TINOS 2015

3RD INTERNATIONAL CONFERENCE on Sustainable Solid Waste Management

LIFE 10 ENV/GR/000610

Source separation and on-site management of municipal biowaste in a prototype composting unit: the case study of Tinos island, Greece

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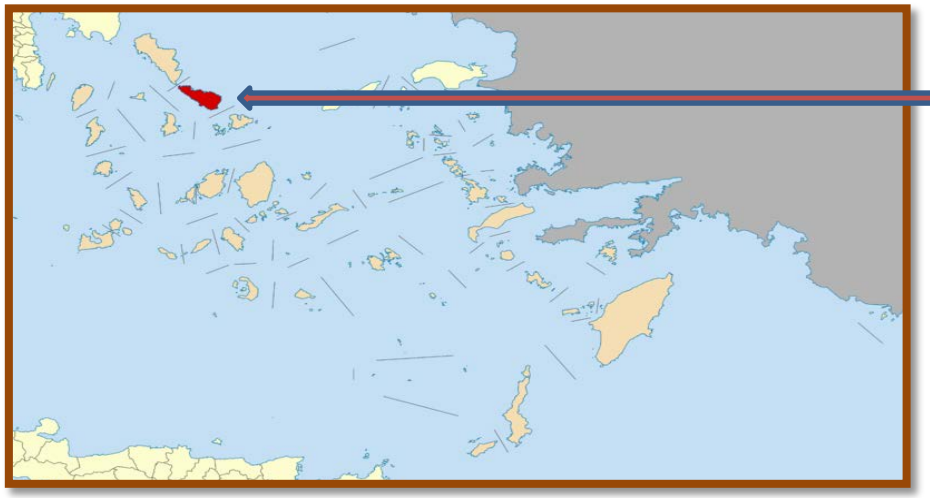
The 'ISWM TINOS' LIFE+ PROJECT

- **Project title & Acronym:** "Development and implementation of a demonstration system on Integrated Solid Waste Management for Tinos in line with the Waste Framework Directive" - 'ISWM TINOS'
- **Project Location:** Tinos Island, Greece
- **Project Budget:** 1,437,368.00 €, **EC Funding:** 718,684.00 € (50%)
- **Duration:** 46 months, **Start:** 01.10.2011 - **End:** 31.07.2015
- **Project partners:**
  - Coordinating Beneficiary: (1) Municipality of Tinos
  - Associated Beneficiaries: (2) National Technical University of Athens
    (3) Università degli studi di Verona
    (4) Centre for Research and Technology Hellas/ Chemical Process and Energy Resources Institute

