Development and implementation of GIS LIS for waste reuse on soil

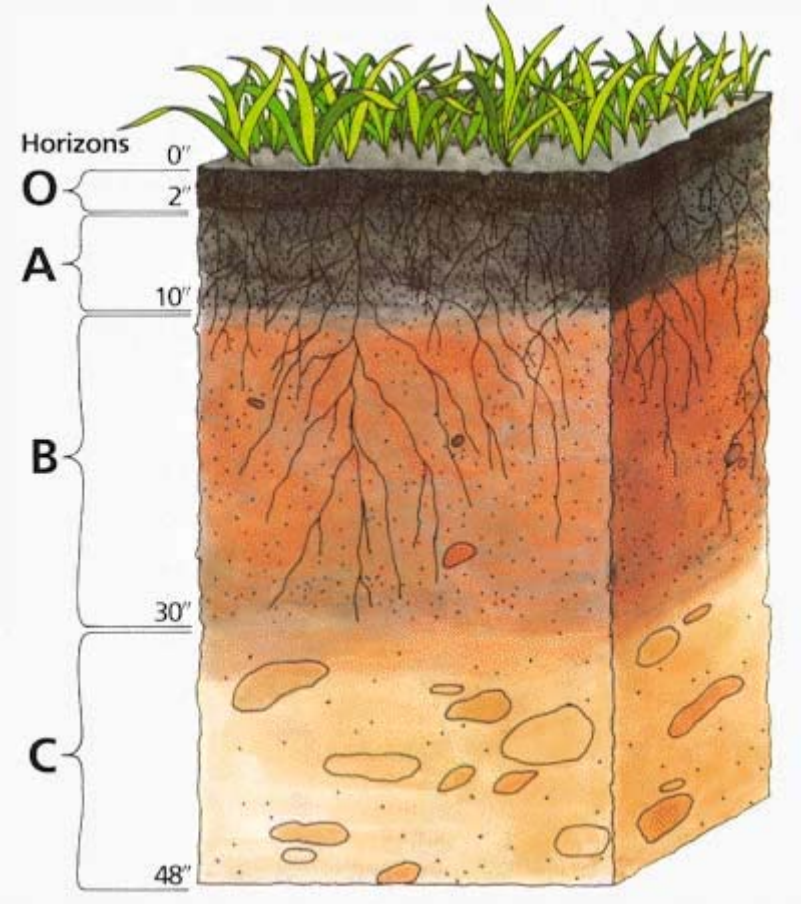
By
Dr Sid. P. Theocharopoulos [(1)], V. Kavvadias [(1)], K. Komnitsas [(2)],

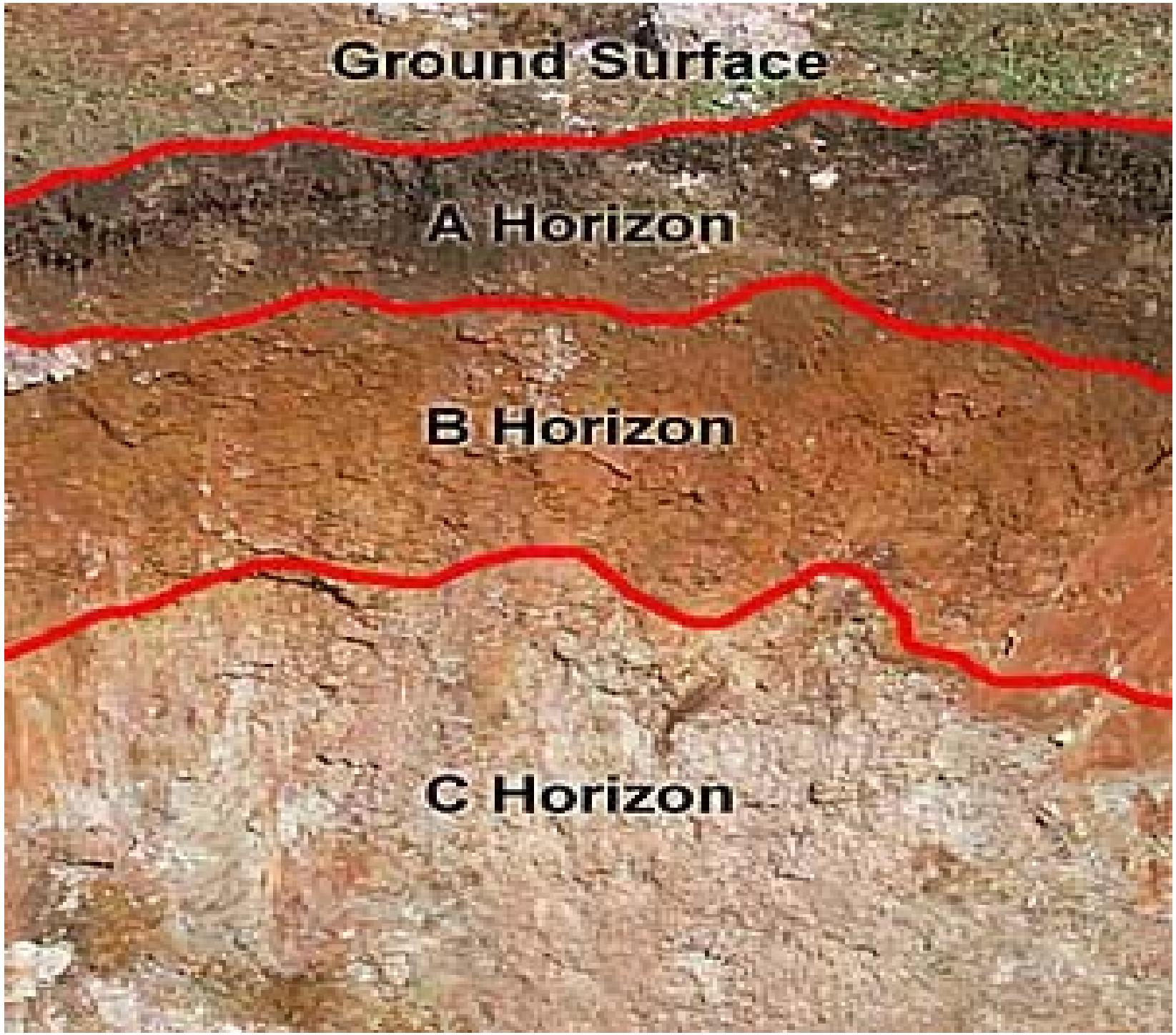
(1)Soil Science Institute of Athens, Hellenic Agricultural Association “DEMETER”,
(2) Technical University of Crete

The Presentation

- Safe Reuse of Wastes on Soil
- Soil/Land:
  - Properties, functions, Threats
- The European Dimension of Threats
- GIS-LIS for land classification:
  - Structure, Uses, Input, Output
- Extrapolation to the EU Med Counties
- Conclusions
- Aknowledgements

Soil : 3D-Structure
Variability, Complexity, Scaling




Ground Surface
A Horizon
B Horizon
C Horizon

Soil Functions/Processes

(a) food and other biomass production, including in agriculture and forestry;

(b) storing, filtering and transforming nutrients, substances and water, as well as replenishing bodies of groundwater;

(c) basis for life and biodiversity, such as habitats, species and genes; (1g=6.000 sp/genotypes B/F)

(d) physical and cultural environment for humans and human activities;

(e) source of raw materials;

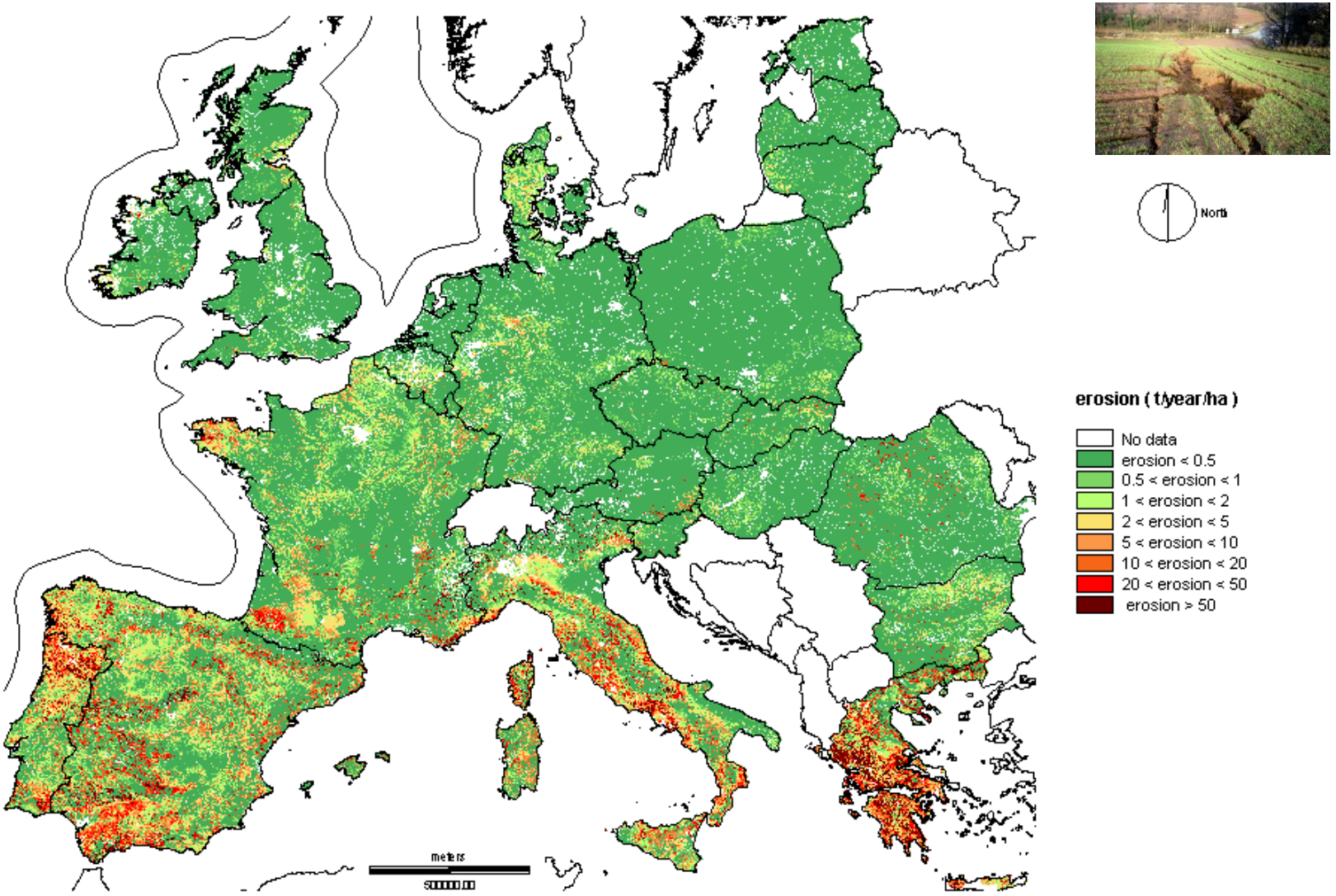
(f) acting as carbon reservoir;

(g) archive of geological, geomorphological and archaeological heritage.

