The environmental footprint of pistachio production in Aegina island, Greece

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Outline of Presentation

- **Brief description of the TUC actions in the framework of the Life-project: AgroStrat**
- **Description and use of Modern Tools for environmental footprint assessment**
- **Study area**
- **Methodology**
- **Results and Discussion**
- **Conclusions**

TUC Actions

A. Monitoring the environmental impact of the project - Life Cycle Analysis (LCA)

- ✓ Identification of the carbon footprint and implementation of a complete life cycle analysis in terms of raw materials consumption, energy use and emissions.

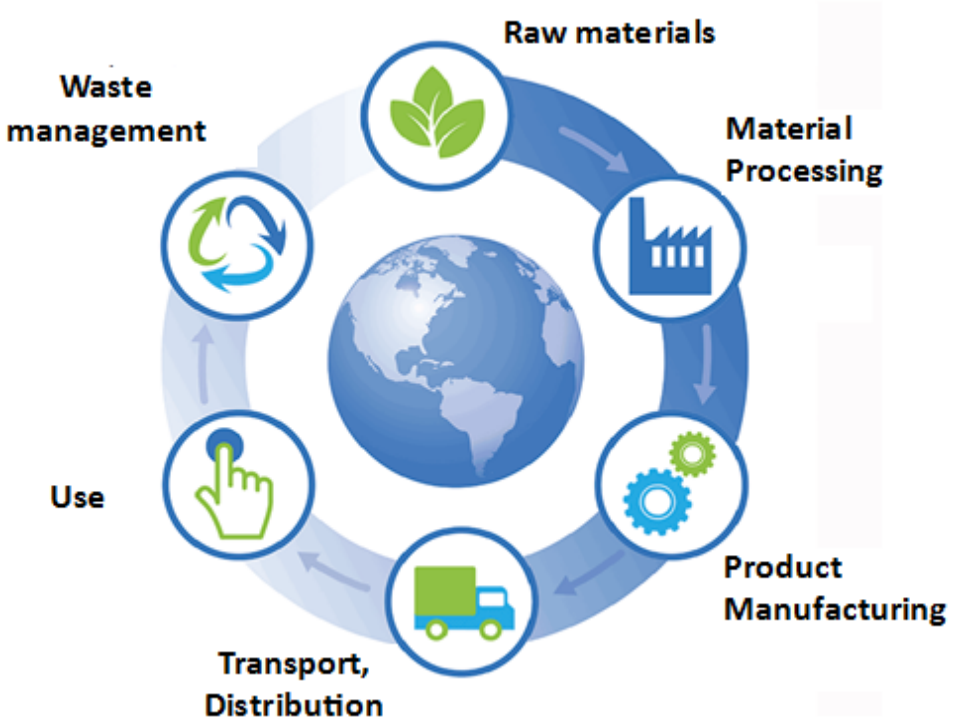
- ✓ Improvement of environmental quality of the pilot area (Creation of Risk maps)

B. Monitoring of the socio-economic impact of the project

- ✓ Assessment of indicators for the evaluation of the socio-economic impact of the "AgroStrat "project

Life cycle analysis – What is it?

Life cycle analysis (LCA) is the most widely applied and accepted approach to quantitatively assess the environmental impact of a given product throughout its life cycle



Dominant decision - making tool that:

