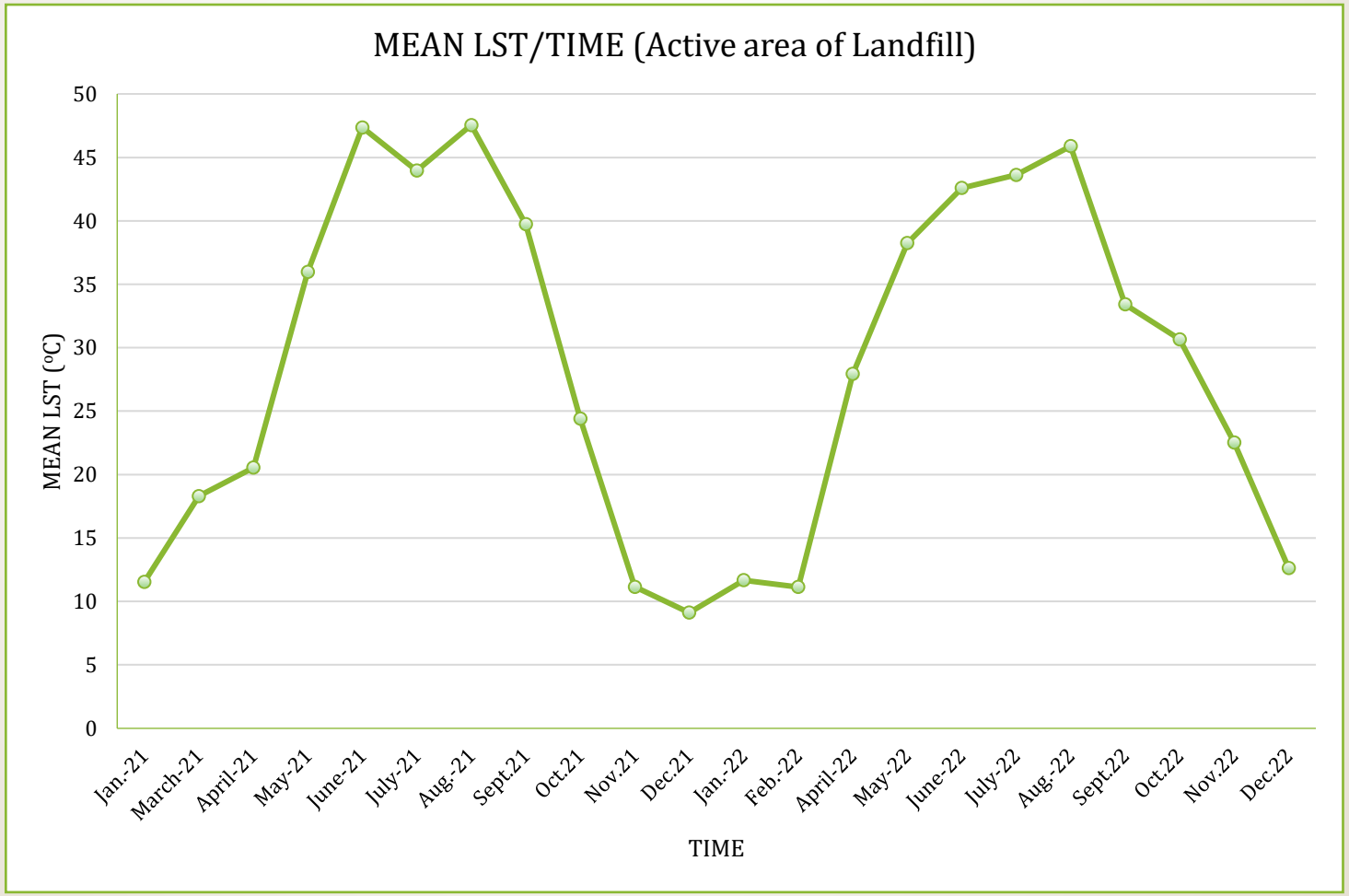
- Part of the Active area of landfill (**site 1**)
- Part of the Inactive area of landfill (**site 2**)
- Bare Soil at the same altitude as landfill (altitude 100 m) (**site 3**)
- Bare Soil at a higher altitude than landfill (altitude 250 m) (**site 4**)
- Cultivation in Aspropyrgos (**site 5**)
- Cultivation in Spata (**site 6**)