Threats to European soil

- Erosion
- Decline in organic matter
- Soil contamination
- Soil sealing
- Soil compaction
- Decline in soil biodiversity
- Salinisation
- Floods and landslides

PESERA Soil Erosion Risk Assessment

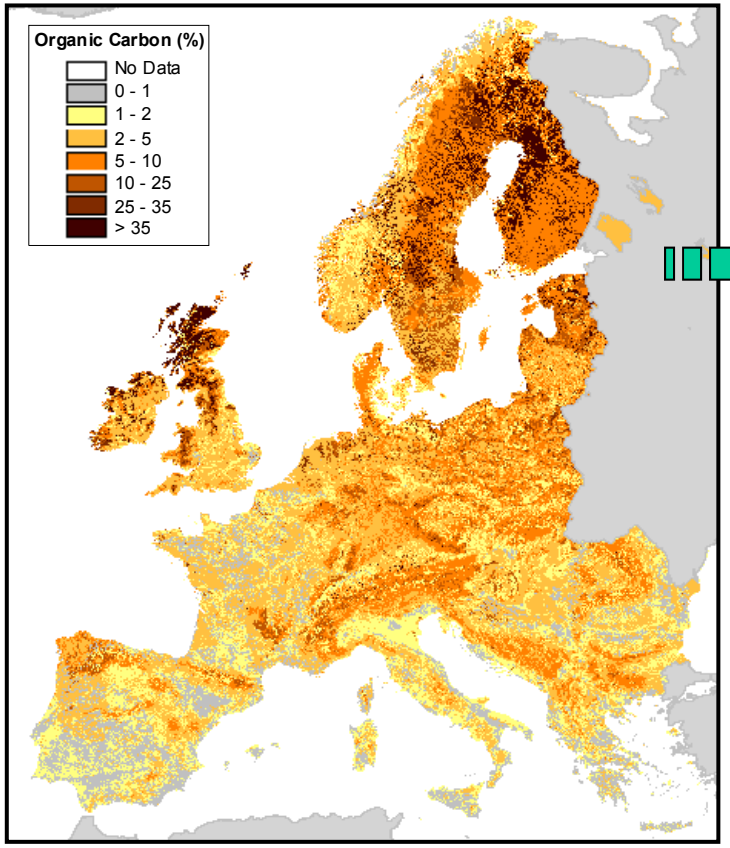


Water erosion: 115 Million ha

Wind erosion: 42 Million ha

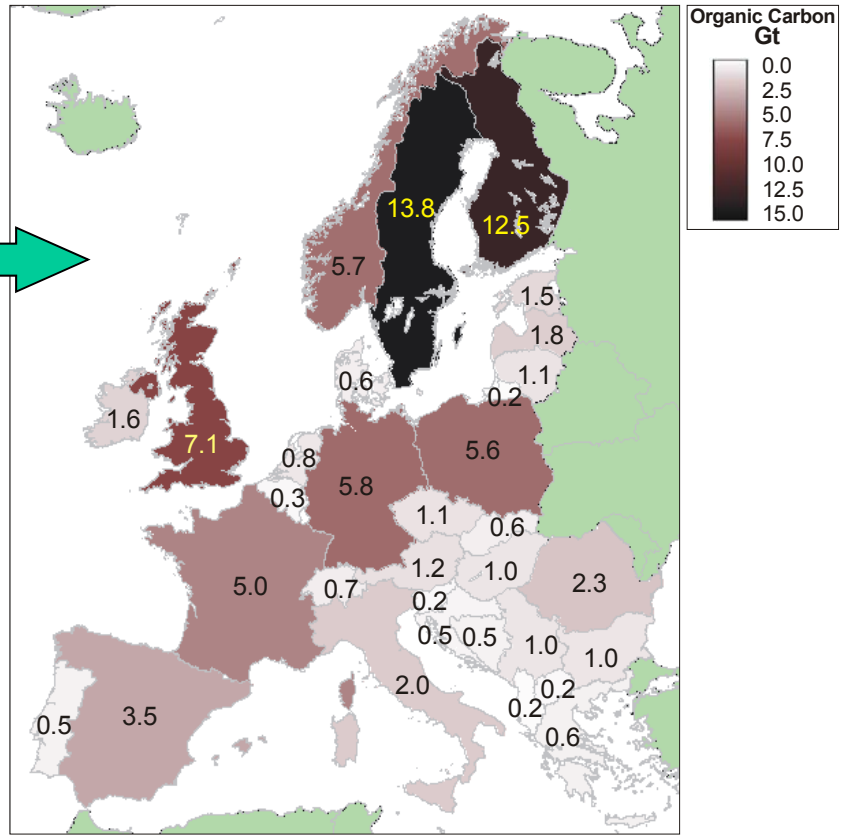
Topsoil Organic Carbon Content (30cm)

Model output



Organic carbon content (%) in the surface horizon (0-30 cm) of soils

Aggregated results

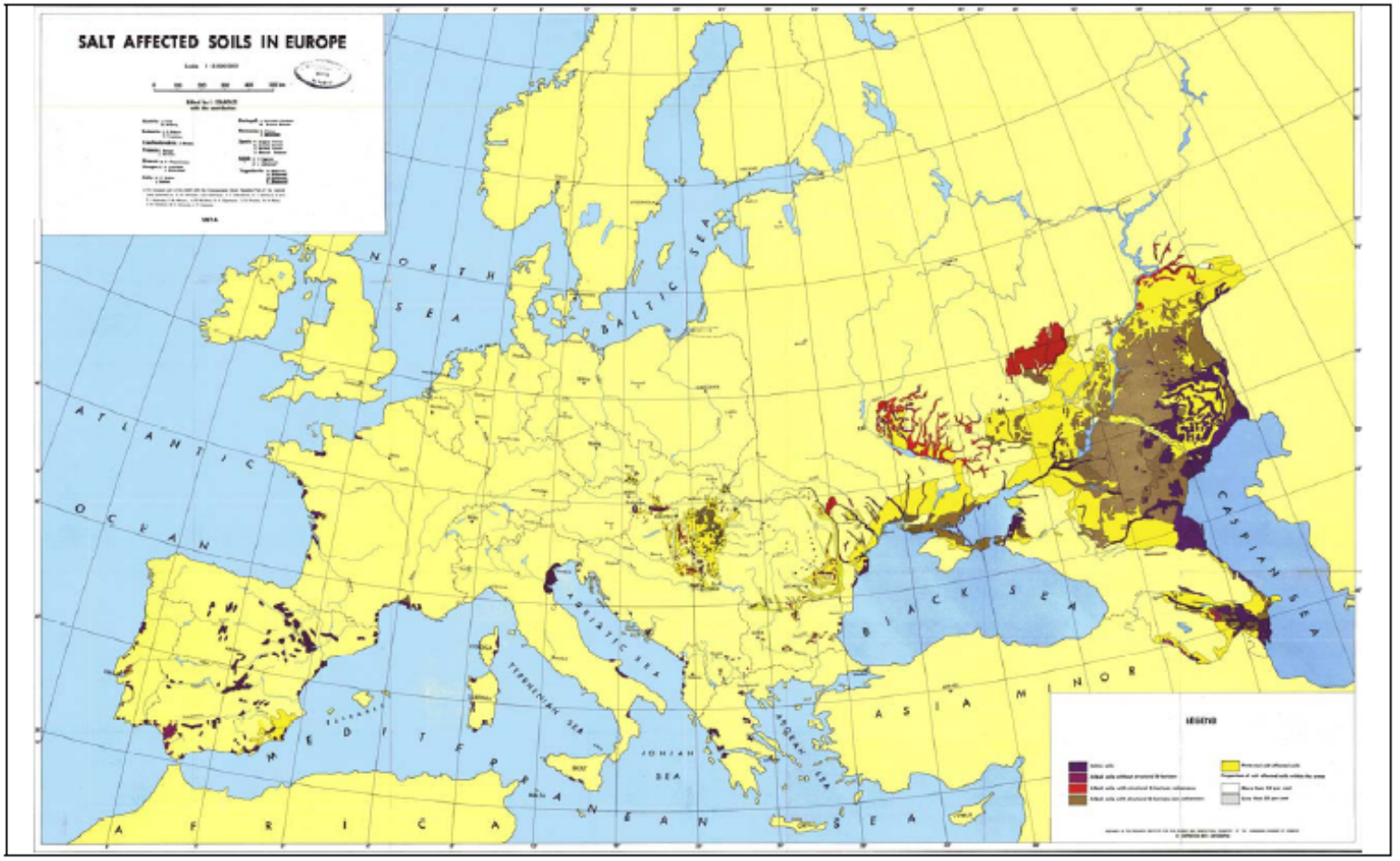


National Soil Organic Carbon stocks (0-30cm) in Gt

Organic matter decline

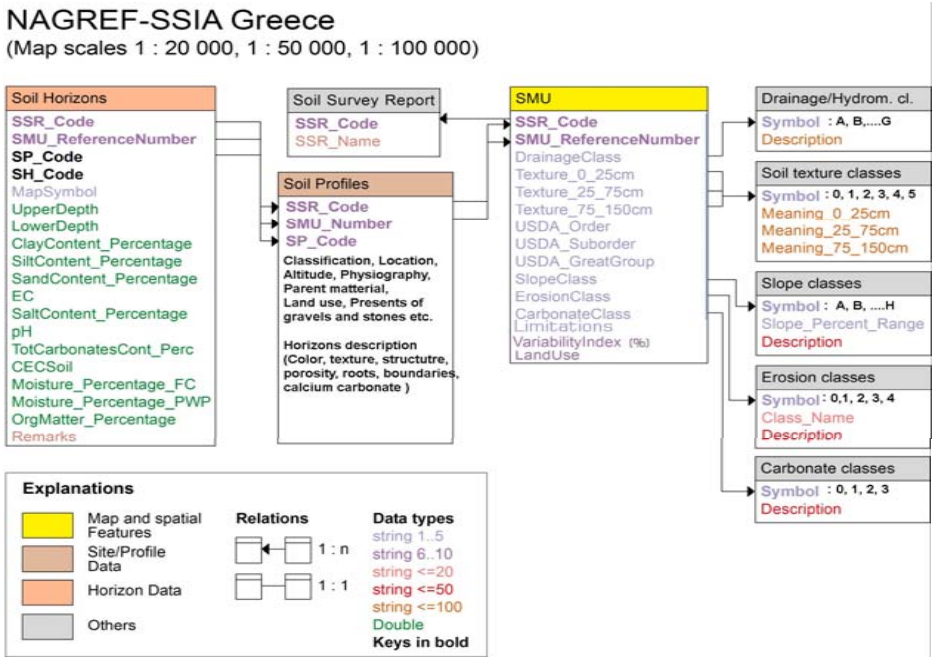
Soil Salinisation in Europe

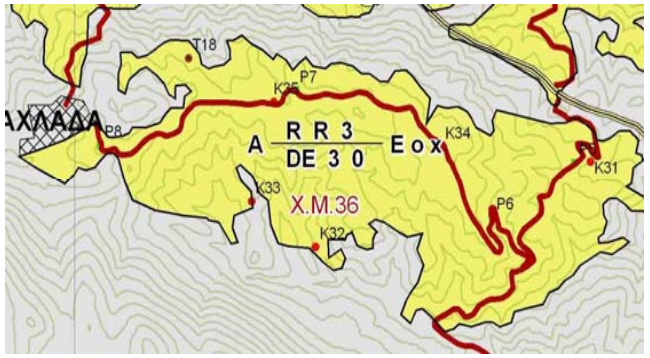
Salinisation affects around 3.8 million ha in Europe