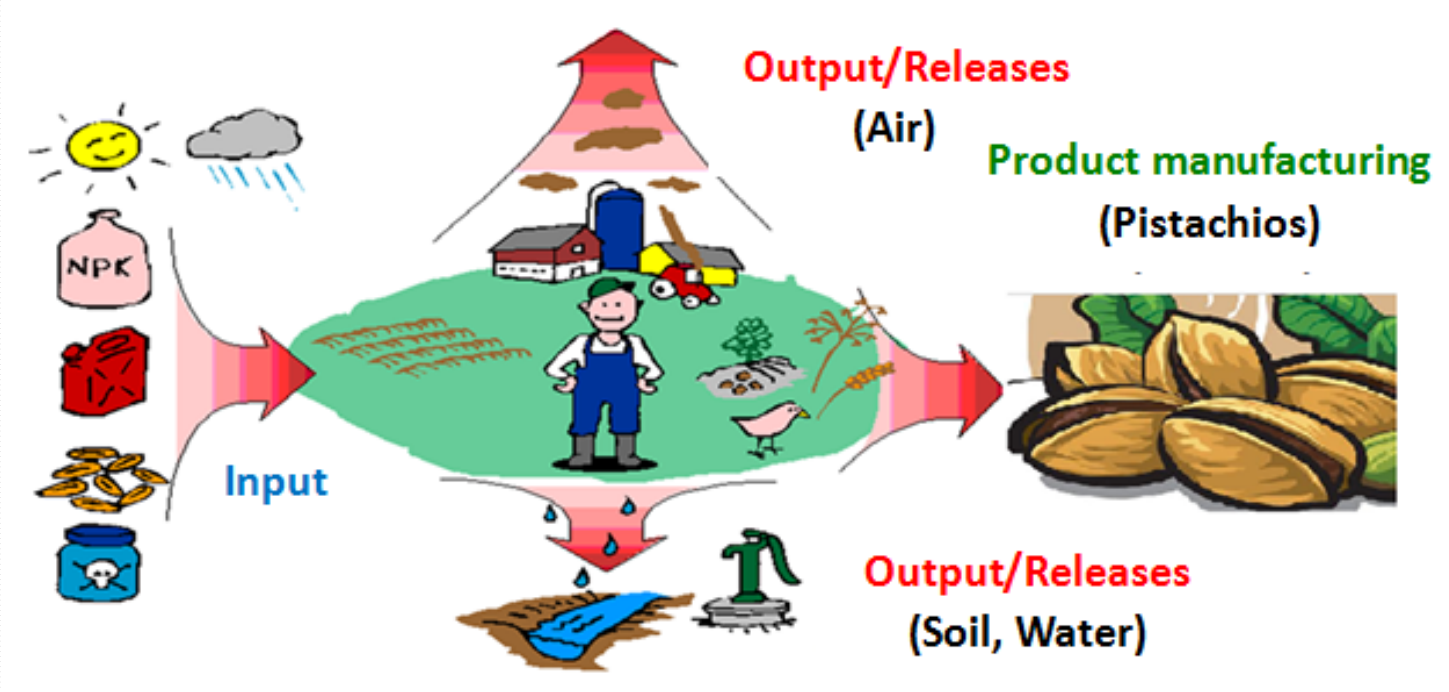
quantifies environmental releases to air, water, and land in relation to each life cycle stage and/or major contributing process in the course of the product's life-span

Life cycle analysis

What is achieved by using LCA……..?

- **Improvement** of product properties
- Identify **opportunities** for improved **eco-efficiency**
- **Rational use** of **raw materials** and **energy**
- **Compare environmental impacts** of different products with the same function or with reference to a standard