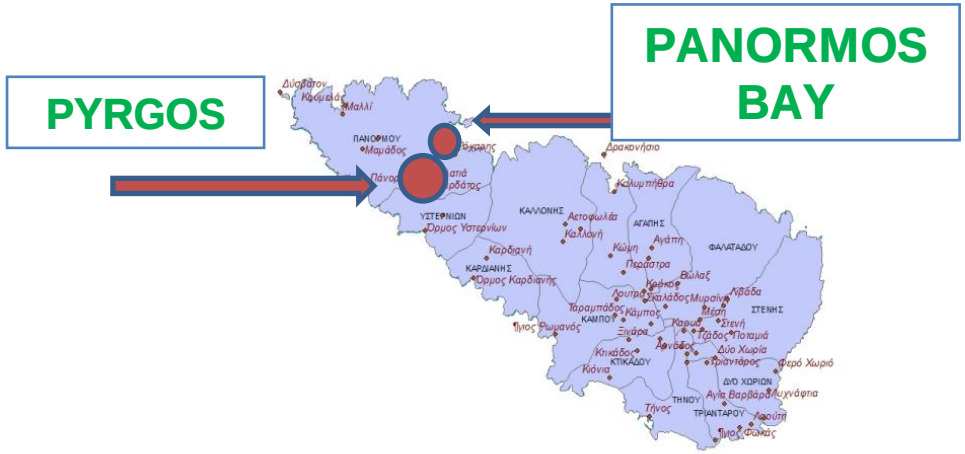
Project Objectives

- **ISWM TINOS** aims to promote and demonstrate an **I**ntegrated **S**olid **W**aste **M**anagement (ISWM) system to the Municipality of Tinos for the sustainable management of MSW in line with the Waste Framework Directive 2008/98/EC
- Separate collection of dry recyclables (**paper/paperboard**, **glass, plastic & metal**) and **biowaste**
- Treatment of the separately collected biowaste in a pilot prototype composting unit in order to produce environmentally safe compost
- Investigation of the possibility of Anaerobic Digestion of source sorted biowaste
- Comparison and evaluation of environmental & social benefits - economic feasibility of different scenarios of biowaste treatment systems in terms of LCA analyses
- Guidelines – suggestions for full scale implementation of the ISWM system for Tinos
- Raising awareness and information provision to local authorities and citizens on sustainable waste management approaches

Project implementation area: Tinos Island



Location in South Aegean Region



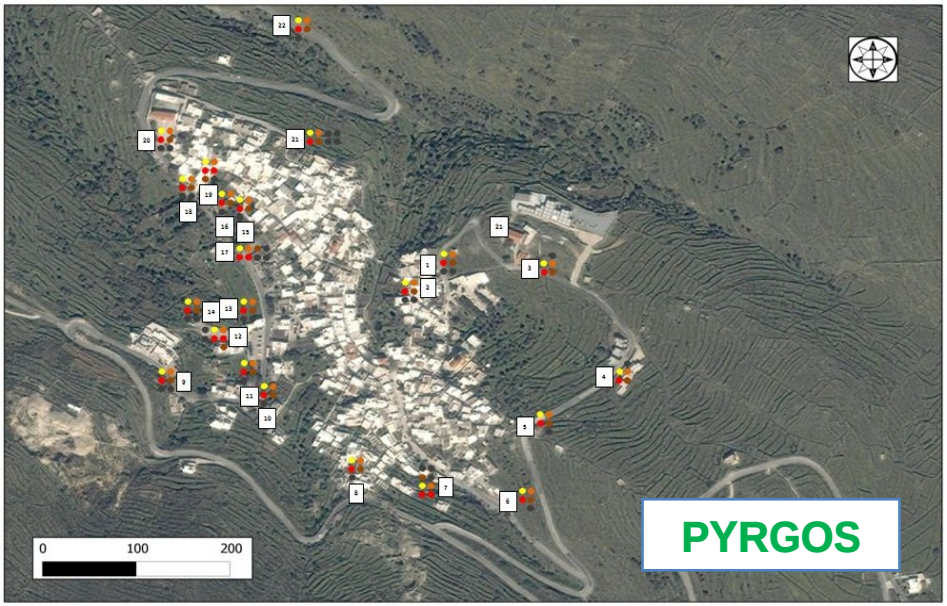
- Two selected communities in Pyrgos & Panormos area of Tinos Municipality
- Sample:

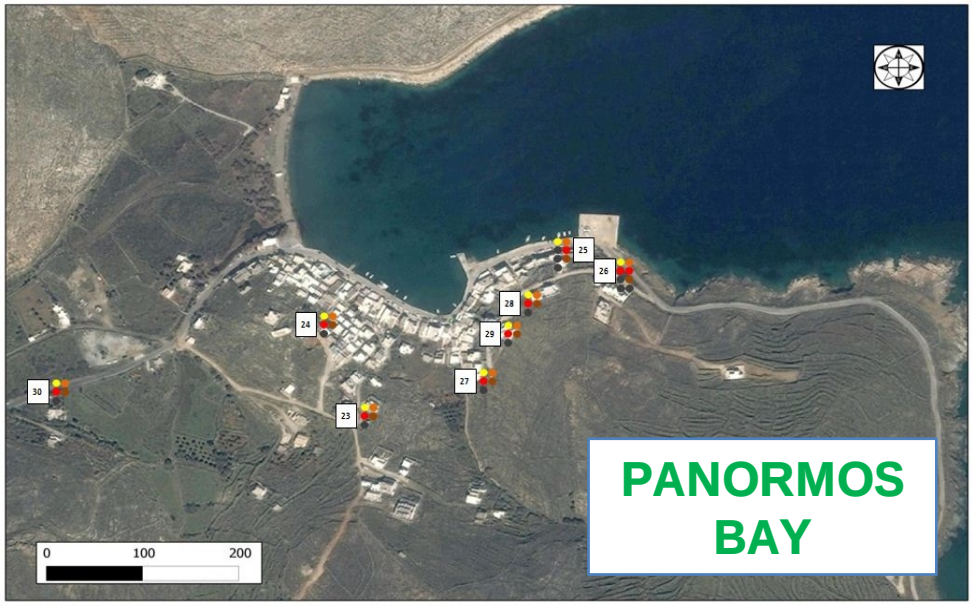
  100 households

  400 inhabitants approx. Mainly residences and institutional, industrial and commercial facilities

  Famous tourist destination

Project implementation area: biowaste collection network





On-site Prototype Composting Unit

Integrated management scheme for biowaste in Pyrgos & Panormos communities

BIOWASTE

Final product - compost

Indoor equipment

- Biodegradable bag
- Brown caddie (10 or 40 L)