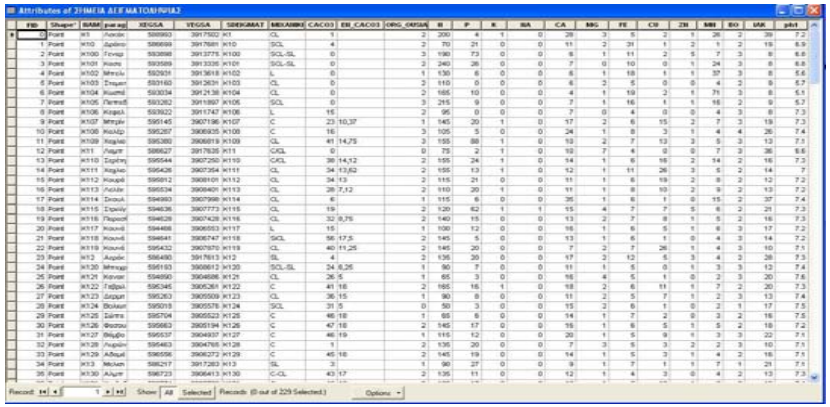
GIS-LIS for Land Classification

1. Structure
2. Data
3. Uses-Output
4. Soil Thematic Maps
5. Production of Land suitability maps for pistachios wastes application
6. Shape file suitable for Cultivation Management Software of Agrostrat



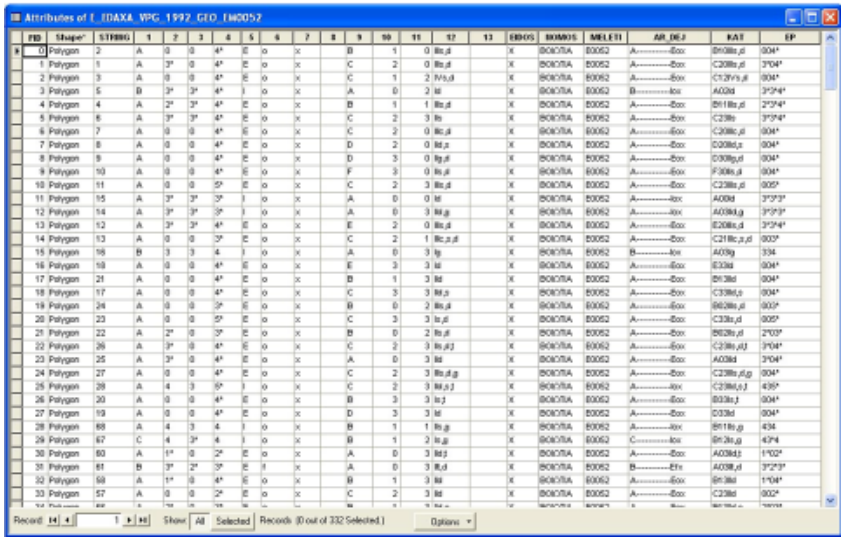


Atribute Table with Analyses

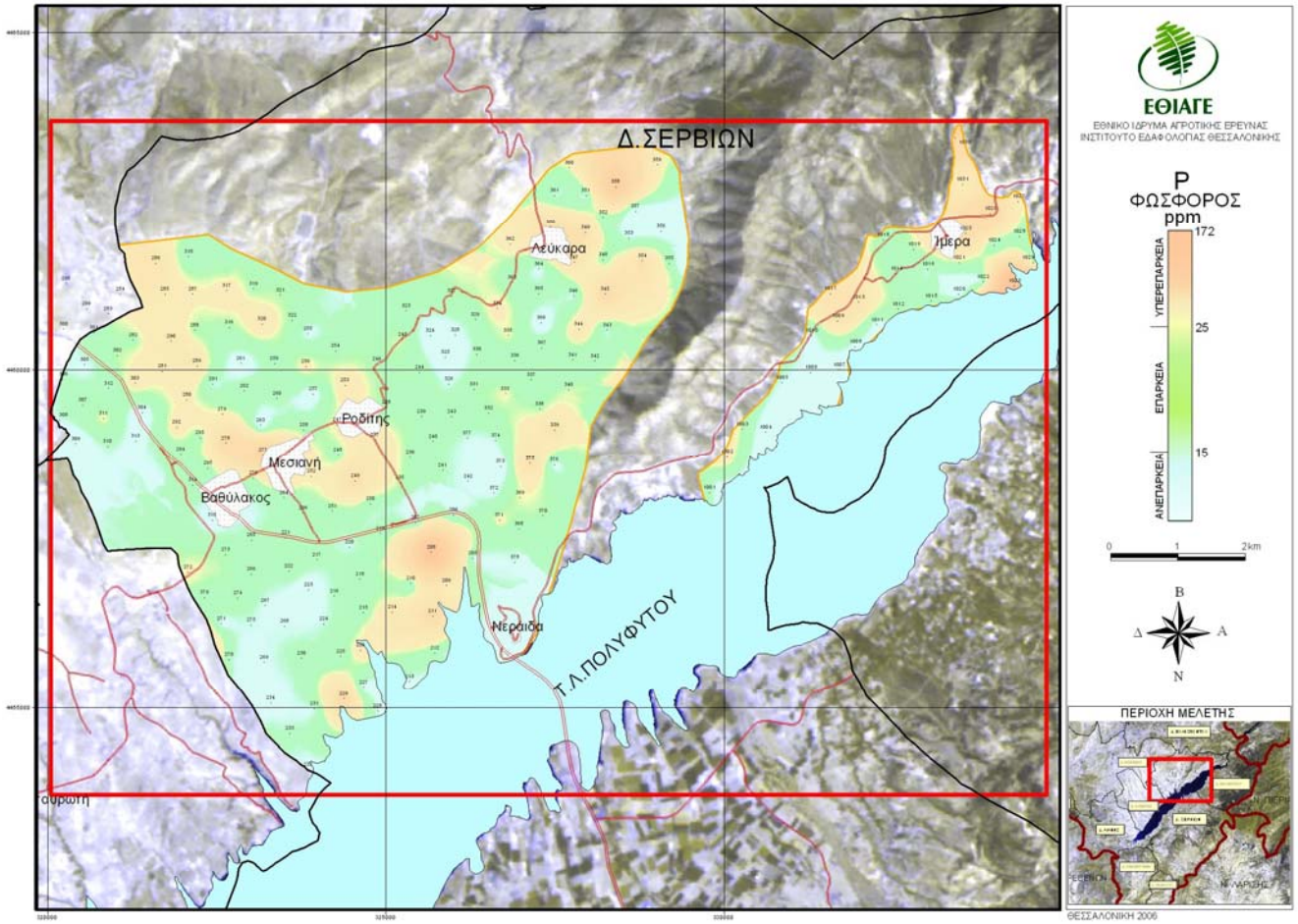


GS Soil

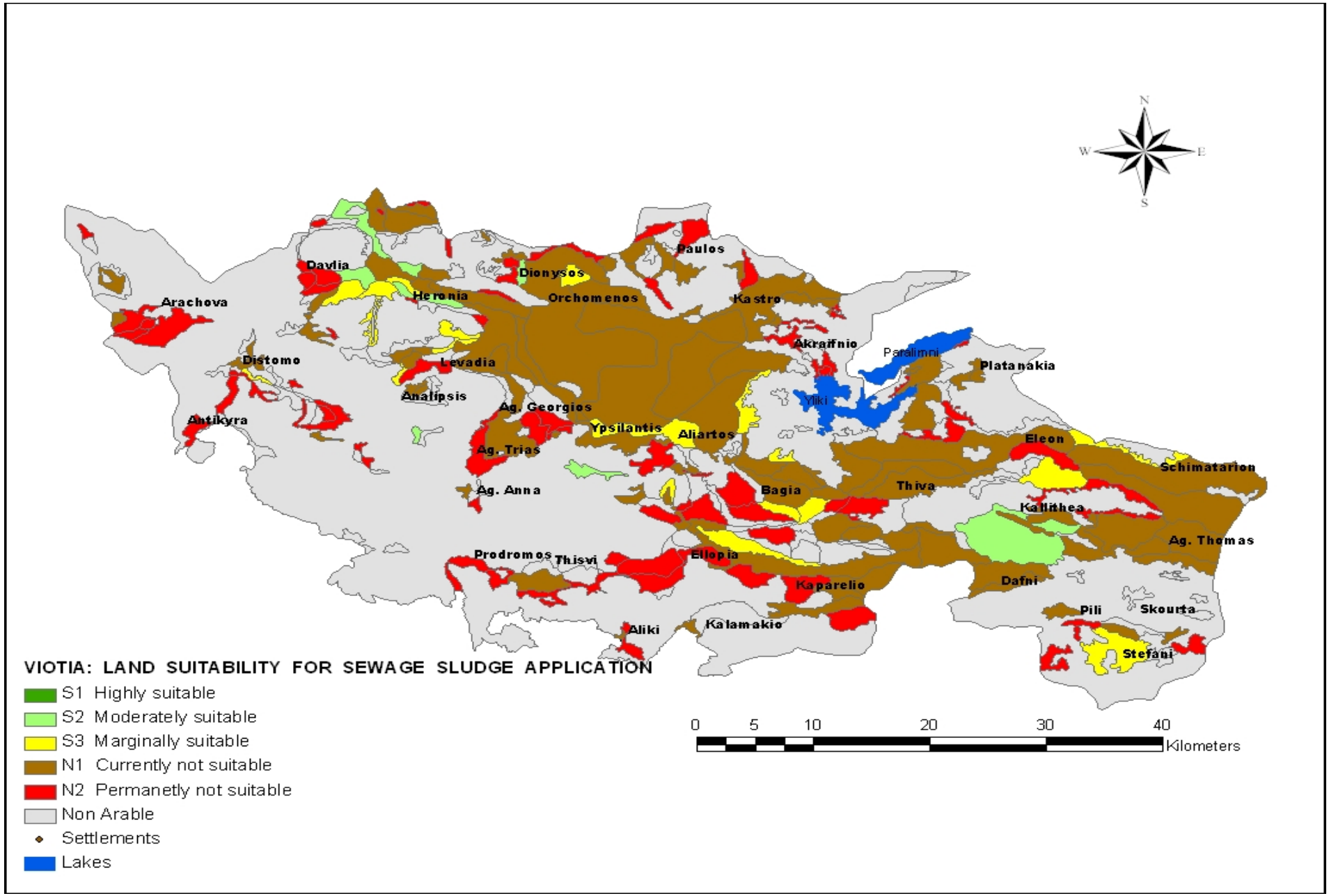
Attribute Table Mapping Unit Description