LCA in the Agricultural sector



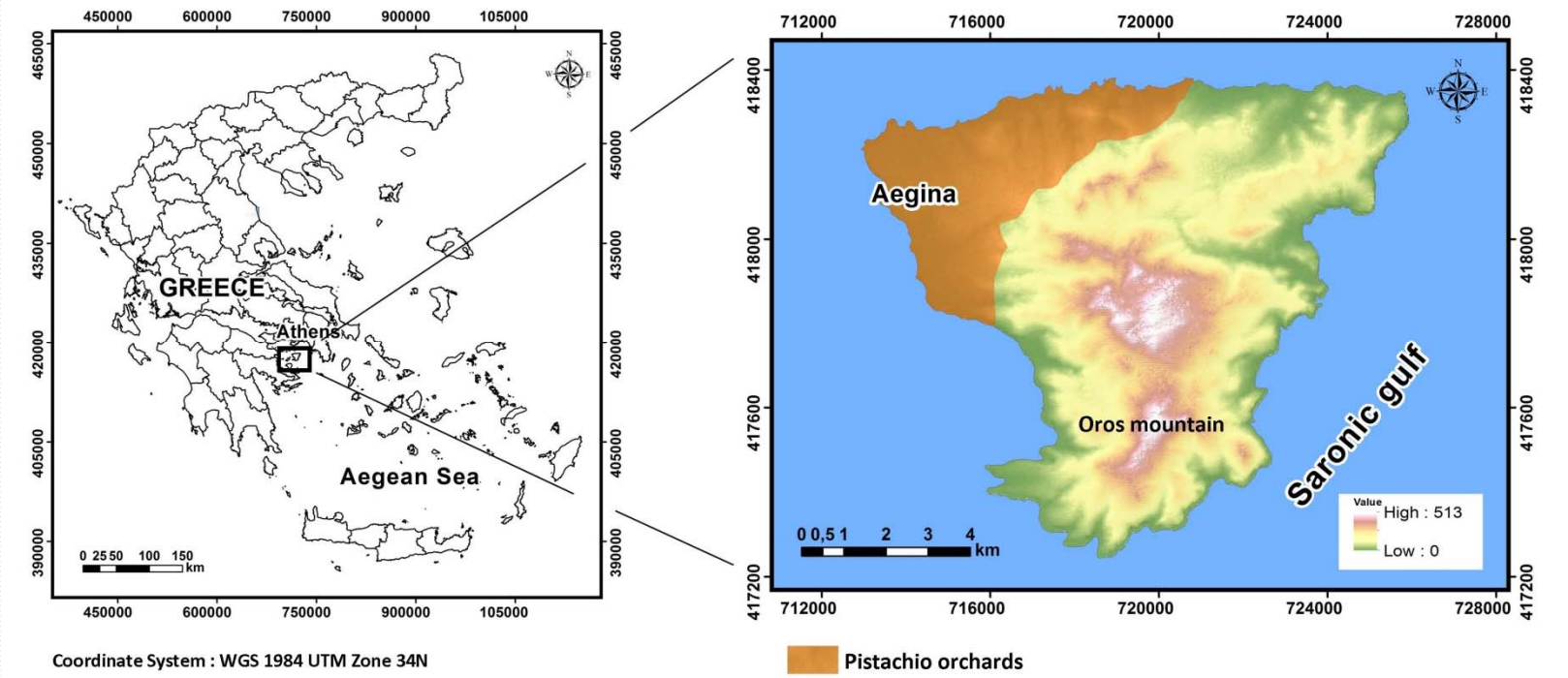
Input: Raw materials (Fertilizers, Pesticides etc.), Energy (Fossil fuels), Water (Irrigation, Processing), Nurseries

Releases (Air): Gas emissions (Carbon dioxide, nitrogen oxides, sulfur dioxide etc.)

Releases (Soil): Solid waste (Shells, Hulls, Prunings)

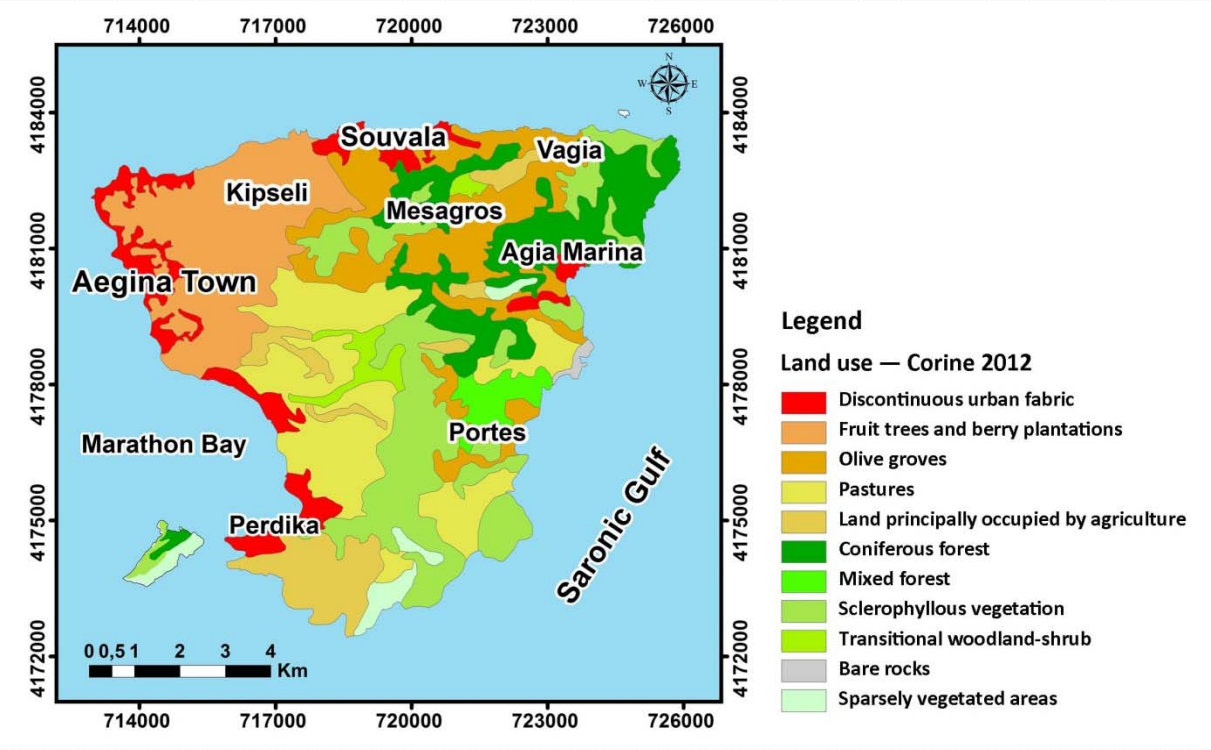
Releases (Water): Liguid waste (N/P/K Leaching)

