

Irrigation water use in Mediterranean islands

Fresh water or wastewater reuse?

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AgroStrat targeted intensively cultivated areas in the Med region which are under desertification risk

Among other objectives...

To propose alternative practices for reducing fresh water consumption, using as example the cultivation of pistachio trees in Aegina island.

Implementation area : Aegina island



The screenshot shows the AgroStrat website homepage. At the top, there is a logo for 'AgroStrategies' and a navigation menu with links for Home, Project, Inventory, News, Contact, and Log in. Below the navigation is a 'Welcome to AgroStrat' section with introductory text about the project's goals for sustainable management of agricultural areas. To the right, there are two main feature boxes: 'Central Management Monitoring System' (CMMT) and 'Cultivation Management Software'. The CMMT box includes a small image of a pistachio tree and text describing the tool's purpose. The Cultivation Management Software box includes a screenshot of the software interface. At the bottom right, there is a section titled 'AgroStrat in Bari, Italy' with a small image of a field. A large red watermark 'http://www.agrostrat.gr' is overlaid diagonally across the entire screenshot.

Pistachios processing and waste generation



Pistachio nuts processing (dehulling)



Discharge of waste on soil and water bodies



For 1 tn dehulled pistachios almost 2 tn of waste are generated
In Aegina island : 3500-4000tn of wastewater are generated annually

Irrigating pistachio trees

Water from from a variety of sources:

- wells, drillings, surface waters delivered through streams, ditches, canals, and reservoirs and, less frequently, from municipal supply network.

A single orchard frequently uses water from more than one source

Farmers irrigate their trees on average twice

However, the common practice is to irrigate 5-7 times annually

....consequences of bad quality irrigation water

- Accumulation of Na^+ in the root zone and of Cl^- in tree leaves
- Salts accumulation on soils and increase in their electrical conductivity, mainly at depths between 30-90 cm, which causes gradual but stable soil degradation.



Irrigation water monitoring

Twenty four sites were monitored periodically. For this five sampling campaigns took place, on:

- 29-30 January 2013,
- 1-5 July 2013,
- 18-23 November 2013,
- 18-22 March 2014,
- 9-14 June 2014.

Samples were collected from drillings, wells and public network



Parameters determined

pH, electrical conductivity, Na, Ca, Mg, K, $\text{HCO}_3^-/\text{CO}_3^{2-}$, Cl^- , SO_4^{2-} , NO_3^- , PO_4^{3-} , Cu, Zn, Mn, Fe

Estimated parameters

Total hardness; Sodium Adsorption Rate (SAR); Residual Sodium Carbonate (RSC); Lime Deposition Potential (LDP);

$$\text{SAR: } \frac{(\text{Na}_l^{\text{meq}})}{\sqrt{0,5 \times [(\text{Ca}_l^{\text{meq}}) + (\text{Mg}_l^{\text{meq}})]}} \quad [1]$$

$$\text{RSC (meq/l): } = (\text{HCO}_3^{2-}) + (\text{CO}_3^{2-}) - (\text{Ca}^{2+}) - (\text{Mg}^{2+}) \quad [2]$$

$$\text{LDP (meq/l) is the lower between the two sums (a) } (\text{HCO}_3^-) + (\text{CO}_3^{2-}), \text{ or (b) } (\text{Ca}^{2+}) + (\text{Mg}^{2+}) \quad [3]$$



Wastewater vs currently used irrigation water (average values)

Parameter	Drillings and wells	Wastewater
pH	7.14	5.68
EC, mS/cm	6.08	6.10
Polyphenols, mg/l	-	1,500
Na, mg/l	897	347
K, mg/l	27.3	1,050
Total hardness, ppm CaCO ₃	1984	1,820
HCO ₃ ⁻ , meq/l	5.79	1.10
CO ₃ ²⁻ , meq/l	0.10	-
Cl ⁻ , mg/l	2,122	710
NO ₃ ⁻ , mg/l	53.1	5.0
LDP, meq/l	5.81	1.10
SAR	8.28	3.5
RSC, meq/l	-34	-35
Risk for soil permeability	Low	Low

Currently used irrigation water

Mean values and the respective evaluation for irrigation water parameters measured between 2013 and 2014 in Aegina island.