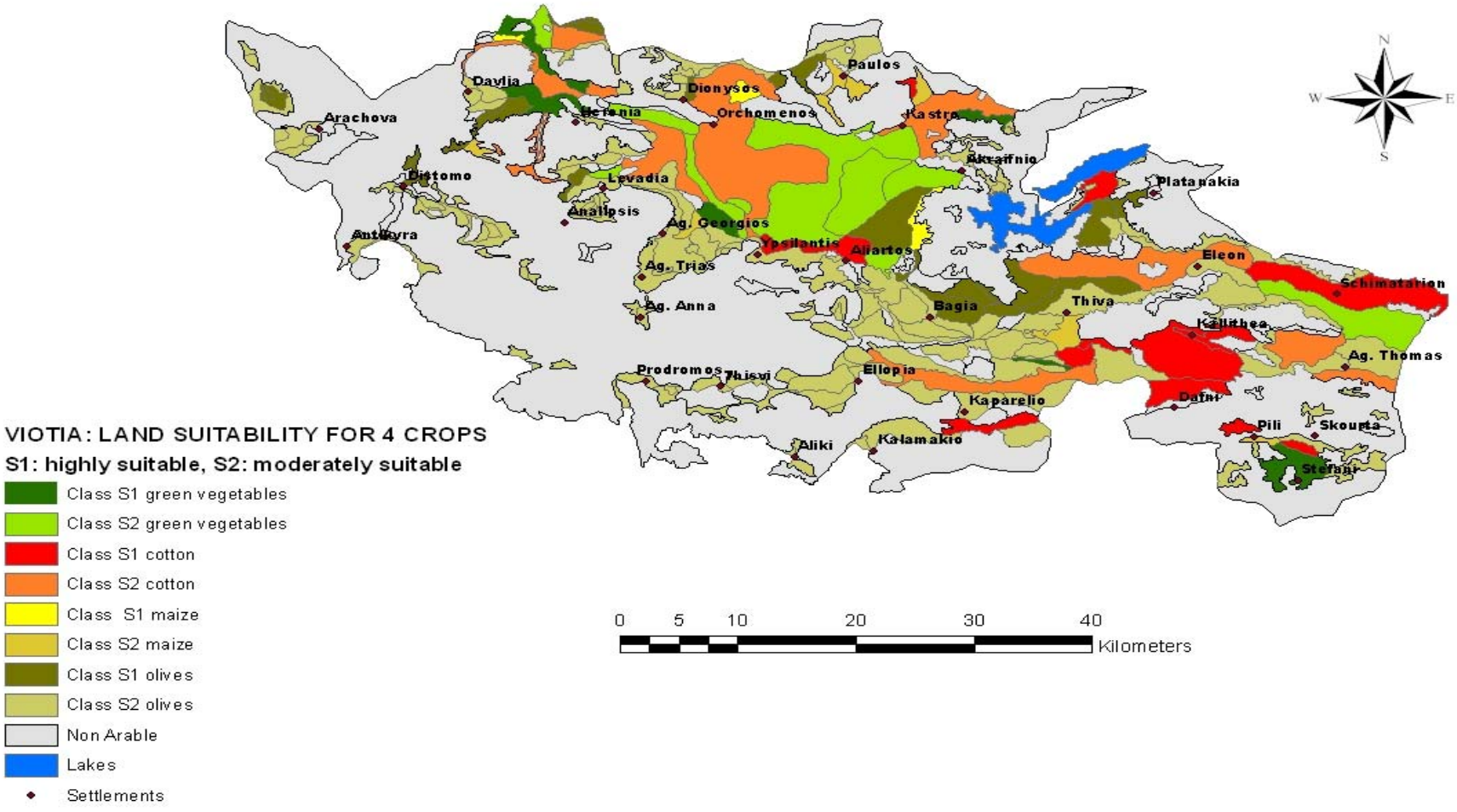
P-Olsen in the soils of the Municipality of W.Serbion.



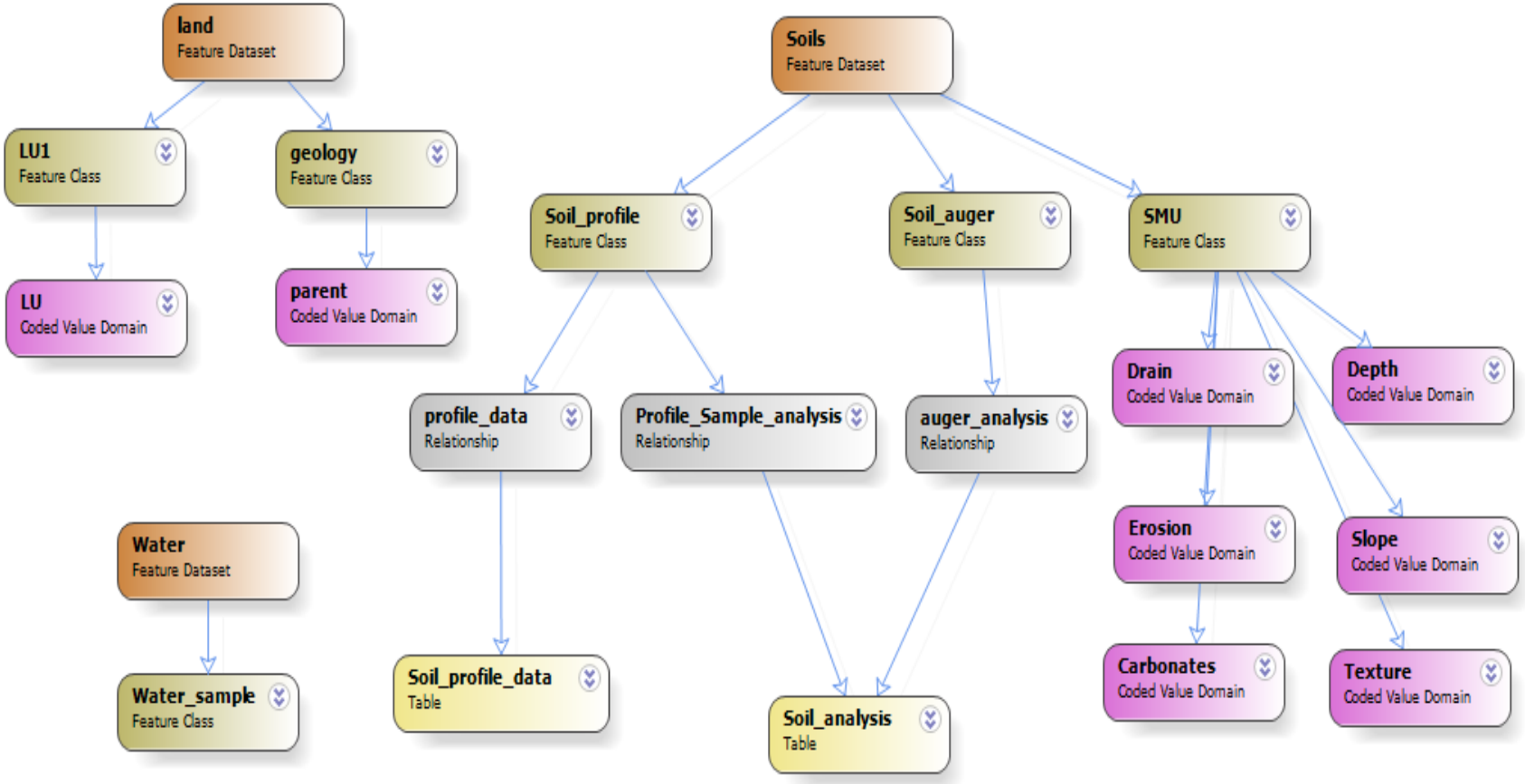
Land Suitability map for sewage sludge application



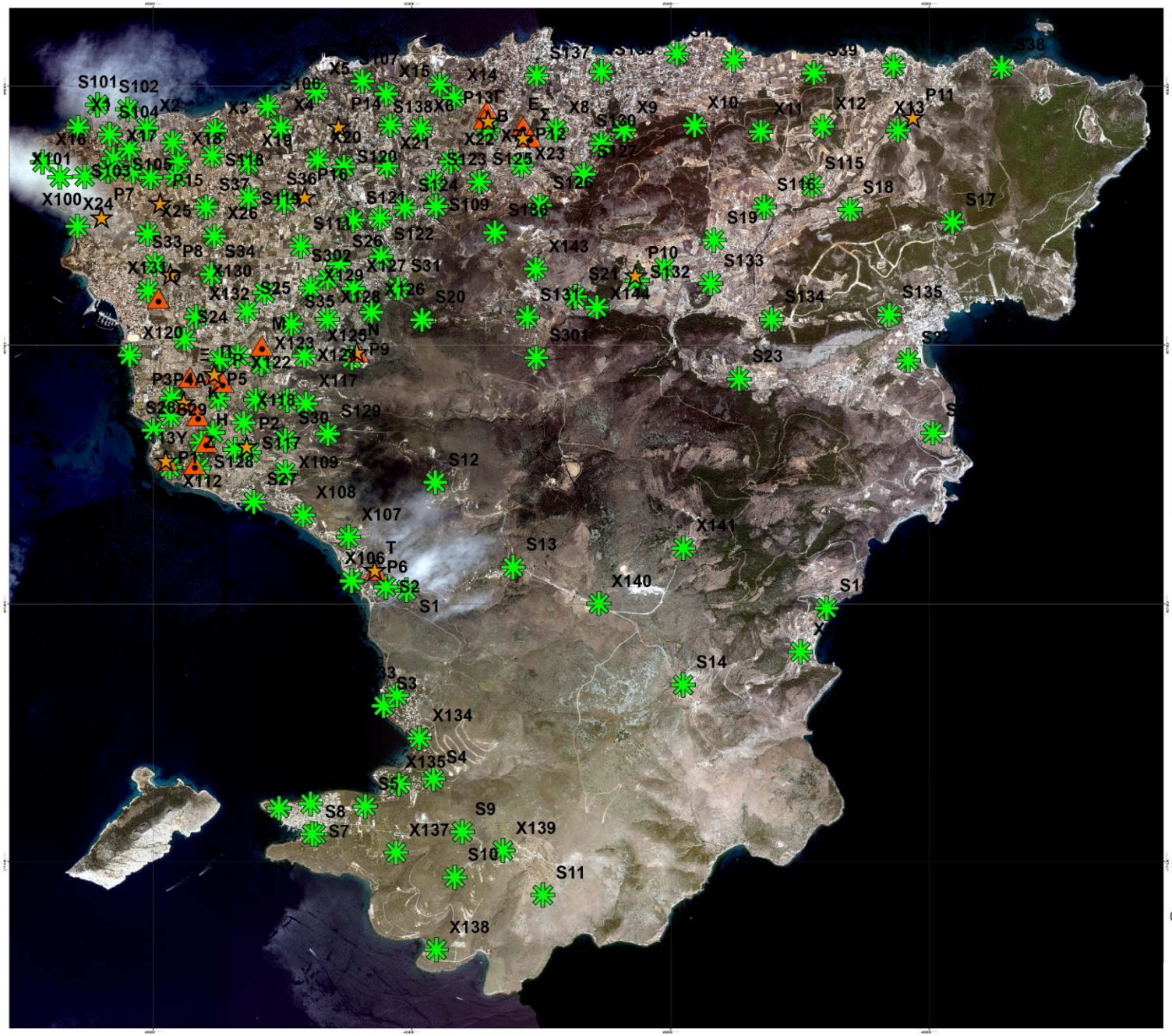
Land planning for maximum income



GIS-LIS developed for Aegina soils (Kolovos , 2014)