Study area – Aegina island



- **Aegina island is located approximately 16.5 miles south of Athens with a total surface area of 87 km^2 and a coastline of 57 km**
- **Characterized by semi-arid Mediterranean climate**
- **Typical topography, coastal plains and mountainous areas with hilly intermediate formations.**

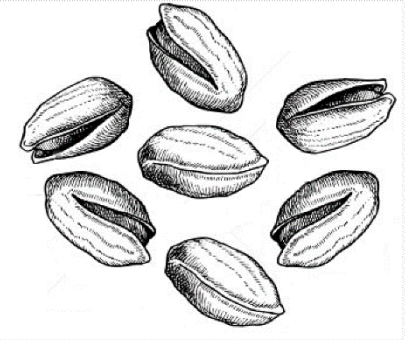
Study area – Aegina island



- **The north part of the study area is intensively cultivated and the major land uses include family orchards with pistachio trees scattered in the urban areas (63% of the irrigated land).**
- **Pistachio waste streams (mainly hulls and shells) account for more than 75 % of the harvested crop and around 7,000 tons are disposed in Greece annually**

Goal and Scope definition

- **LCA was carried out using the commercial GaBi 6 software and related databases.**
- **Quantification of environmental footprint of the existing life cycle of pistachio production in terms of energy consumption and greenhouse gas emissions**



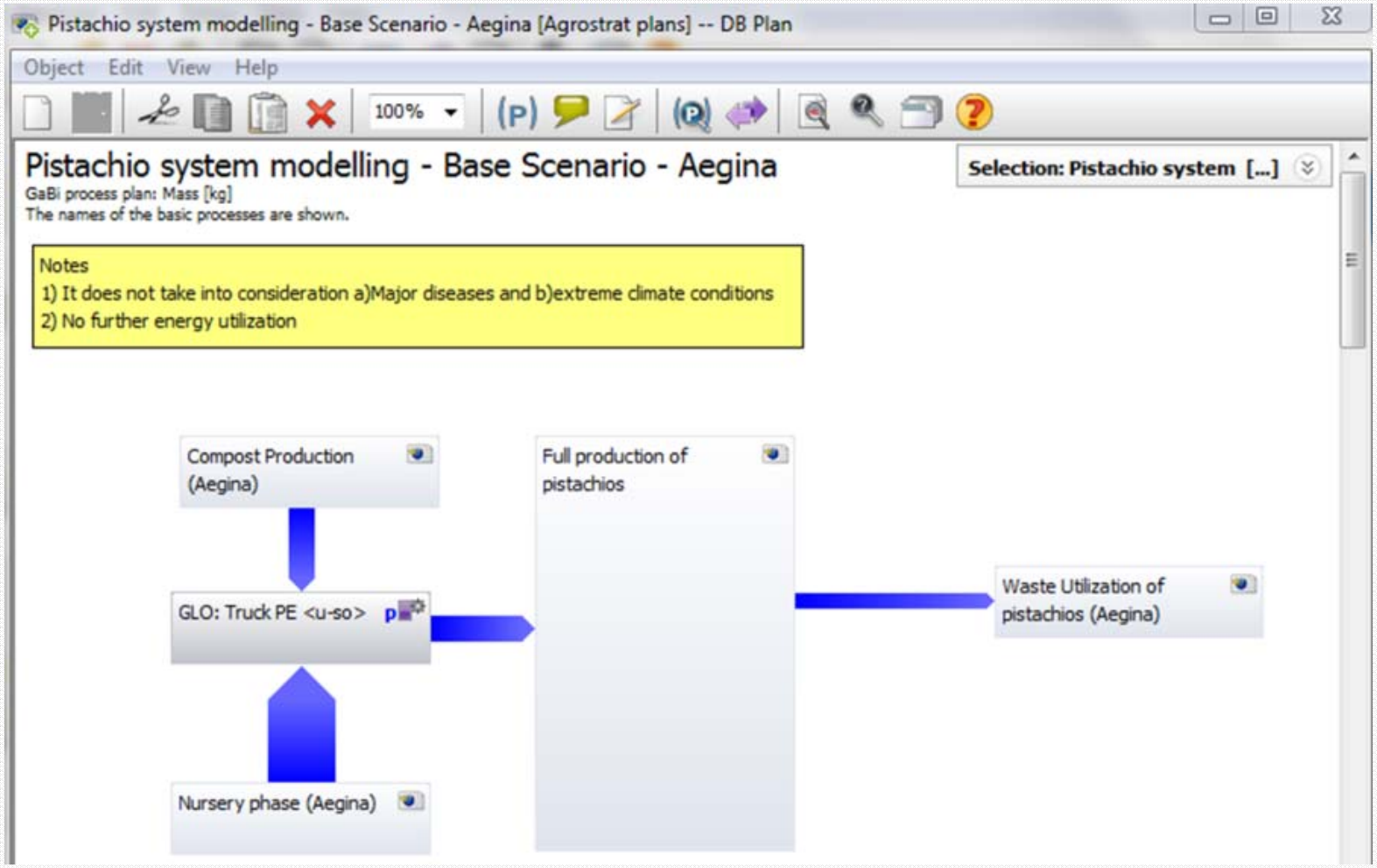
- **Functional Unit: 1 t of dry in-shell pistachios**
- **Input data obtained from different sources**