Outdoor equipment

Wheelie bin 120L

Collection & Transportation of biowaste

Treatment in the PROTOTYPE Composting Unit

Integrated management scheme for biowaste

1. Separately collected biowaste

2. Feeding portal

3. Chamber of Hydraulic system

V=6.84 m3

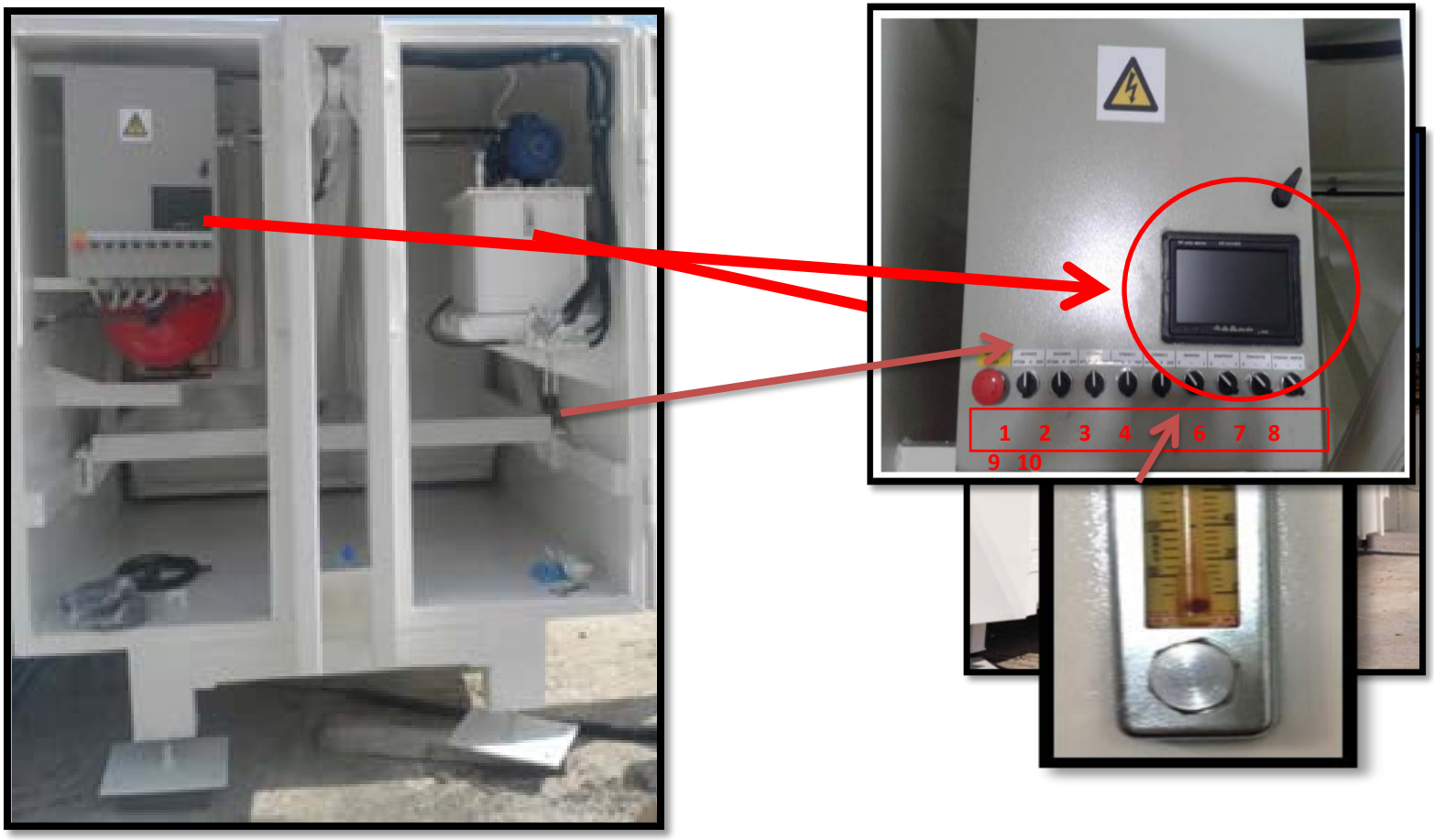
4. Bioreactor

V=20.8 m3

5. Exit portal for final product

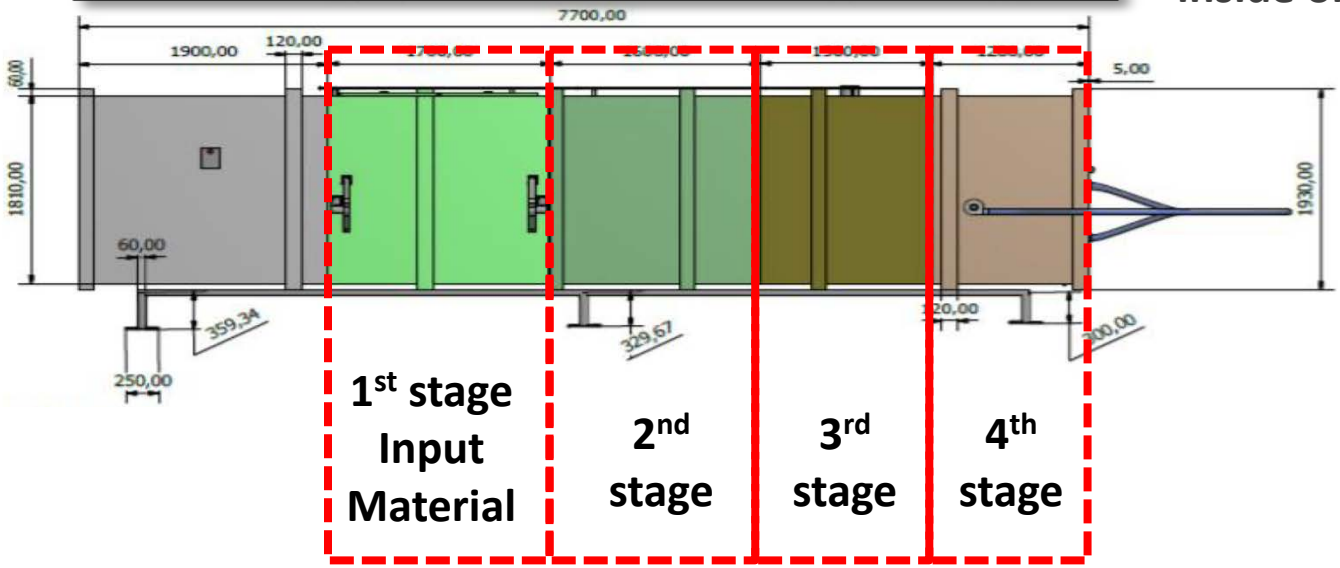
6. Biofilter

Innovative design and operation features of the prototype composting unit: lifting mechanism & hydraulic system