Parameter	Mean value	Evaluation
pH	7.14	Within normal range
Electrical Conductivity, dS/m	6.08	High hazard. The water is unacceptable for irrigation, except for very salt-tolerant plants where there is excellent drainage, frequent leaching and intensive management. The risk for soil salinity is very high.
Total hardness, ppm CaCO ₃	1,979	Unacceptable high hardness
HCO ₃ ²⁻ , meq/l	4.7	Slight to moderate restriction on use
Cl ⁻ , mg/l	2,118	Chlorides concentration is very high and can cause severe damages to plants
N-NO ₃ ⁻ , mg/l	12	Slight to moderate restriction on use
SAR	8.8	Low risk for sodium hazard
RSC, meq/l	-34	The residual sodium carbonate is low. No calcium deposition and infiltration decrease problems are anticipated
LDP, meq/l	4.7	Very high risk for lime deposition on leaves, fruits and trees roots.

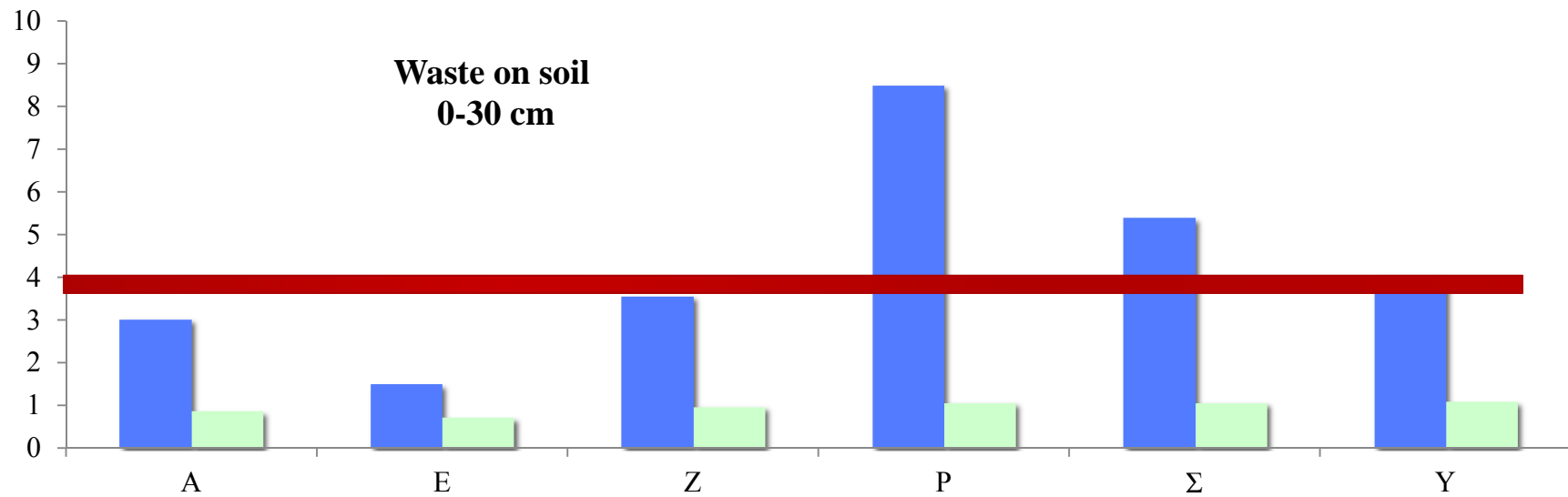
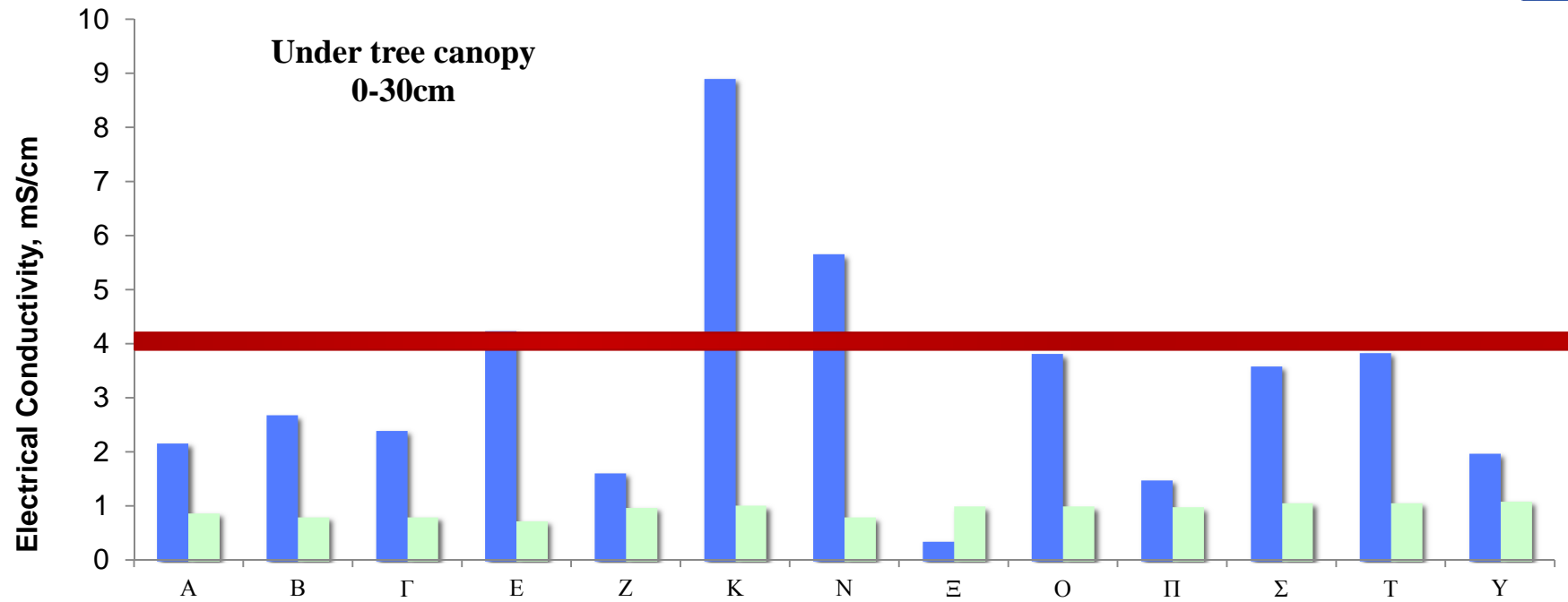