  a) Primary: (Survey data – AgroStrat project)

  b) Secondary: (Literature data)

  c) Background: from available Gabi software databases (Ecoinvent, Professional)

GaBi plan


Pistachio system modelling - Base Scenario - Aegina [Agrostrat plans] -- DB Plan
Object Edit View Help
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Pistachio system modelling - Base Scenario - Aegina
GaBi process plan: Mass [kg]
The names of the basic processes are shown.
Selection: Pistachio system [...]
Notes
1) It does not take into consideration a)Major diseases and b)extreme climate conditions
2) No further energy utilization
Compost Production (Aegina)
Full production of pistachios
GLO: Truck PE <u-so>
Waste Utilization of pistachios (Aegina)
Nursery phase (Aegina)

LCA inventory: Input data

Characteristics	Unit*	PDO Pistachios
Cultivar	-	Aegina
Orchard age	years	40
Density	trees ha^{-1}	250
Yield	t ha^{-1}	2.5
Harvest period	-	1st week of September
Irrigation technique	-	Furrow, drip and sprinkler irrigation
Irrigation period	-	April to September
Fertilizers application rate		
N (as N)	kg ha^{-1}	230
P (as P_2O_5)	kg ha^{-1}	70
K (as K_2O)	kg ha^{-1}	200
Pesticides application rate		
Fungicides	kg ha^{-1}	3
Insecticides	kg ha^{-1}	2.4
Irrigation water	m^3 ha^{-1}	4450

Results (1)

- **Environmental footprint: 2.04 kg CO_2-eq per tonne of dry in-shell pistachios {0.109 kg CO_2-eq for apples and 2.00 kg CO_2-eq for almonds produced in Thessaly region (Agia, Larissa)}**
- **Energetic footprint: 28.05 GJ per tonne of dry in-shell pistachios {0.96 GJ for apples and 27.33 GJ for almonds}**
- **Production cost (fixed and variable): 12,600 €/ha/year**
- **Gross production value: 20,000 €/ha/year (8 € per kg of pistachios)**
- **Net return/Profit: 7,400 €/ha/year***

***(not to be used from Greek tax authorities , Troika or Quartet)**

Results (2)

- **Contribution analysis of Environmental footprint:**
  - ✓ **Fertilizers production (25.5 %)**
  - ✓ **Irrigation system (22.5 %)**
  - ✓ **Cultivation operations (Agrochemicals application, Machinery use, Planting, Tillage, Ploughing, Harvesting) (16.5%)**
  - ✓ **Post-harvest (Dehulling, sorting, cleaning, drying, grading, storage)(13%)**
  - ✓ **Agricultural machinery (Production) (9%)**
  - ✓ **Waste management (6%)**
  - ✓ **Others (Transport, nursery) (8 %)**
- **Contribution analysis of Energetic footprint:**