Materials and Methods

- NDVI data from the same website, is also used, so that the areas outside the landfill, which will be studied, to have similar NDVI values to those of the inactive area of landfill. First, the NDVI index values are checked and as long as the examined area has a low vegetation index, the extraction of LST data for the specific area continues.
- Used data are from Sentinel EO Browser for the period January 2021 to December 2022 with a cloud coverage of 7% so that there is no strong influence from clouds. For each month there are more than one LST values. The final mean LST value is a result of the AVERAGE function of excel in order to assign one LST value to each month. The same procedure is followed for the NDVI index.
- Finally, the LST of the areas is compared with the air temperature provided by the weather station of Ano Liosia in close proximity to landfill.

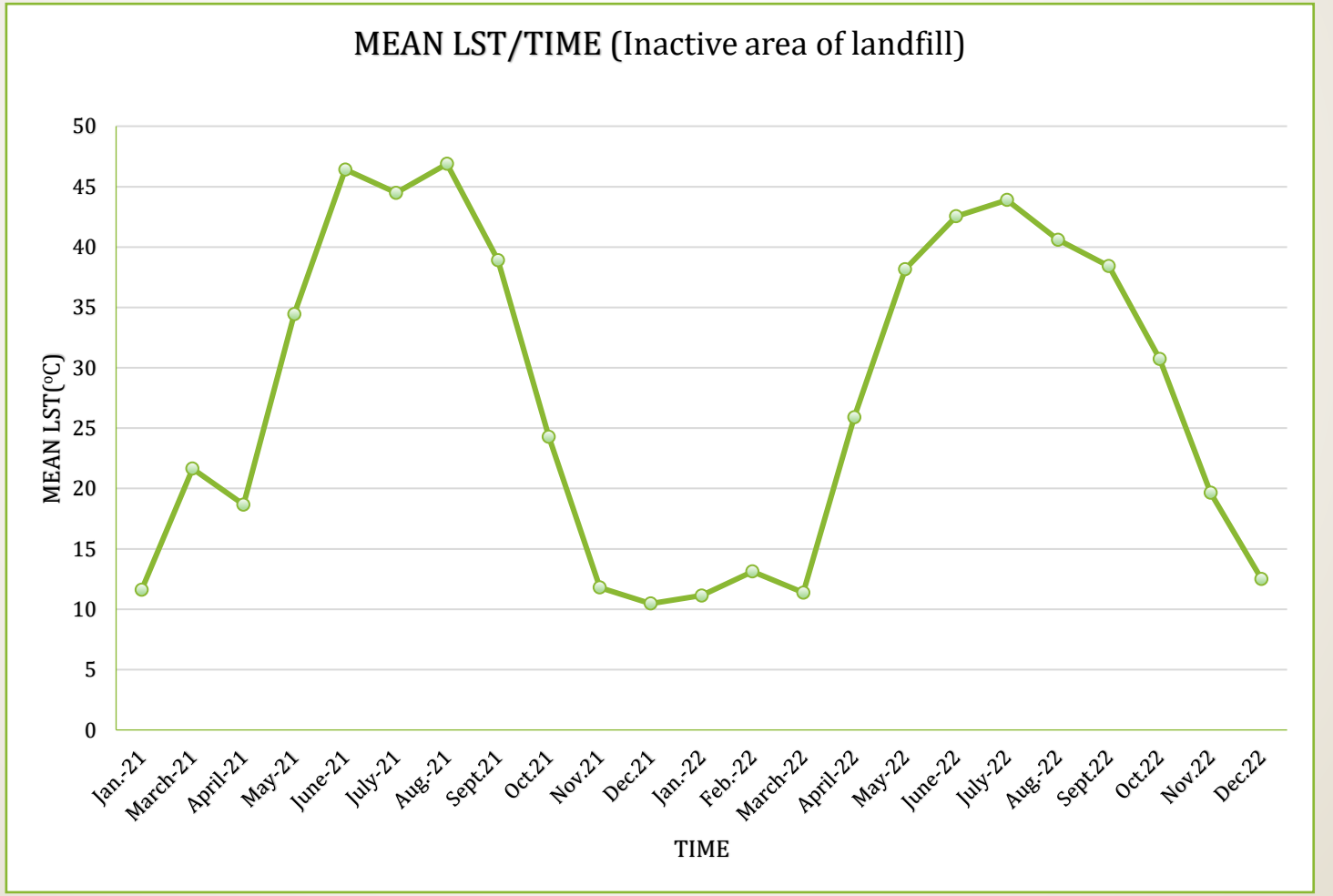
Results

- Part of the Active area of landfill



Results

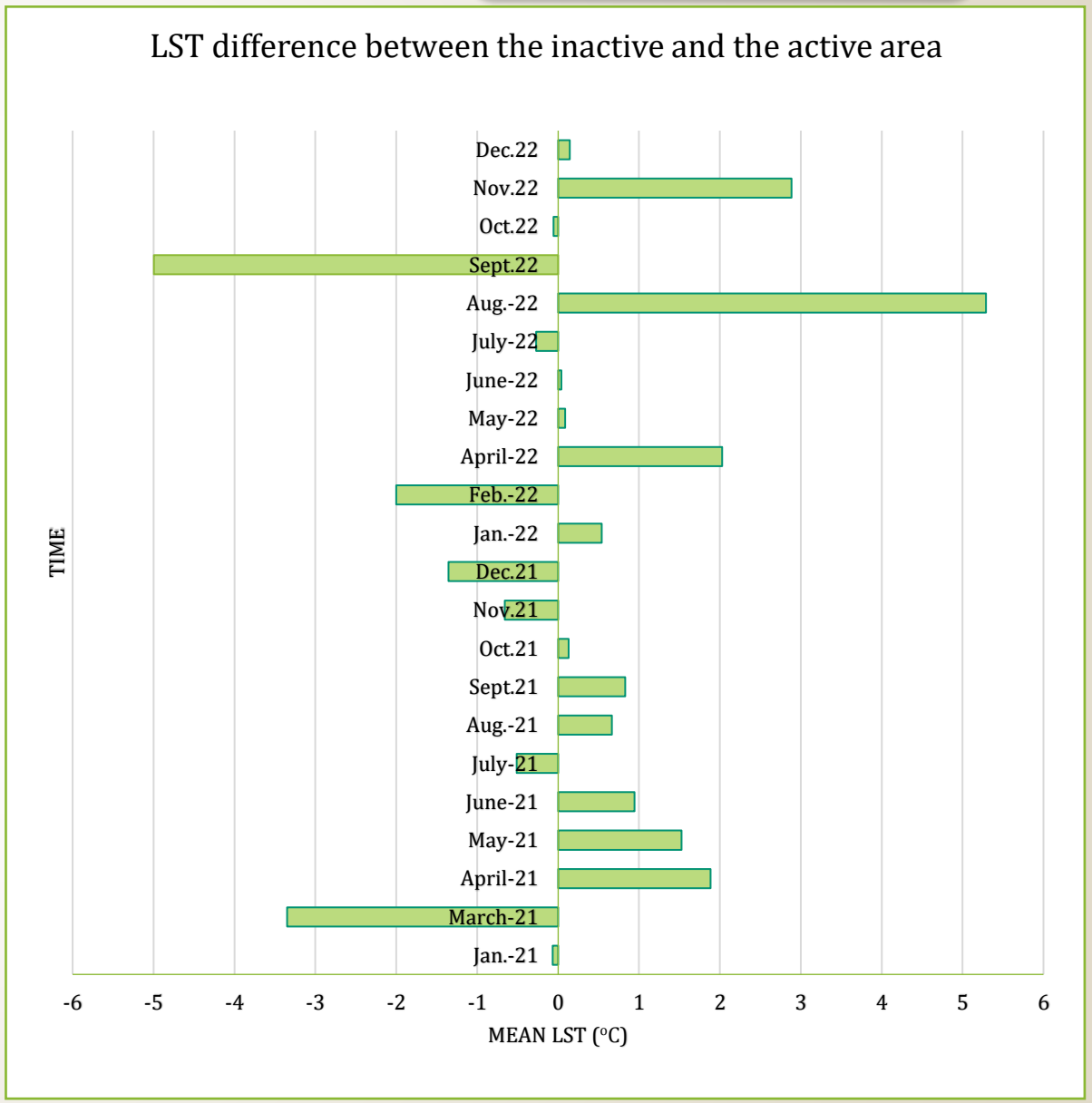
- Part of the Inactive area of landfill



Results