SOIL SAMPLING POINTS OF AIGINA ISLAND



SOIL SCIENCE INSTITUTE OF ATHENS

SOIL SAMPLING POINTS OF AIGINA ISLAND

LEGEND

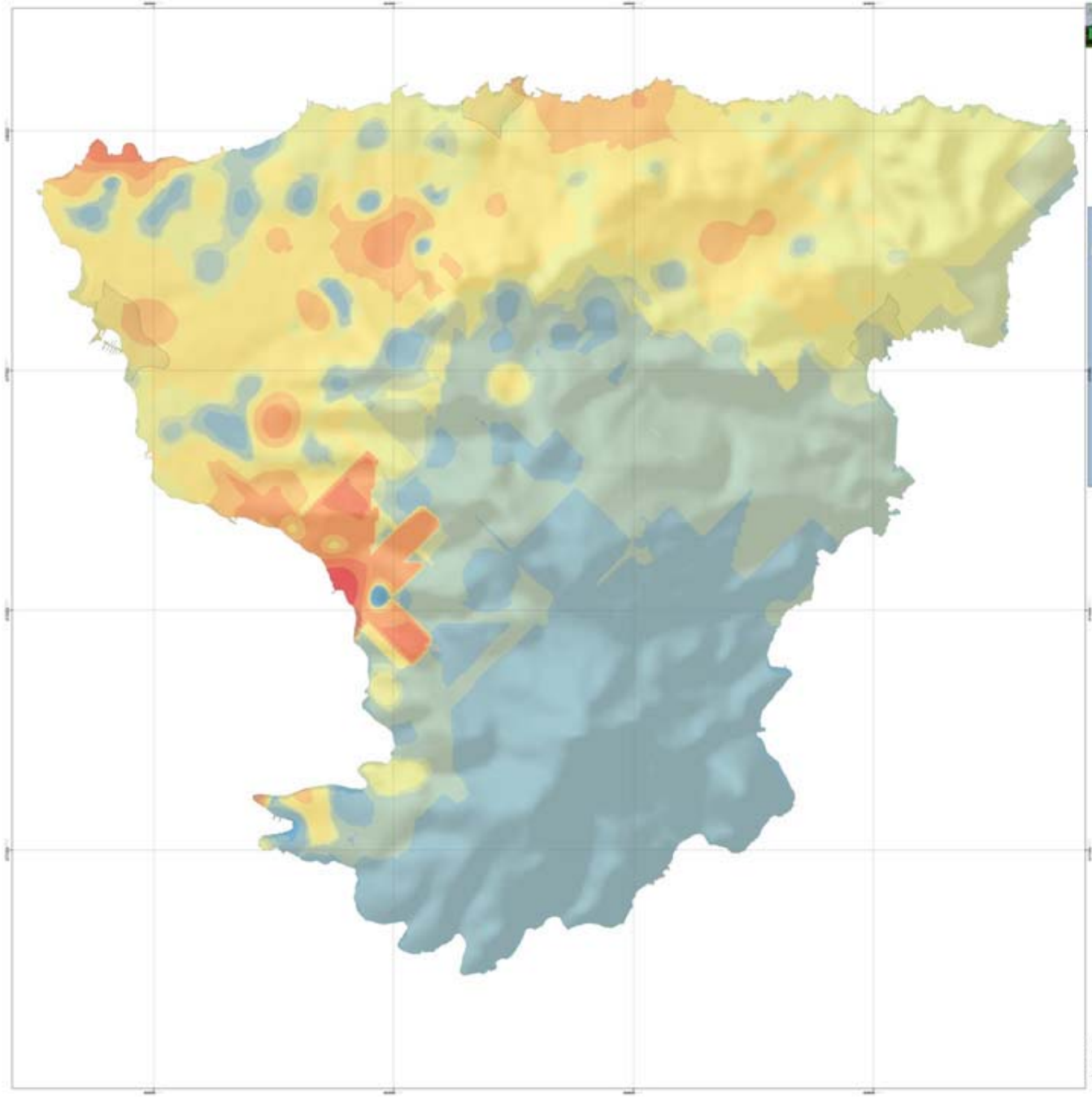
- Soil Profile
- Test Fields
- Soil Sampling

N
W
E
S

0 0.75 1.5 3
Kilometers

Created by
Ch. Kolovos, S. Theocharopoulos

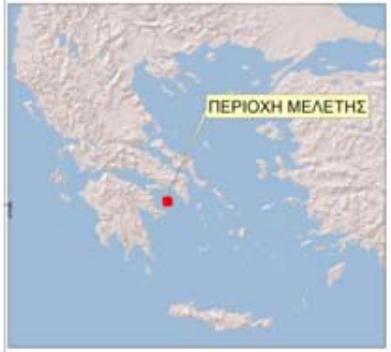
ELECTRICAL CONDUCTIVITY MAP OF AIGINA ISLAND



ΙΝΣΤΙΤΟΥΤΟ ΕΔΑΦΟΛΟΓΙΑΣ ΑΘΗΝΩΝ

ELECTRICAL CONDUCTIVITY

AIGINA ISLAND



LEGEND

- -0.57 - 0.38
- 0.39 - 0.72
- 0.73 - 0.85
- 0.86 - 0.89
- 0.9 - 1.01
- 1.02 - 1.36
- 1.37 - 2.3
- 2.31 - 4.93
- 4.94 - 12.22
- 12.23 - 32.41
- Urban