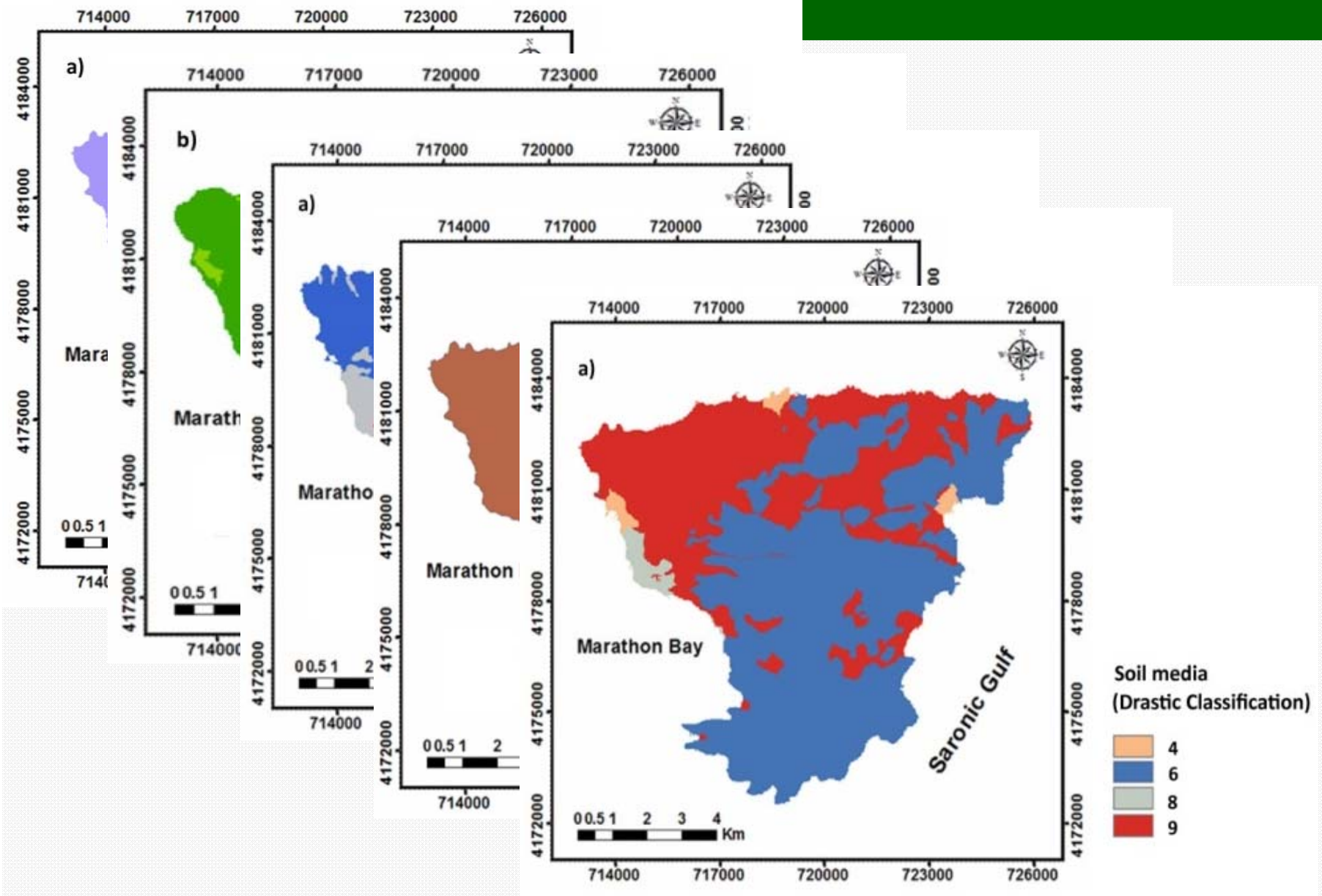
Fertilizers production (29 %)	**Post-harvest (9 %)**
Irrigation system (22 %)	**Waste management (7%)**
Cultivation operations (15%)	**Others (8 %)**
Agricultural machinery (10%)	