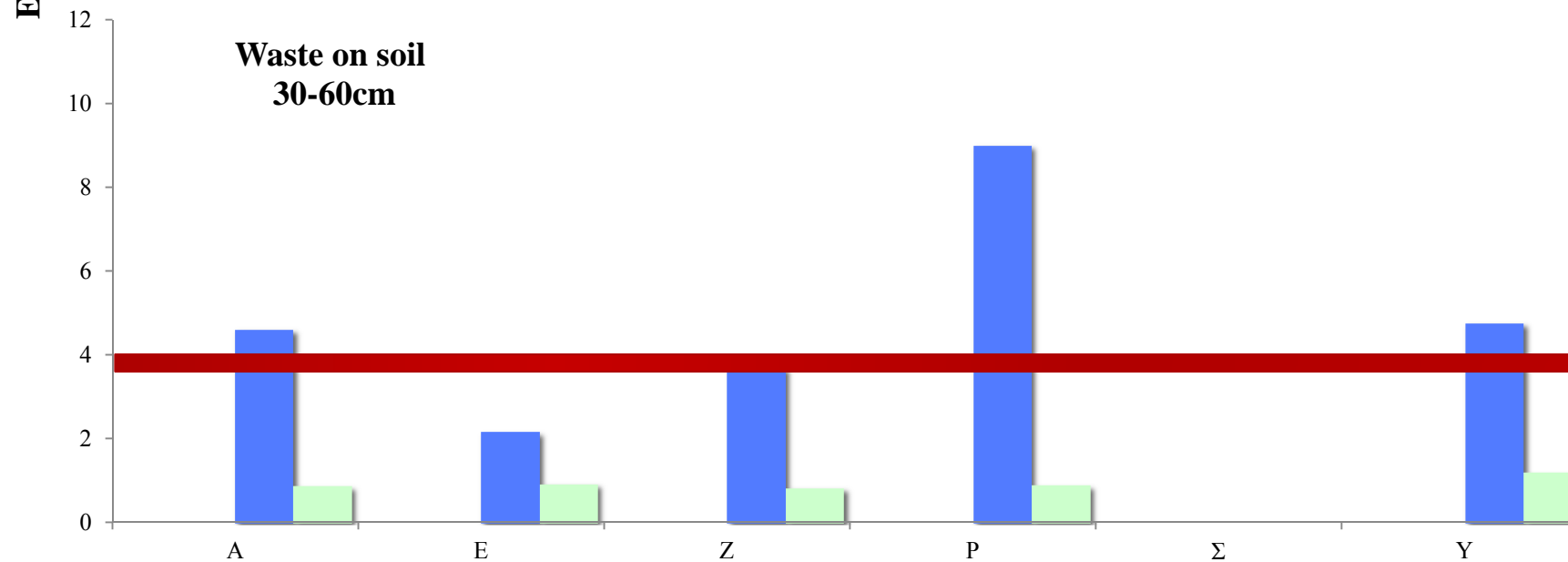
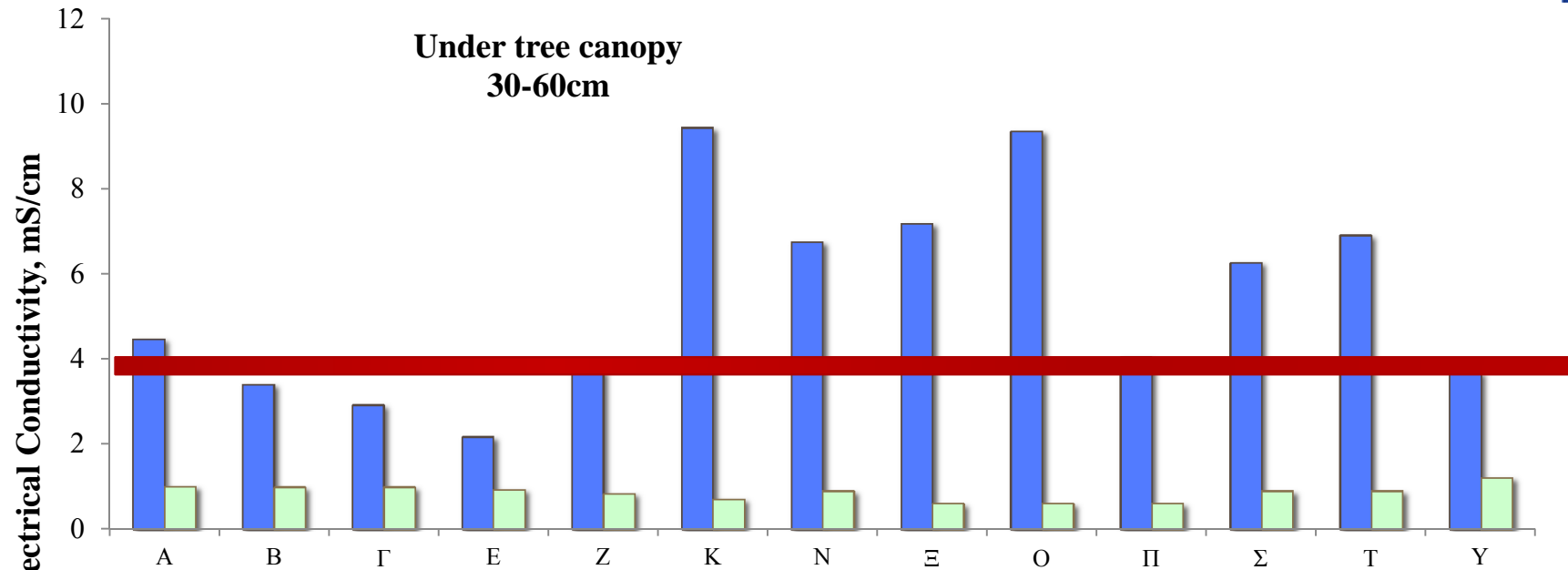
Pistachio wastewater