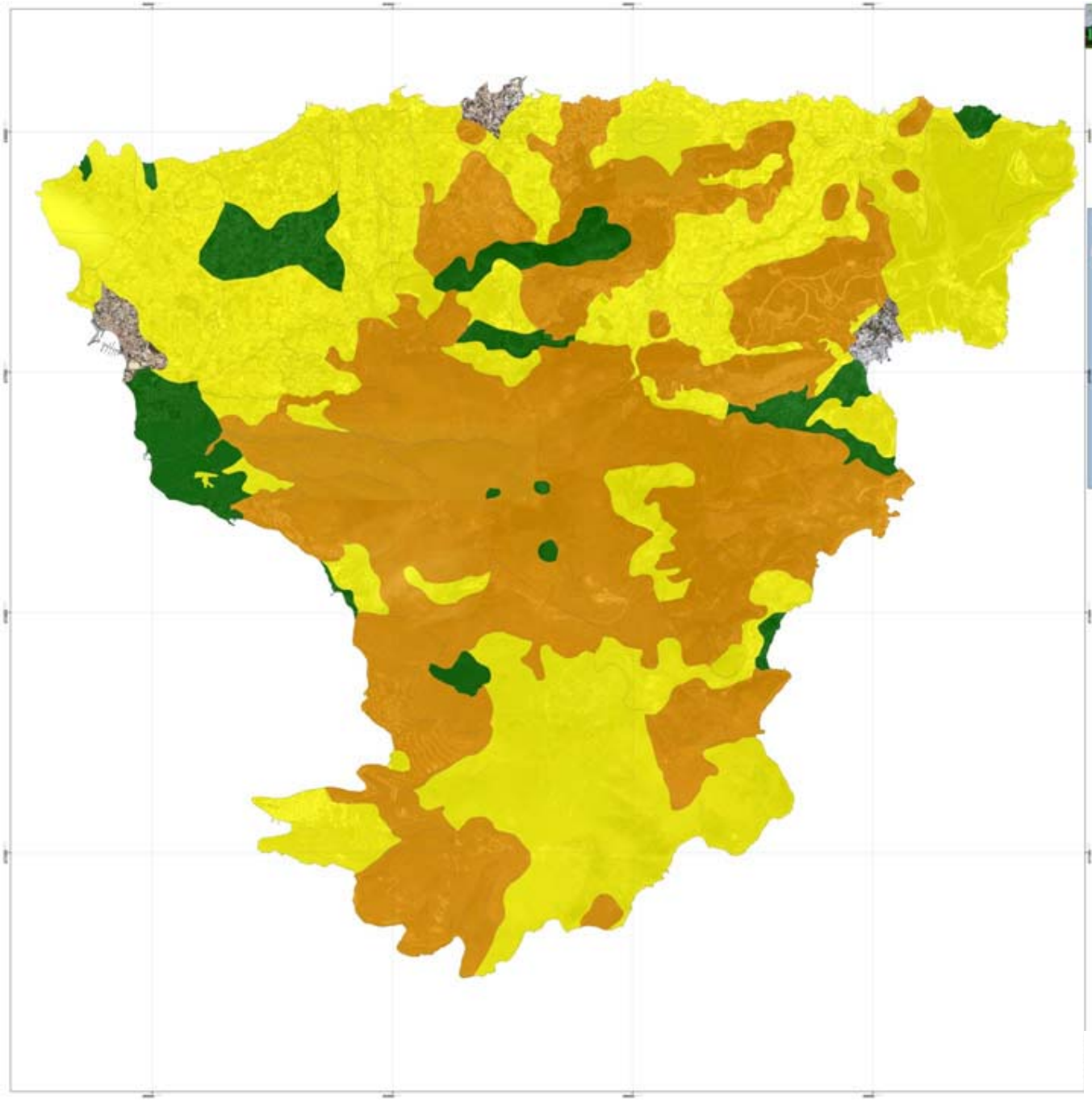
N W E S

1.5 0.75 0 1.5

Kilometers

Created by
Ch. Kolovos, S. Theocharopoulos

SOIL EROSION MAP OF AIGINA ISLAND



ΙΝΣΤΙΤΟΥΤΟ ΕΔΑΦΟΛΟΓΙΑΣ ΑΘΗΝΩΝ

EROSION CLASSES
AIGINA ISLAND

LEGEND

EROSION

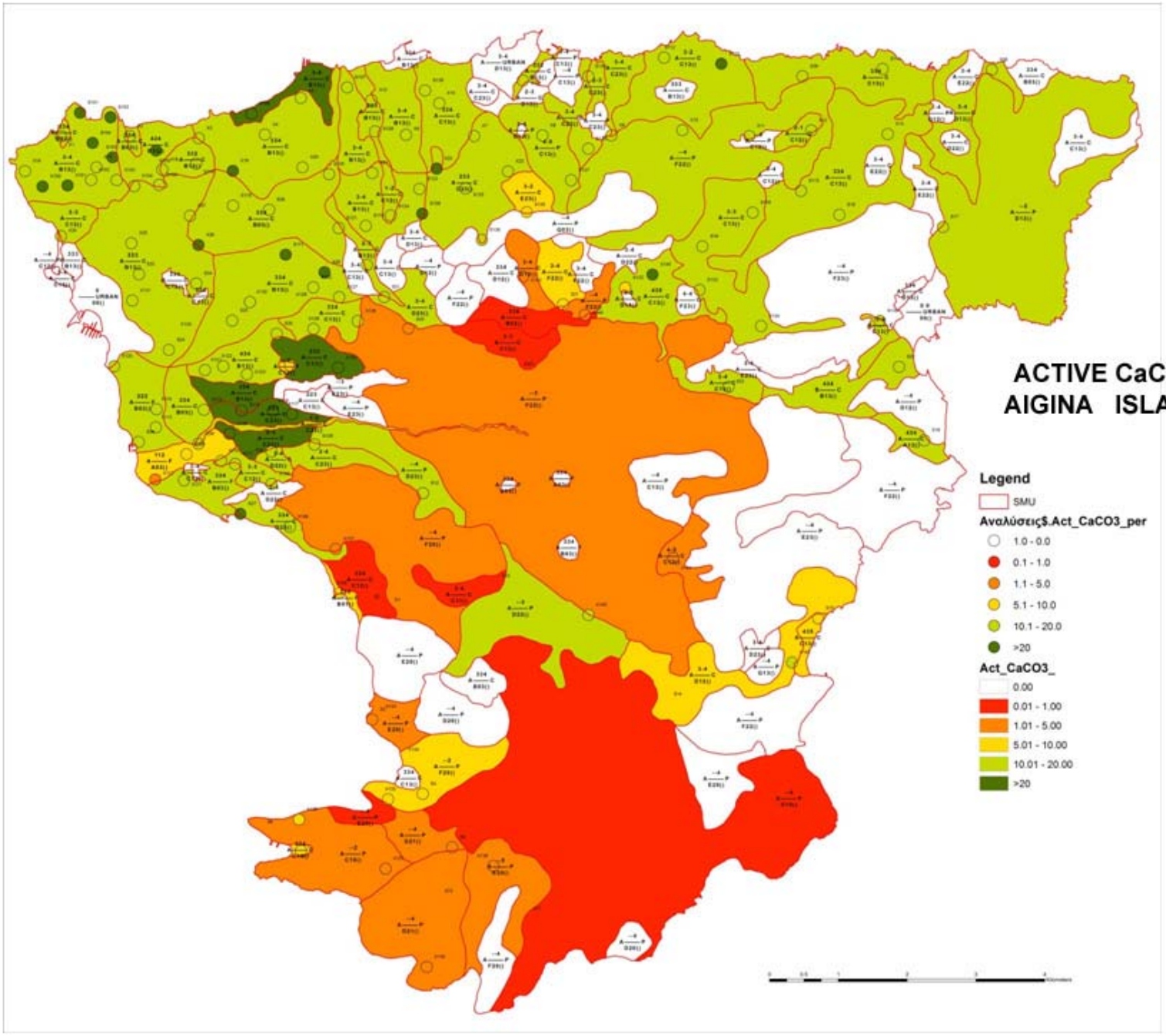
- **NO EROSION**
- **SLIGHT EROSION**
- **MODERATE EROSION**
- **URBAN**

N
W E
S

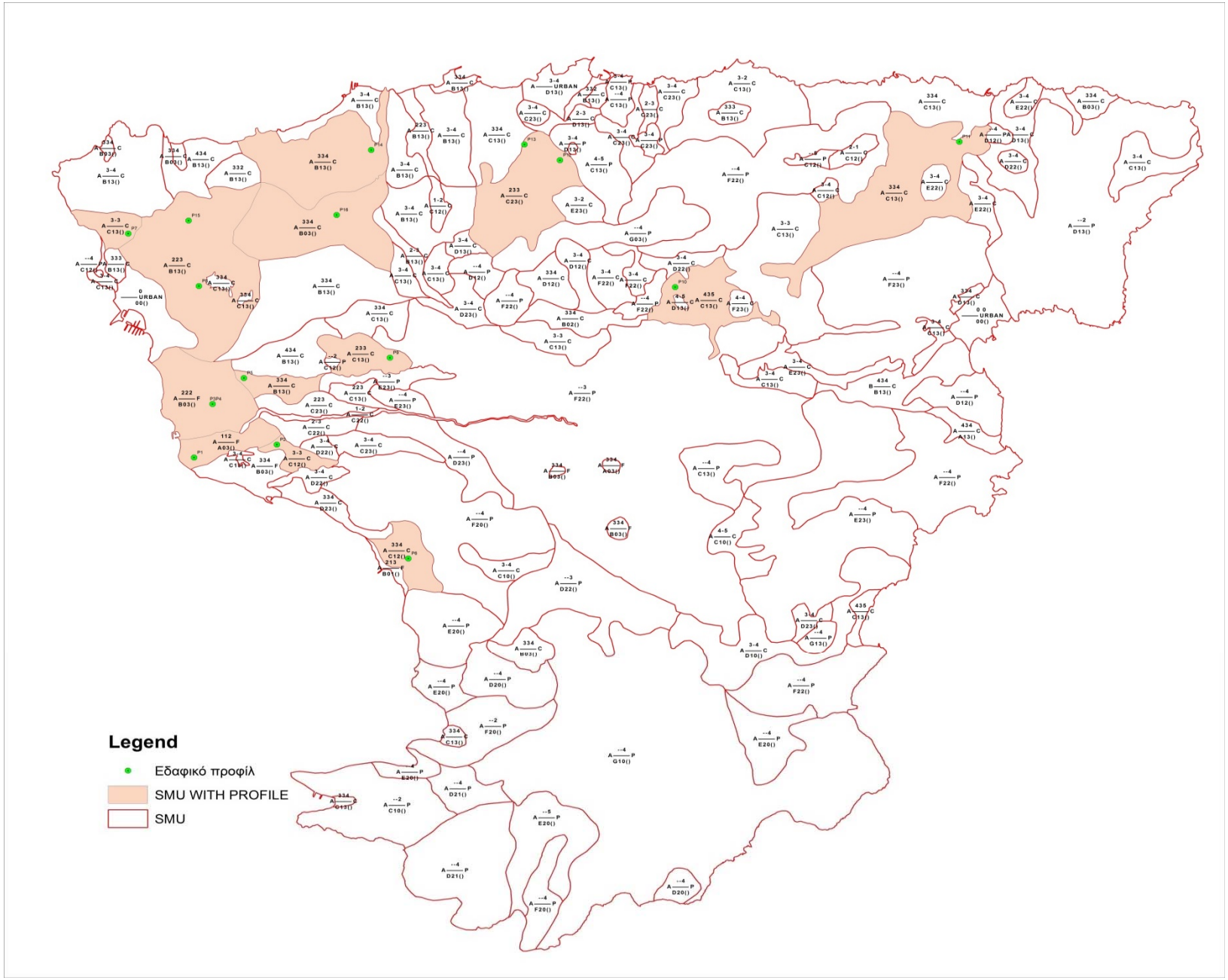
1.5 0.75 0 1.5

Created by
Ch. Kolovos, S. Theocharopoulos

ACTIVE $CaCO_3$ MAP OF AIGINA ISLAND



SOIL MAP OF Aegina Island



GIS-LIS Extrapolation to EU Med areas

- Classification System (Land suitability)
- Guidance to find the required proper Soil Data:
  1. Download from existing GIS-LIS
  2. Evaluation
  3. Harmonization/Interoperability/INSPIRE
  4. Produce New data/Collect additional updated soil data
  5. Pedo-transfer functions/Multivariate techniques/geostatistical techniques
- Soil and Water monitoring/Evaluation
- Guidance from the Agrostrat Team

GIS-LIS Extrapolation to EU Med areas is Supported

- Groundwater vulnerability Assessment
- Life Cycle Analysis
- Offers a Holistic approach for agricultural waste management
- Tool for improvement of sustainability in sensitive and prone to desertification agricultural areas
- Soil and Water monitoring scheme NEEDED

Table 4. Land Suitability Classes (FAO, 1976)

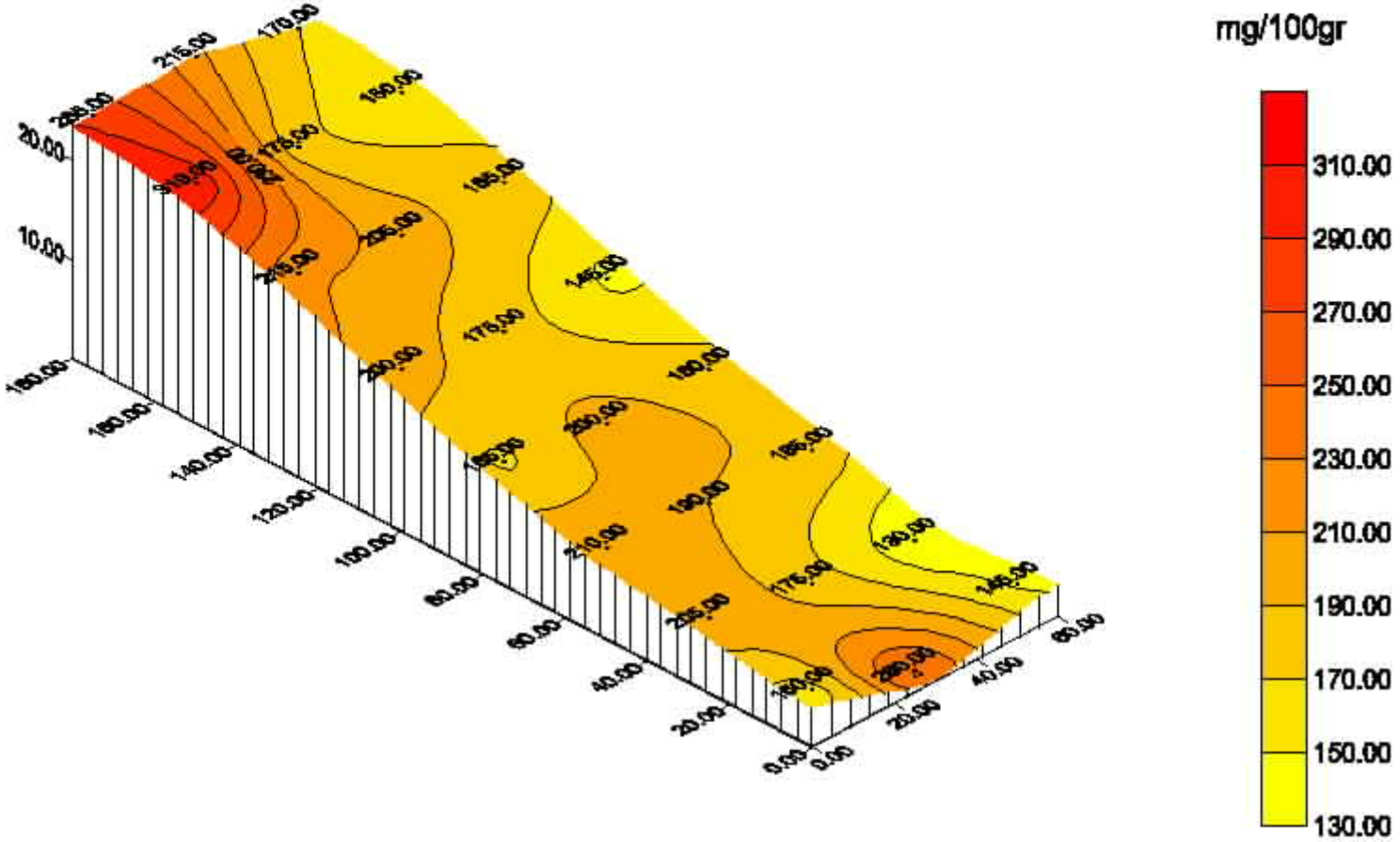
Suitability Classes	Description
S1 Highly Suitable	Land having no significant limitations to sustained application for given land use or only minor limitations. Nil to minor negativ economic, environmental, health and/or social outcomes.
S2 Moderately Suitable	Land having limitations which in aggregate are moderately severe fo sustained application of a given land use. Appreciably inferior to S land. Potential negative economic, environmental, health and/or socia outcomes if not adequately managed.
S3 Marginally suitable	Land having limitations which in aggregate are severe for sustaine application of a given use. Moderate to high risk of negative economic environmental, health and/or social outcomes if not adequatel managed.
N1 Not Suitable	Land having limitations, which may be insurmountable. Limitation are so severe as to preclude successful sustained use of the land. Very high risk o negative economic, environmental and/or social outcomes if no managed.
N2 Not Suitable	Land having limitations which appear so severe as to preclude any possibilities of successful sustained use of the land in the given manner. Almost certain risk of significant negative economic, environmental and/or social outcomes