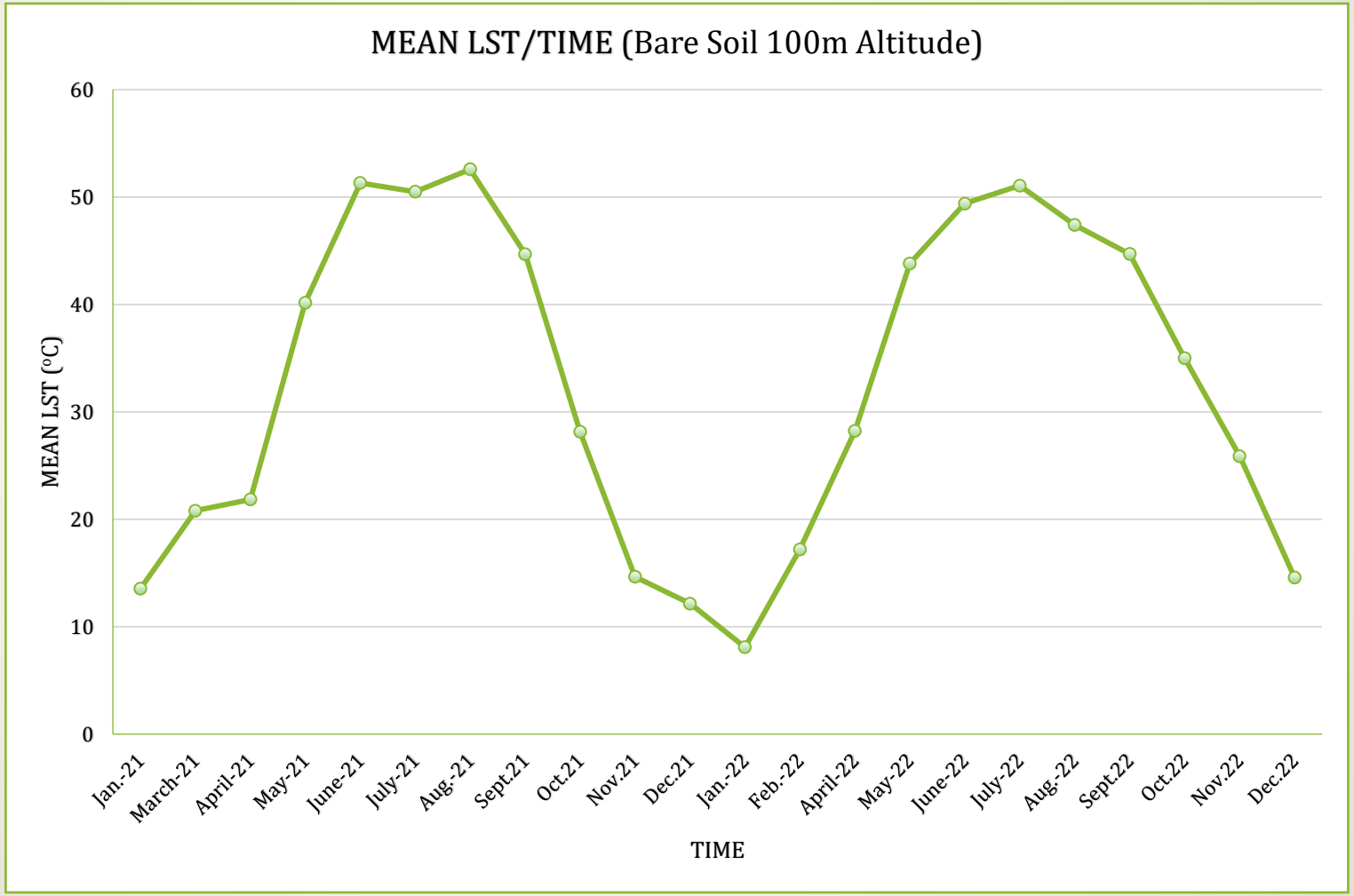
- It seems that in most of the months during the time period under study, the LST recorded in the active area of the landfill is higher than that of the inactive region by 1°C-2°C on average.
- There are months where the LST in the inactive region is higher than that in the active region. This is explained by the fact that the part of the inactive area that was selected, is not actually inactive. Satellite images show that a part of it is already under exploitation, probably for future landfill operations.