Mean values and the respective evaluation pistachios wastewater parameters measured between 2013 and 2014 in Aegina island.

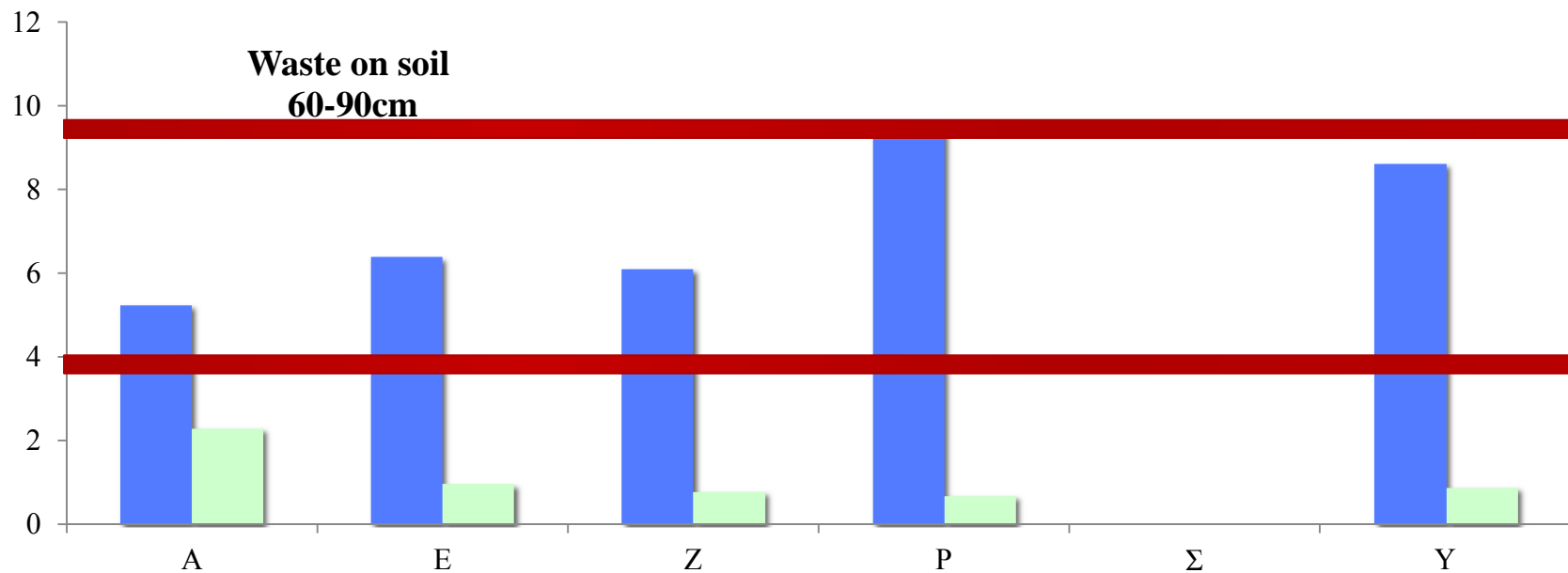
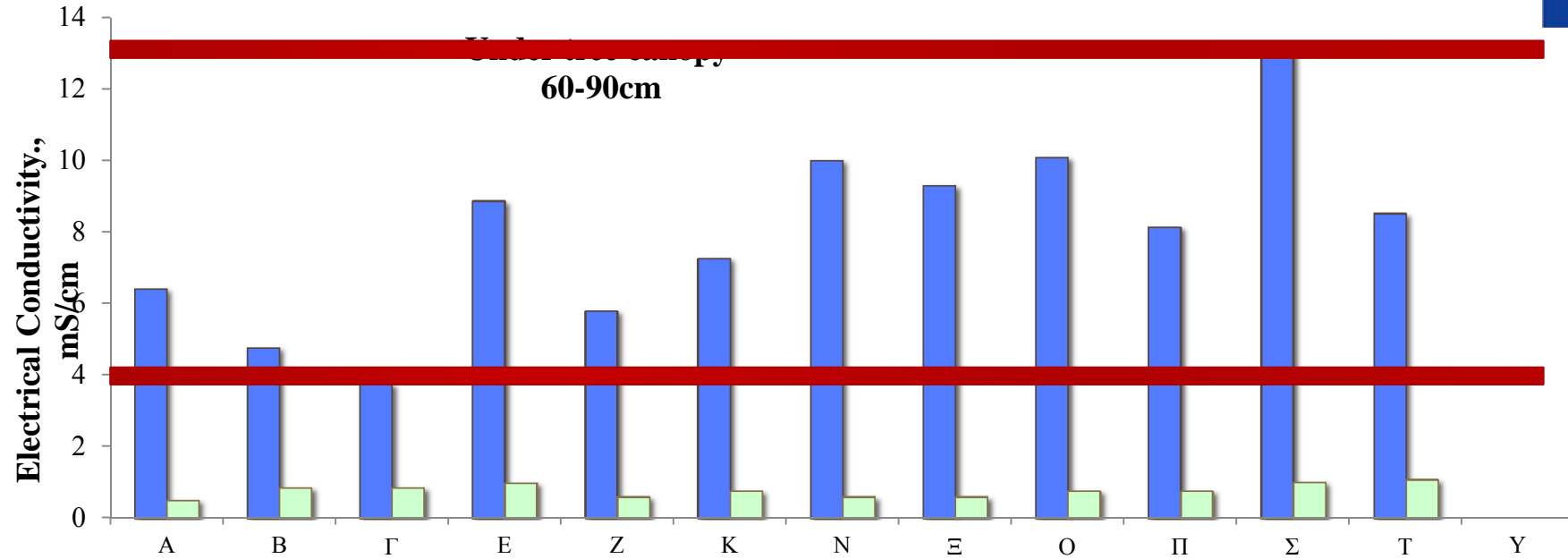
Parameter	Mean value	Evaluation
pH	5.68	Very low, out of the normal range
Electrical Conductivity, dS/m	6.10	High hazard. The water is unacceptable for irrigation, except for very salt-tolerant plants where there is excellent drainage, frequent leaching an intensive management. The risk for soil salinity is very high.
Total hardness, ppm CaCO ₃	1,820	Unacceptable high hardness
HCO ₃ ²⁻ , mg/l	1.1	None restriction on use
Cl ⁻ , mg/l	710	Chlorides concentration is very high and can cause severe damages to plants
N-NO ₃ ⁻ , mg/l	1.1	None restriction on use
SAR	3.5	Low risk for sodium hazard
RSC, meq/l	-35	The residual sodium carbonate is low. No calcium deposition and infiltration decrease problems are anticipated
LDP, meq/l	1.1	No risk for lime deposition on leaves, fruits and trees roots