FLOODED SOILS/Ground Water Gley

FLOODED SOIL/Surface water Gley

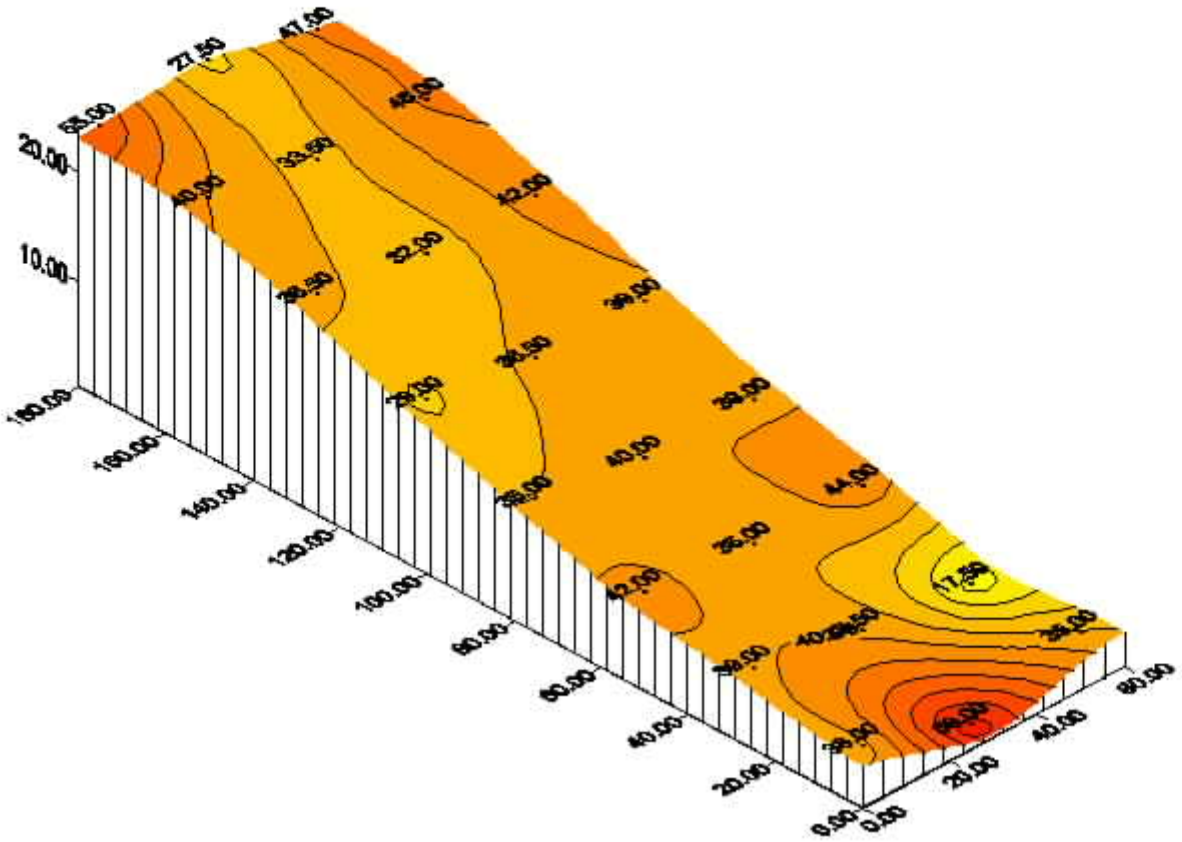
Vertic Soils/Cracked Soils

3-D Distribution of N (mg/100gr) in the grid sampling,in the Mouriki catchment



ΕΘΙΑΓΕ
ΕΘΝΙΚΟ ΙΔΡΥΜΑ
ΑΓΡΟΤΙΚΗΣ ΕΡΕΥΝΑΣ

3-D Distribution of P (mg/kg) in the grid sampling,in the Mouriki catchment



Shallow soils

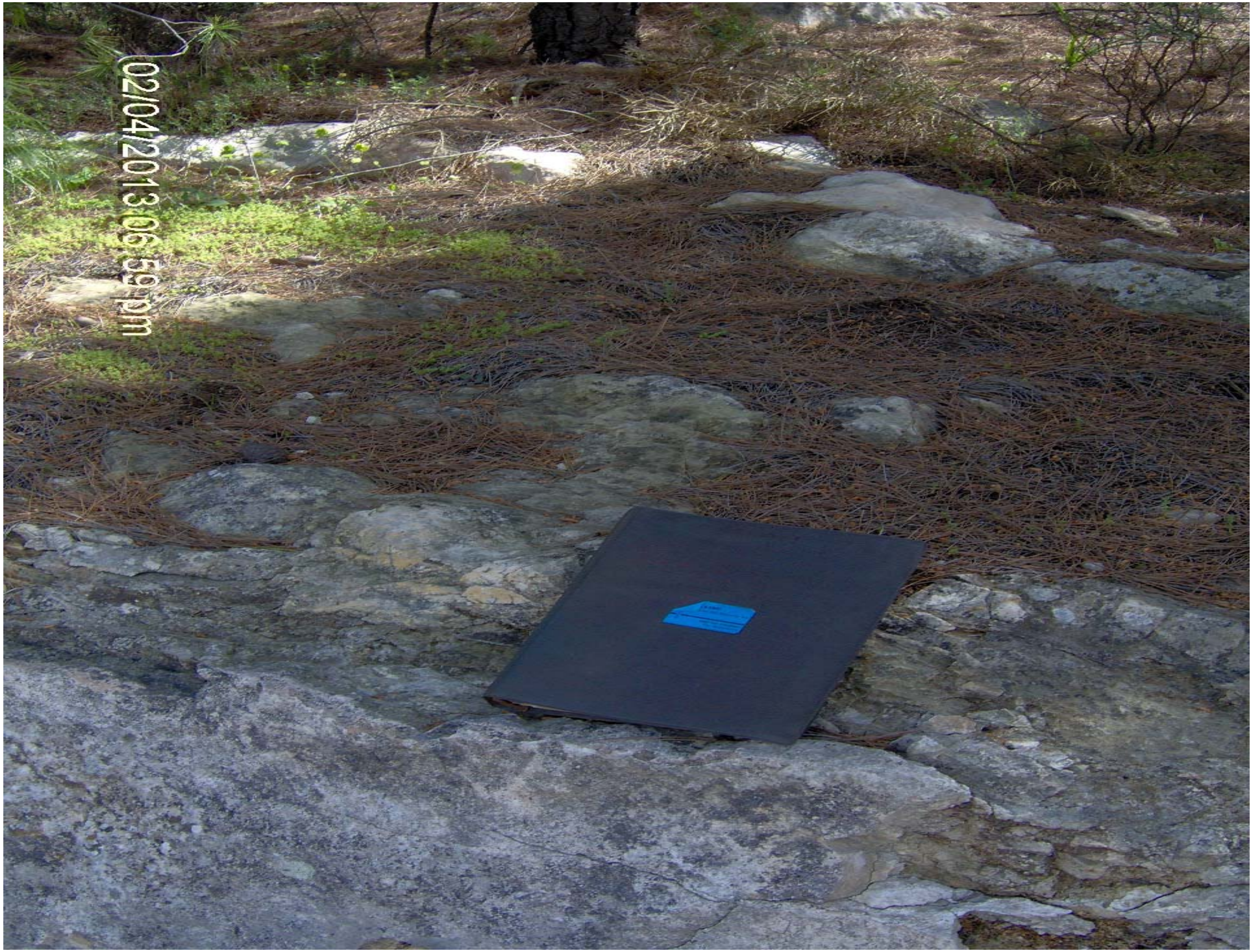

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Table 12. Parameters for land evaluation for pistachio wastewater disposal

Property/parameter	Suitability Classes				
	S1	**S2**	**S3**	**N1**	**N2**
Drainage	A	B,C	D	E	F.G
Slope, %	A	B	C	D	E
Depth	6, 5	4	3	2	1
Erosion	0	1	2	3	4
On-site wastewater management	A	B	C	D	D
Salinity, dS/m	< 2	2-4	4-8	>8	
Infiltration rate, cm/h	2-8	0.1-2.0 8-16	<0.1 16-50		
CEC, meq/100g	>15	8-15	<8		
ESP, %	0-6	6-10	10-15	15-25	>25
Total Nitrogen, %	<0.1	0.1-0.3	>0.3		
$N\text{-}NO_3$, mg/kg	<10	10-20	20-30	>30	
P-Olsen, mg/kg	<10	10-28	28-40	40-59	>59
Exchangeable K, cmol(+)/kg	<0.26	0.26-1.2	1.2-2.0	>2.0	>2.0
DTPA Cu, mg/kg	<3	3.0-10	10-20	>20	
DTPA Zn, mg/kg	<2.9	2.9-8.1	8.1-13	> 13	
Polyphenols, mg/kg	<50			>50	

(Doula et al., 2015)

Table 13. Parameters for land evaluation for pistachio solid waste/sludge disposal

Property/parameter	Suitability Classes				
	S1	**S2**	**S3**	**N1**	**N2**
Drainage	A, B	C	D, E	F	G
Slope, %	A, B	C	D	E	E
Depth	6, 5, 4	3	2	1	1
Erosion	0, 1	2	3	4	4
Salinity, dS/m	< 2	2-4	4-8	>8	
Infiltration rate, cm/h	2-8	0.1-2.0 8-16	<0.1 16-50		
CEC, meq/100g	>15	8-15	<8		
ESP, %	0-6	6-10	10-15	15-25	>25
Total Nitrogen, %	<0.1	0.1-0.3	>0.3		
N-NO_3, mg/kg	<10	10-20	20-30	>30	
P-Olsen, mg/kg	<10	10-28	28-40	40-59	>59
Exchangeable K, cmol(+)/kg	<0.26	0.26-1.2	1.2-2.0	>2.0	>2.0
DTPA Cu, mg/kg	<3	3.0-10	10-20	>20	
DTPA Zn, mg/kg	<2.9	2.9-8.1	8.1-13	> 13	
Polyphenols, mg/kg	<50			>50	

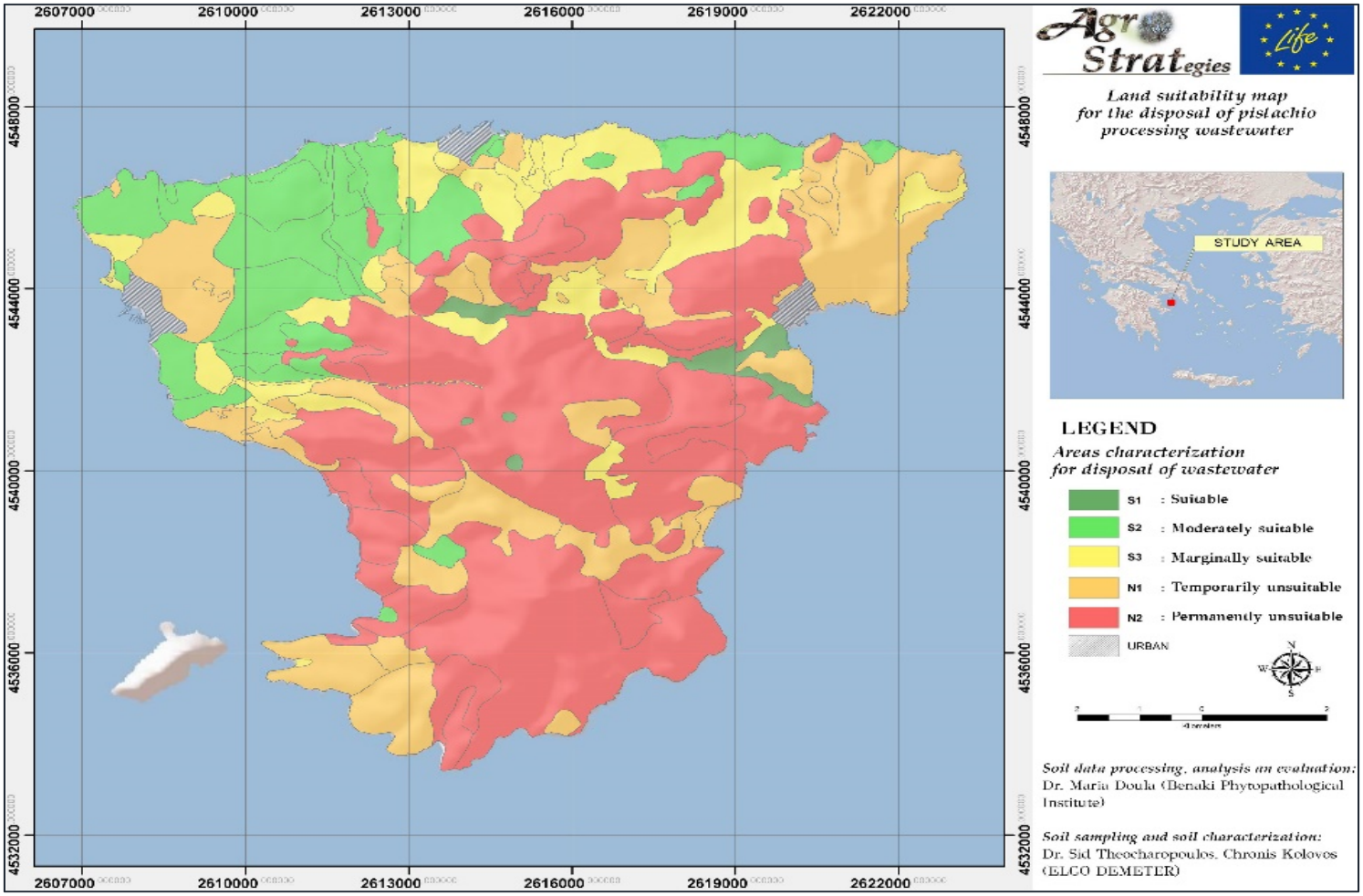
(Doula et al., 2015)

Table 14. An example for categorization of a map unit for which one soil indicator belong N2 class.