LST difference between the inactive and the active area



Results

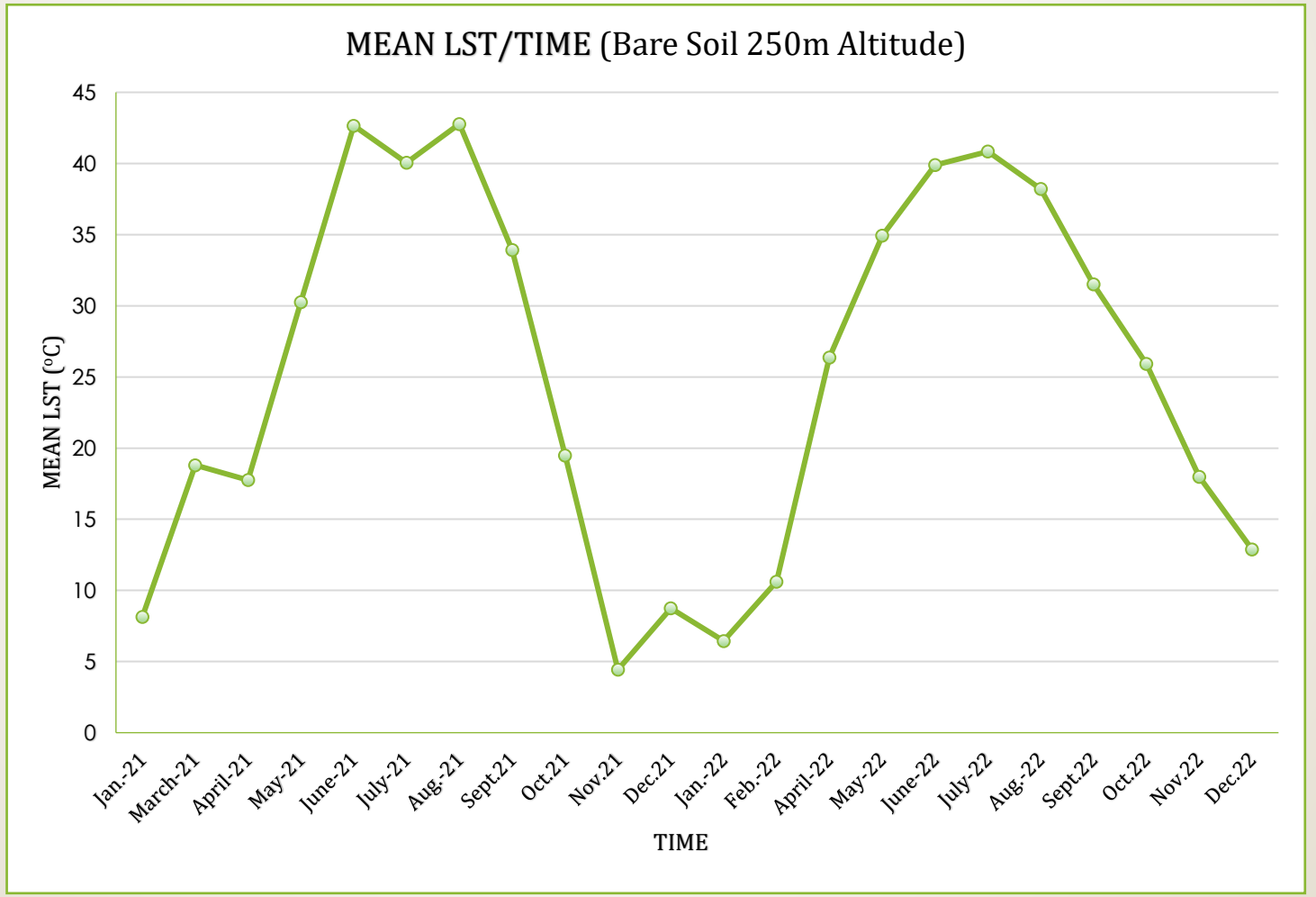
- Bare Soil at the same altitude as landfill (altitude 100 m)