Risk assessment of the pilot area

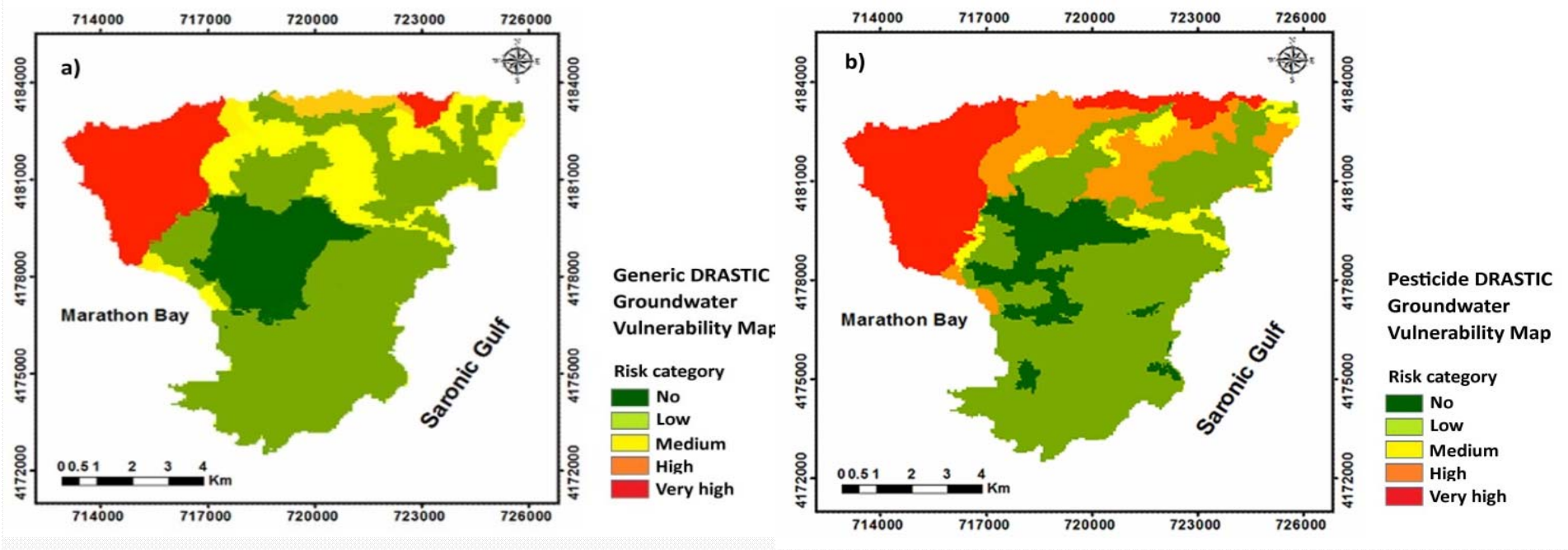
Pilot area: Aegina island (87.41 km^2)

- **Estimation of groundwater vulnerability to contamination in the island of Aegina, Greece, using Generic and Pesticide DRASTIC models suitable for shallow coastal aquifer systems and agricultural areas.**
- **Primary data (soil properties, water table, meteorological) obtained from in-situ measurements carried out in the frame of the ongoing AgroStrat project and other sources (IGME, literature etc.)**
- **Primary source data covering the period 2005–2015**
- **Creation of Risk Maps in GIS environment**

Risk assessment of the pilot area



Risk assessment Maps



Risk Category	Generic DRASTIC		Pesticide DRASTIC	
	Area (km^2)	Area (%)	Area (km^2)	Area (%)
No	13.81	12.07	9.71	11.11
Low	50.01	43.71	42.20	48.28
Medium	16.15	14.12	4.75	5.43
High	2.04	1.78	11.07	12.67
Very high	17.99	15.73	19.68	22.51
Total	87.41	100.00	87.41	100.00

Summarizing……

- Environmental impact assessment tools, primarily LCA, can be used to identify opportunities to improve sustainability in terms of implying more eco-friendly farm practices and promoting utilization of the waste/byproducts
- Risk assessment is particularly accurate and reliable in terms of delineating the most vulnerable areas that require in-depth and frequent monitoring.
- Both tools can be useful for policy/decision makers during the implementation and prioritization of policies for groundwater protection and waste management, especially in areas where intensive agricultural activities in terms of water consumption and use of agrochemicals are carried out.
- More data obtained from additional field and survey studies, pertinent to production and application of soil amendments would be extremely useful in order to minimize uncertainty of the obtained results.

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AgroStrat, www.agrostrat.gr

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