Innovative design and operation features of the prototype composting unit: bioreactor

- 4 successive stages
- Average Retention time: 15 days per stage
- Capacity: 70 - 200 tn/year
- Composting cycle: 20-60 days depending on whether the maturation stage takes place inside or outside the bioreactor



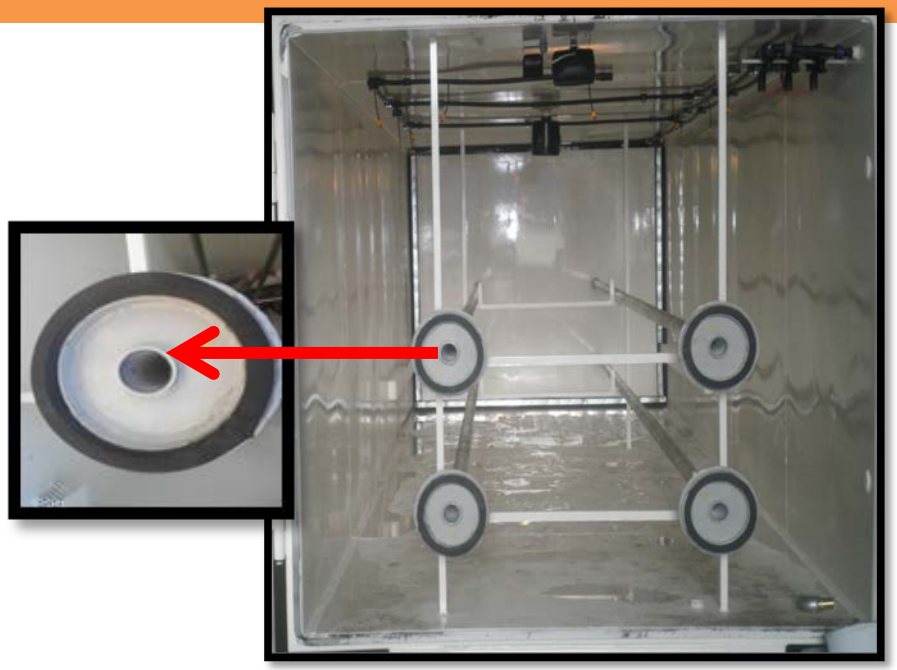
Automated operation for:

- aeration system

- hydration system

- deodorization system

Innovative design and operation features of the prototype composting unit: aeration system