...about soil



AgroStrat proposed...



Agro
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Land suitability map
for the disposal of pistachio
processing wastewater



LEGEND

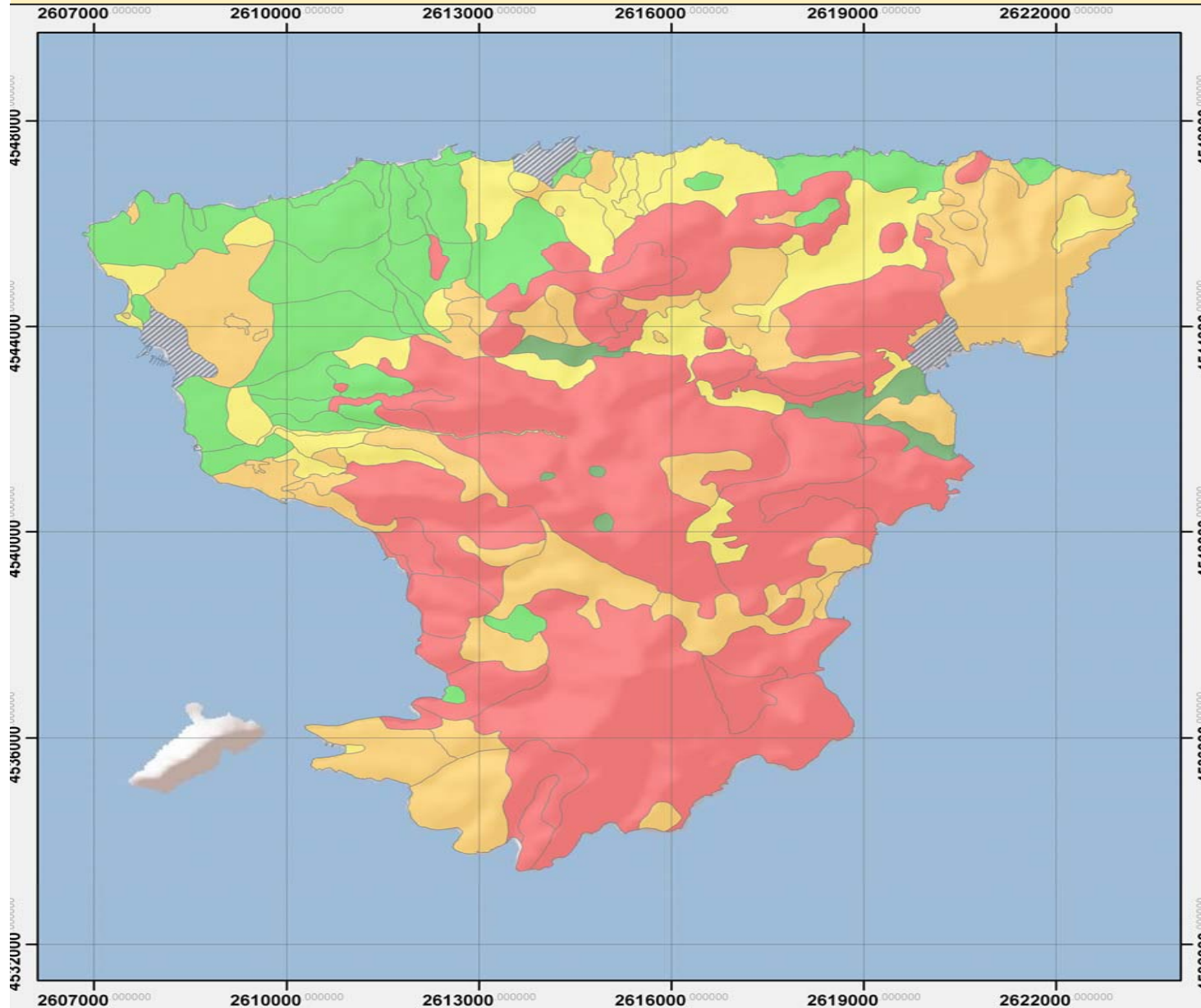
Areas characterization
for disposal of wastewater

- S1 : Suitable
- S2 : Moderately suitable
- S3 : Marginally suitable
- N1 : Temporarily unsuitable
- N2 : Permanently unsuitable
- URBAN



Soil data processing, analysis and evaluation
Dr. Maria Doula (Benaki Phytopathological
Institute)

Soil sampling and soil characterization:
Dr. Sid Theocharopoulos, Chronis Kolovos
(ELGO DEMETER)



Strategy depends upon the ability to foresee future consequences of present initiatives

Thank you
for your attention

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