Results

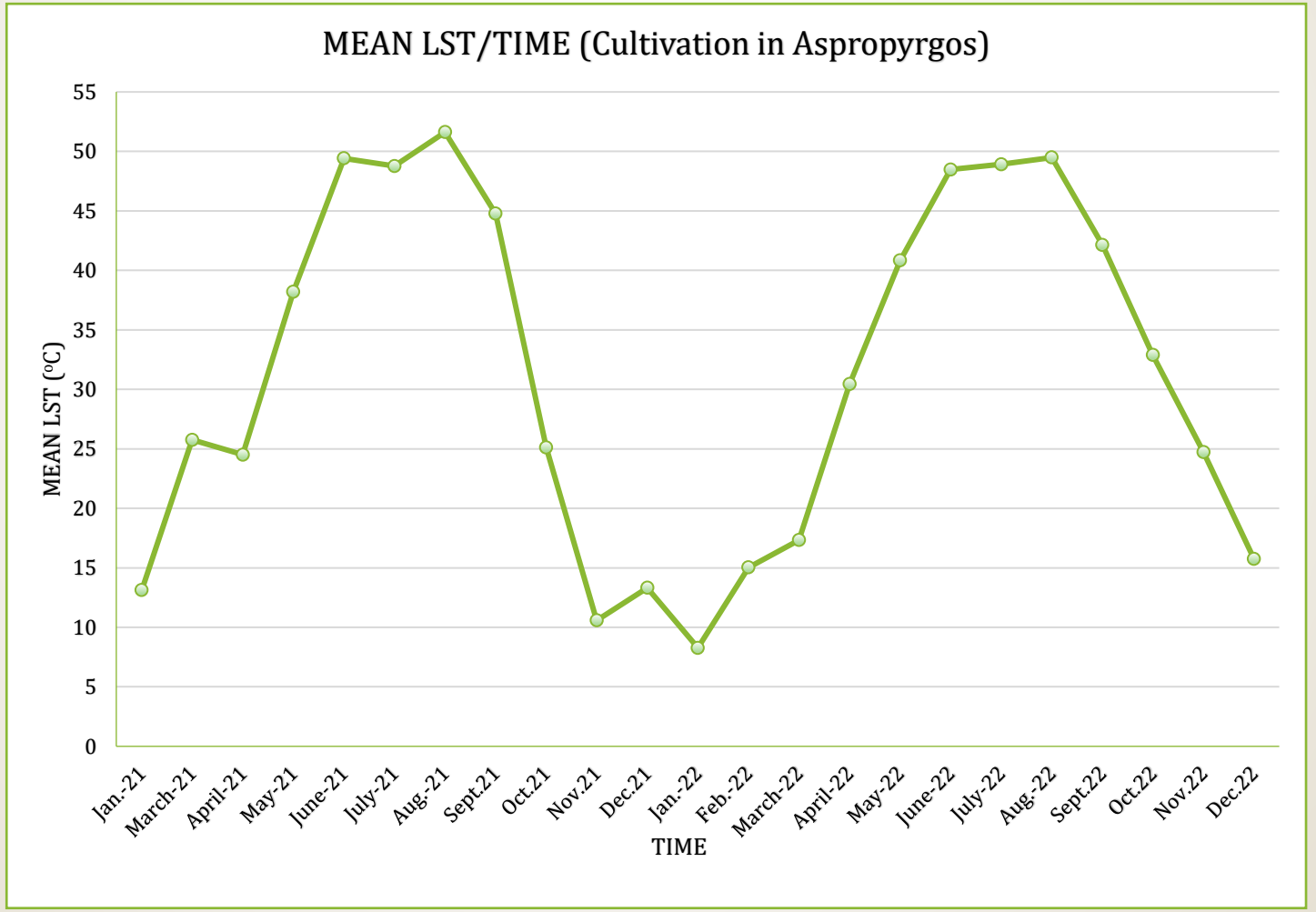
The LST of an area is affected by its elevation, slope, vegetation, humidity, and albedo.

- Bare Soil at a higher altitude than landfill (altitude 250 m)