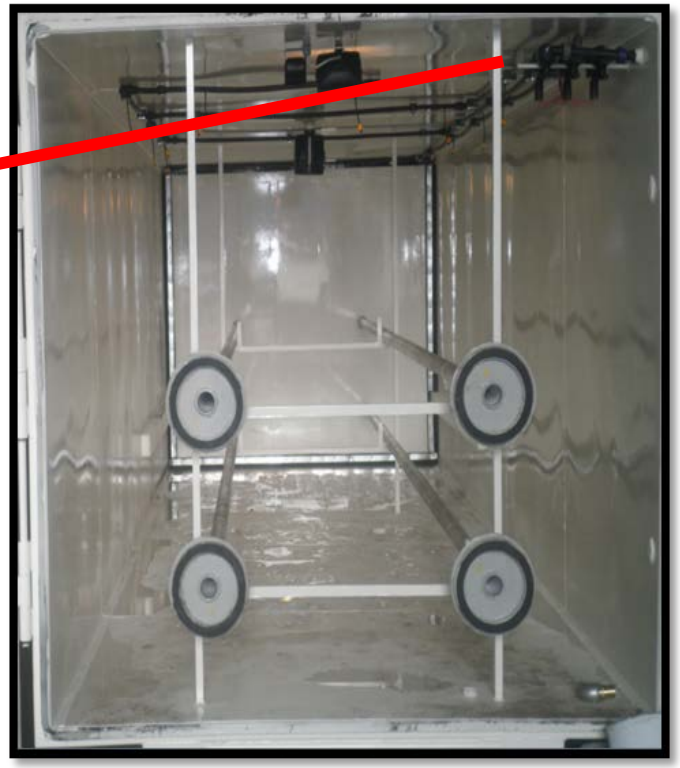


Forced aeration system

Monitoring through PLC system & appropriate software

Differentiation in aeration needs throughout the subsequent composting stages 1st – 2nd - 3rd - 4th

Innovative design and operation features of the prototype composting unit: hydration system



Hydration system (exterior interior)

Monitoring through PLC system & appropriate software

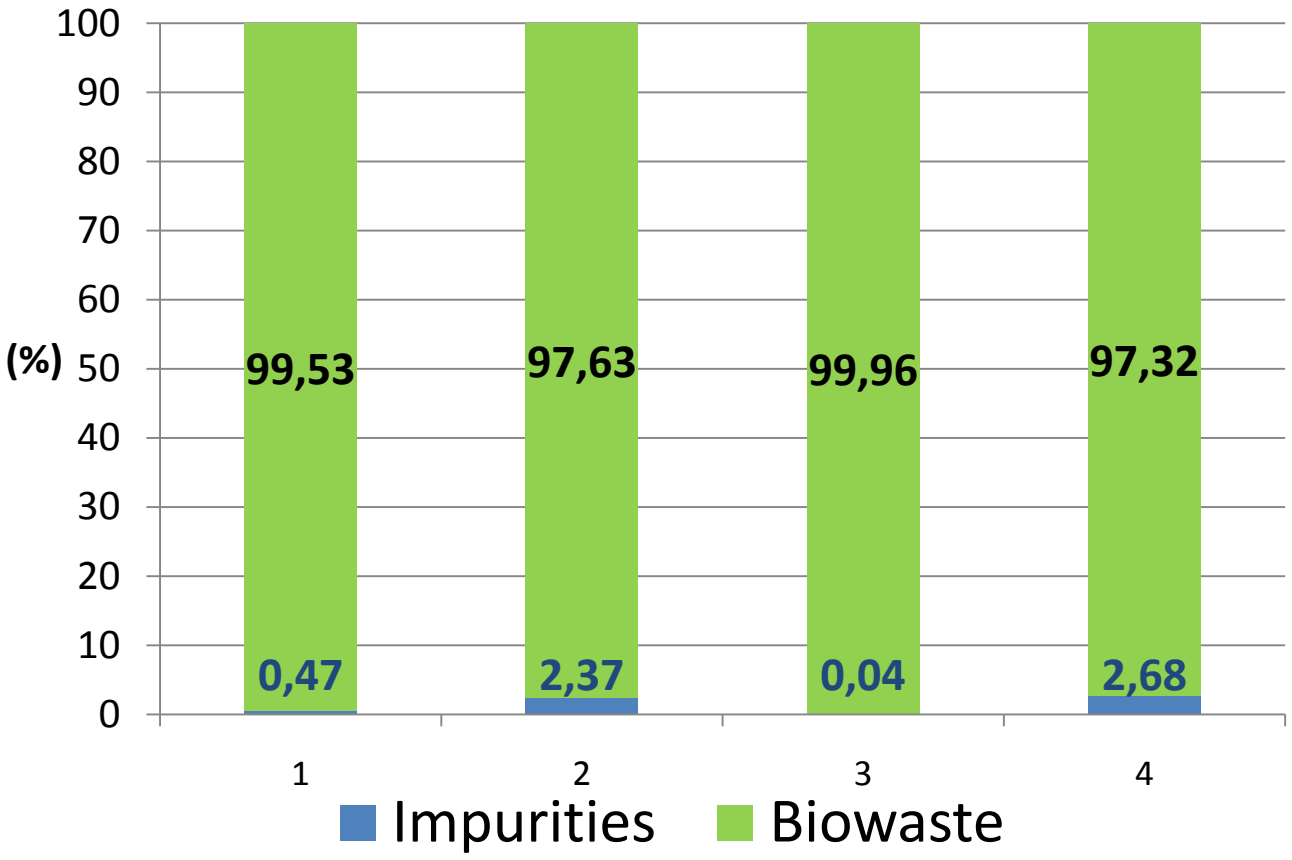
Innovative design and operation features of the prototype composting unit: deodorization system & biofilter