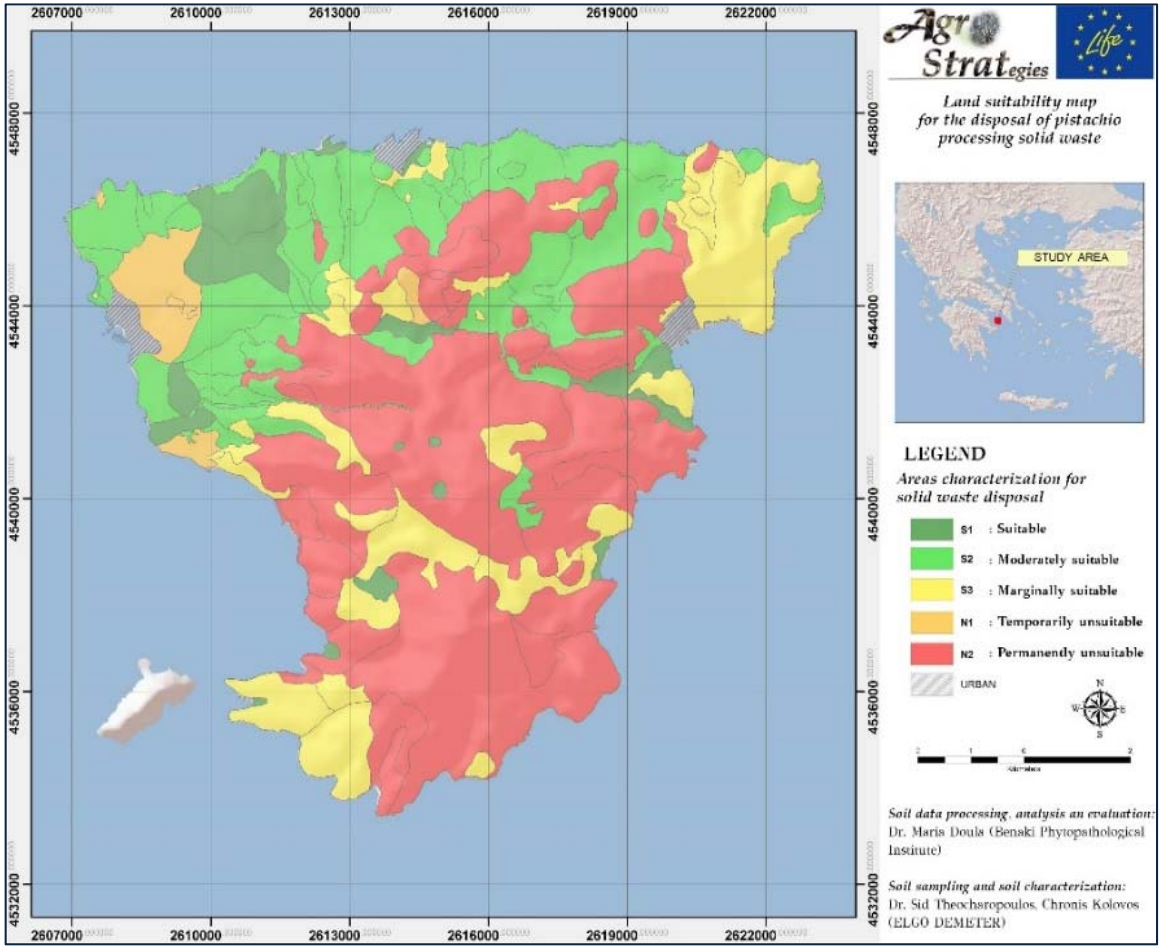
Property/parameter	Suitability Classes				
	S1	**S2**	**S3**	**N1**	**N2**
Drainage	X				
Slope, %		X			
Depth	X				
Erosion	X				
Salinity, dS/m		X			
Infiltration rate, cm/h	X				
CEC, meq/100g	X				
ESP, %		X			
Categorization According to physical properties		X			
Total Nitrogen, %	X				
N-NO_3, mg/kg	X				
P-Olsen, mg/kg	X				
Exchangeable K, cmol(+)/kg					X
DTPA Cu, mg/kg			X		
DTPA Zn, mg/kg			X		
Polyphenols, mg/kg		X			
Although the suitability class of the area, considering physical properties, CEC and ESP is S2, however, the concentration of exchangeable K of the area is extremely high, therefore the disposal or reuse of the wastes must not be allowed. Therefore the area is re-categorized as N2.					

(Doula et al., 2015)

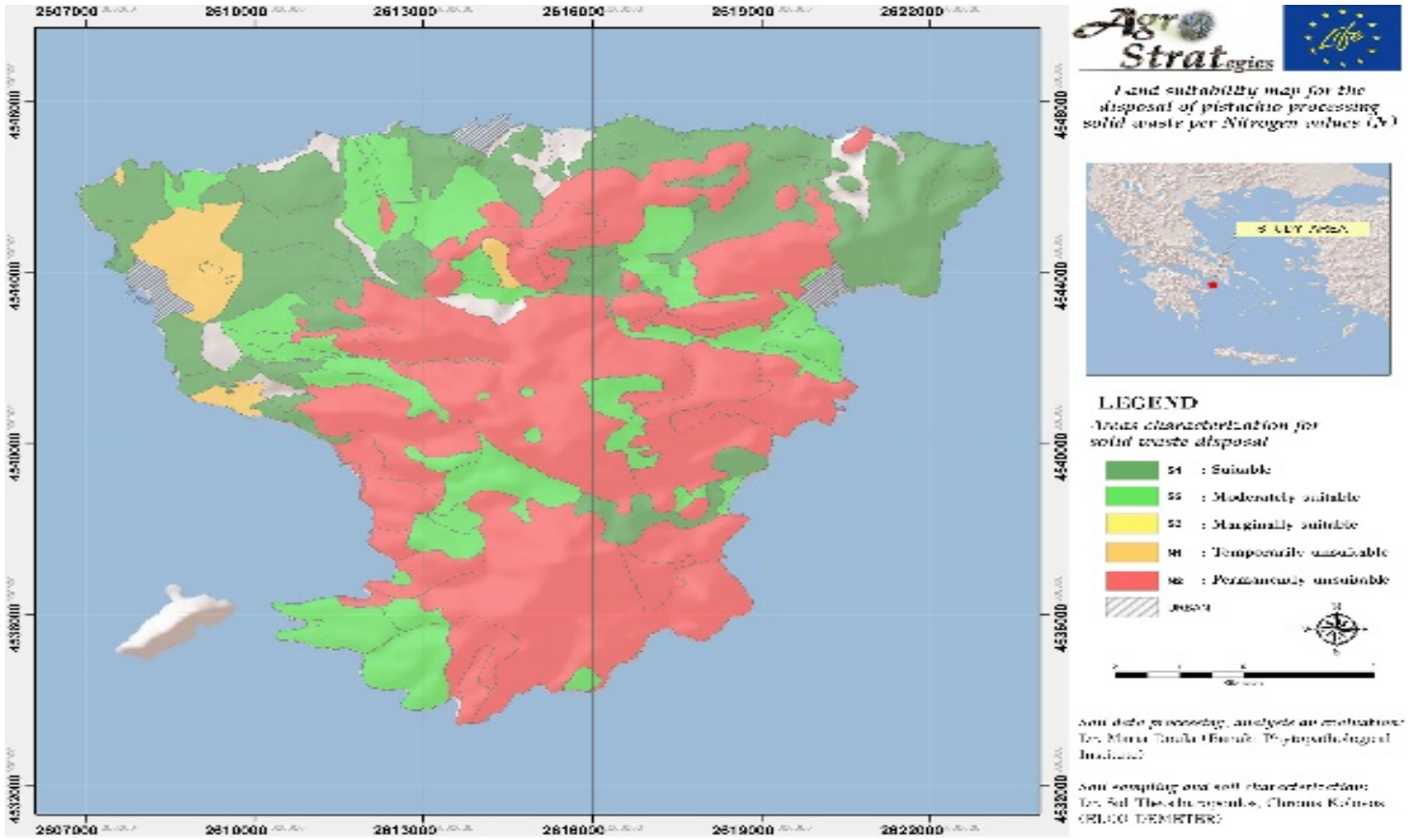
Land Suitability for pistachio waste water (Doula et al., 2015)



Land Suitability for pistachio solid wastes (Doula et al., 2015)



Land Suitability Map according to N content (Doula et al., 2016)



Conclusions/1

- Extrapolation of the GIS-LIS classification for Pistachios liquid and solid wastes to EU Med Countries:
  - The system described is web available
  - Existed Soil Data must be used :
    - Lucas Soil Data Base
    - ESDAC Raster Soil Data
    - ESDAC Vector Soil Data
    - National-Regional Soil Dbases/www.GSSOIL.eu
  - Existing soil data need:
    - Evaluation
    - Harmonization/ineroperability
    - Updating/new data/seasonal variability
    - Pedotransfer functions/multivariate /geostatistical techniques
  - Guidance from the Agrostrat Team
  - Evaluation by local experts

Conclusions/2

- GIS-LIS is supported by (TUC):
  - Groundwater vulnerability Assessment
  - Life Cycle Analysis
- Offers a Holistic approach for agricultural waste management
- Powerfull tool for :
  - Improvement of sustainability in sensitive and prone to desertification agricultural areas
- MONITORING SOIL and WATER

AKNOWLEDGEMENTS

- **EC-LIFE+ for funding this project (50%)**
- **HAO-DEMETER for funding the project (50%)**
- **Astrale, Dr S. Papageorgiou, Dr G. Valaoras**
- **IMS/TUC**
- **Local Authorities of Aegina,**
- **Cooperative of Pistachios producers N. Anyfantis**
- **Staff of DSSA-HAO-DEMETER >20,000 analyses**
- **Dr M Doula, Scientific Coordinator (analyses of water)**
- **Researchers_Staff of the DSSA ie: Dr V. Kavvadias for pistachios nutrition), N. Liakopoulou (trace-elements) , P. Lolos (P, B), P. Kefalogianni (O.M-Financial management), A. Katsoula (K, Ca, Mg, Nα), Christidou, (pH, salts), K. Dimopoulos (Texture, CaCO3) , A. Tsoutsikos (sampling, preanalyses treatment,) X. Liakopoulou, (Sample analyses management), E. Mpania (Financial management), A. Kokkineli & E. Zontanou (Administrative support)**
- **DSSA & AGROSTRAT TEAM is always available for any help and guidance .**
- **ALL OF YOU FOR YOUR ATTENTION**