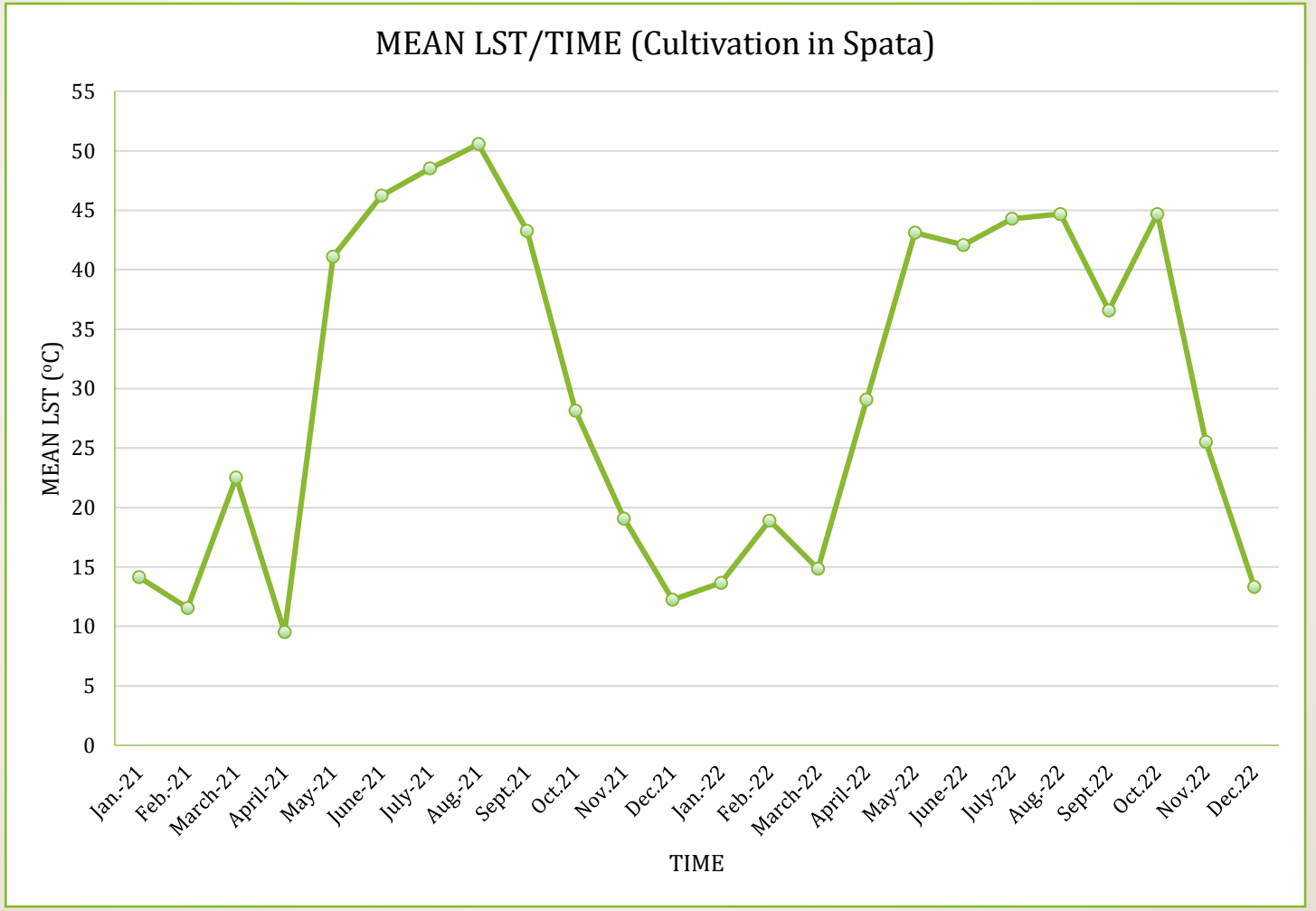
Results

- Cultivation in Aspropyrgos



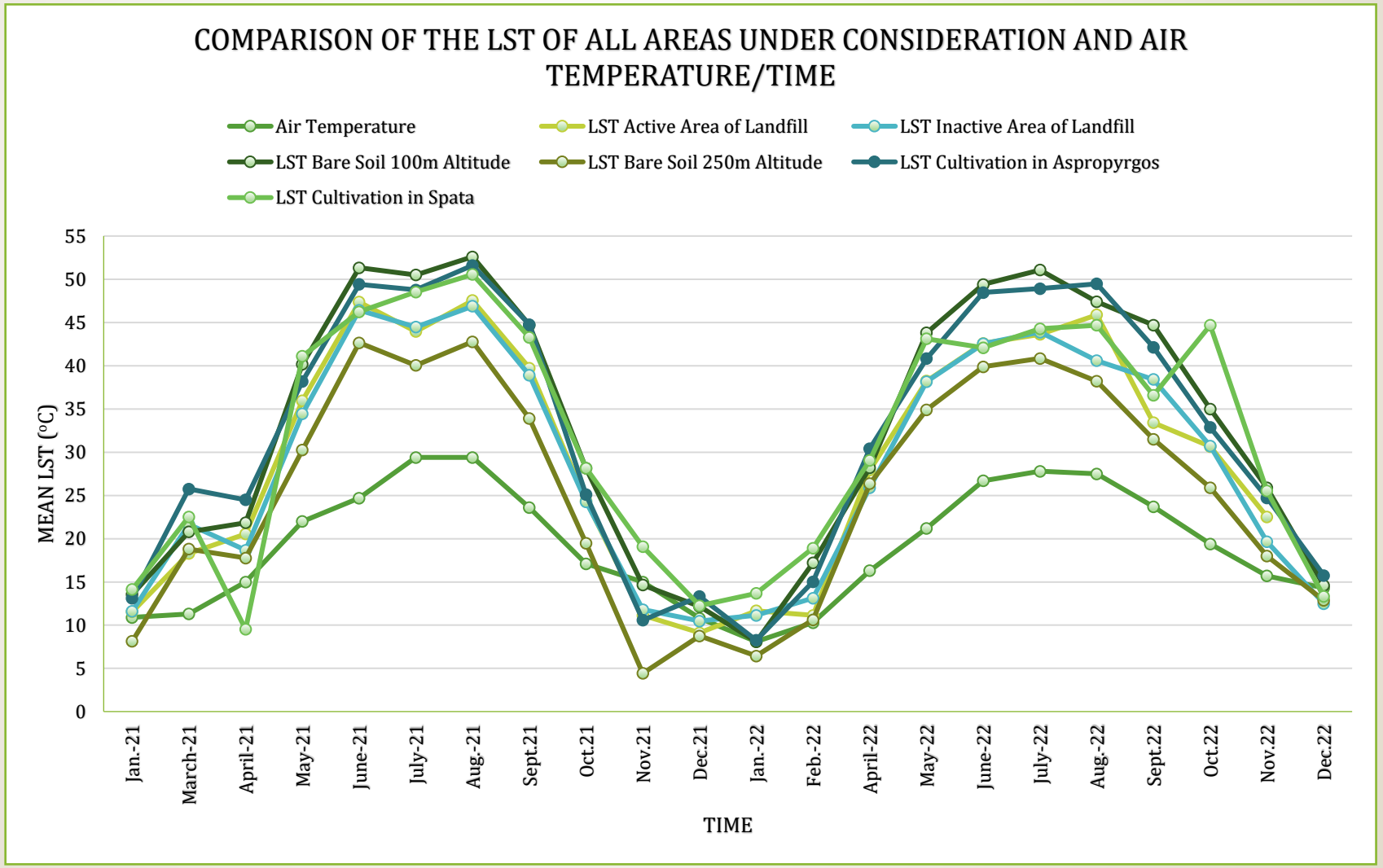
Results

- Cultivation in Spata



Results

- Overall chart-Comparison with air temperature



Conclusions

- The temperatures which are observed in the active area of the landfill are slightly higher than those of its inactive region, a fact which is evaluated as normal according to literature research (Shaker Ahmed & Yan Wai Yeung , 2010). The reason for this is the intense biodegradation that takes place in these areas. However, the LST differences are not large, with the active area of the landfill to show an increase of approx 1°C-2°C during most months of the year.
- The bare soil area at an altitude of 250 m shows lower LST values than those of the landfill, which is expected, given the fact that the specific area is at a higher altitude than the landfill, having a different slope and sparse vegetation (sparse bushes).
- The remaining three samples show higher LST values than those of landfill.

Conclusions

- The LST of the bare soil at an altitude of 100m as well as the cultivation in Aspropyrgos is probably affected by the intense industrial activity of the wider area. For this reason, the sample in Spata was also examined, an area quite far from Aspropyrgos, in which, however, the LST is again greater than that of the landfill's.
- The surface soil temperature in a landfill is considered high when it exceeds 60°C. Its increase is mainly due to the intense biodegradation of the waste in combination with the escape of gases and leachates within the landfill.
- Considering the LST data of Landsat 8-9 satellites for the examined areas, we come to the conclusion that the LST in Fyli – Ano Liosia Landfill is within normal limits as the LST in its active area reaches 47.55°C.
- To confirm the above theory, the last annual environmental report of landfill is studied (March 2022 edition), according to which there are no biogas escapes into the atmosphere from the active area of the landfill.

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