Deodorization system

Monitoring through PLC system & appropriate software

Biowaste compositional analysis: methodology

Biowaste compositional analysis: purity levels of source sorted biowaste in Pyrgos & Panormos

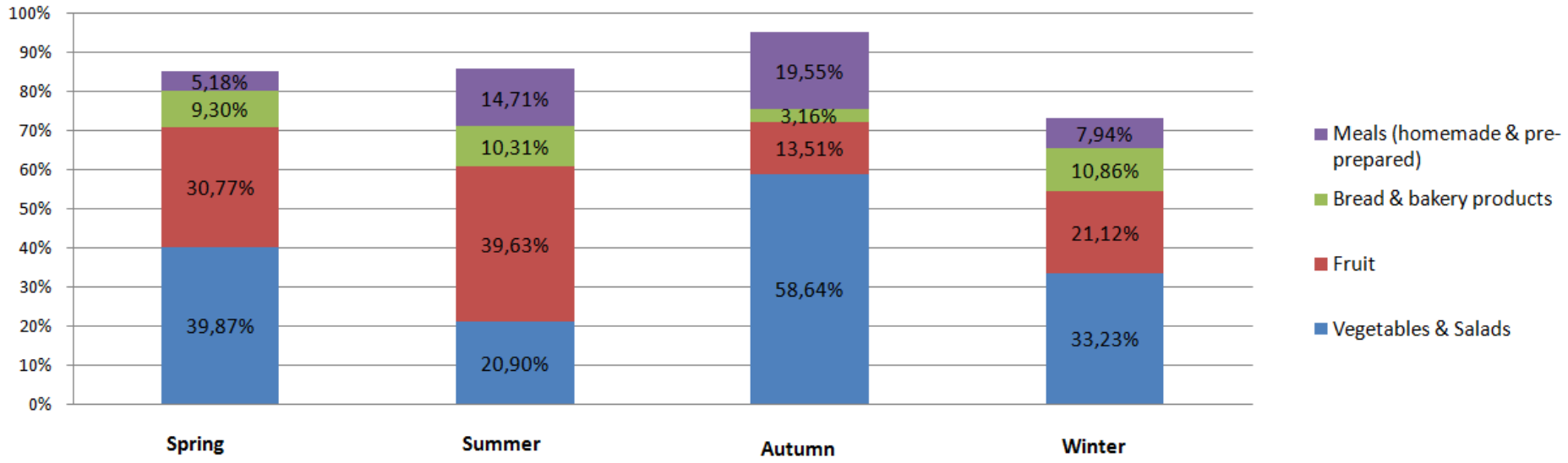


Effective source separation of biowaste

Very low level of impurities **(<1.5%)** throughout the implementation phase

Plastic bags: 53 -67% of impurities

Biowaste compositional analysis: seasonal variation of source sorted biowaste in Pyrgos & Panormos



The characterization of food waste and the available bulking agent before composting is of primary importance, to balance the recipe in terms of moisture content for aeration, pH for a proper microbial environment, and carbon and nitrogen for proper microbial development.

Biowaste physicochemical characteristics

Study area	Unit	Tinos Island (GR)	Kifissia (GR)	Athens (GR)	Forsa (FI)	Luton (UK)	Treviso (IT)	Valencia (ES)	Montreal (CA)
pH (1/5 water extract)	-	**5.28**	5.09	5.31	5.34	5.12	6.16	5.26	4.11
Conductivity (1/5 water extract)	mS cm^{-1}	**3.17**	4.44	2.24	N/A	N/A	N/A	3.43	N/A
Water content	% w.w.	**78.48**	76.13	80.97	72.98	76.30	72.53	70.84	88.4
Bulk Density	gr cm-3 w.w.	**0.48**	0.53	0.54	N/A	N/A	N/A	N/A	0.43
Total Organic Carbon (TOC)	% TS	**51.33**	53.33	53.36	49.4	51.2	47.2	N/A	48.07
Organic Matter (LOI)	% dw	**90.22**	86.32	88.98	92.26	91.28	86.60	85.15	88.0
Total Nitrogen (TN)	% dw	**2.6**	1.88	2.11	2.4 6	3.12	2.55		2.2
TOC/TN (ratio)	-	**25**	29	25	20	16	18	17	23

Biowaste physicochemical characteristics

	Heavy metals content (mg/kg dw)					
	Cu	**Cr**	**Ni**	**Cd**	**Pb**	**Zn**
Tinos island (GR) - SC	**8,27**	**8,55**	**8,78**	**0,19**	**6,59**	**56,59**
Kifissia (GR)- SC	12,85	1,06	1,44	0,25	5,73	35,47
Athens (GR) -SC	12,99	1,51	1,14	0,23	15,67	56,97
EoW 2014	**100**	**100**	**50**	**1,5**	**120**	**400**
Vienna (AT)- SC	28,97	N/A	12,79	0,03	31,09	159,76
Valencia (ES) - SC	15	2	2	0,3	4	34
Valencia (ES) - MC	**33**	**9**	**10**	**0,3**	**33**	**82**
Madrid (ES) - SC	289	30	N/A	2	206	160
Treviso (IT) - SC	34,73	9,49	8,46	0,24	7,04	107,86
Changwon (KR) - SC	14	8,00	N/A	0,20	7,00	35,00

SC: Separate Collection, MC: Mixed MSW Collection

Monitoring of the operation of the prototype unit and the composting process

- Monitoring and evaluation of the composting process for source-sorted biowaste

- Selected monitoring parameters:

✓ Temperature evolution (° C)

✓ Moisture content evolution (% w/w)

etc

- Selected sampling points in prototype bioreactor

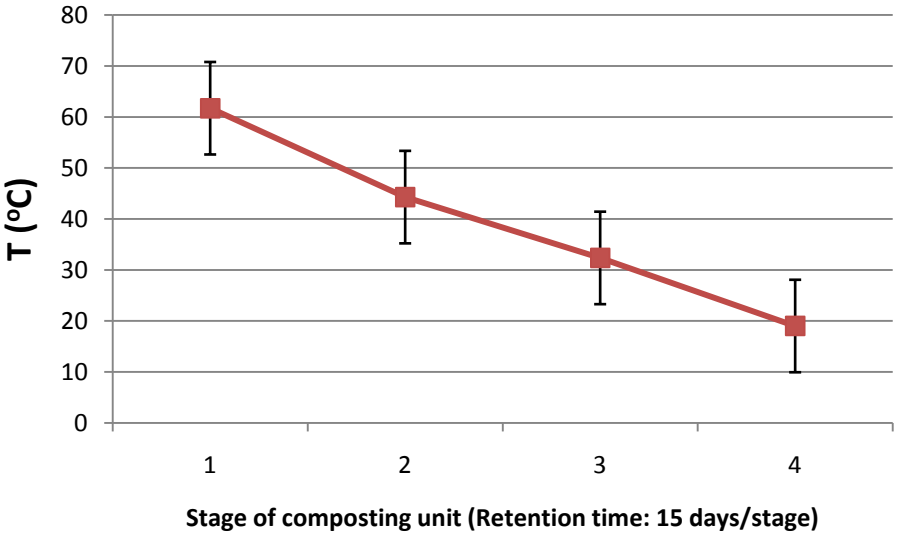
✓First (1st) stage

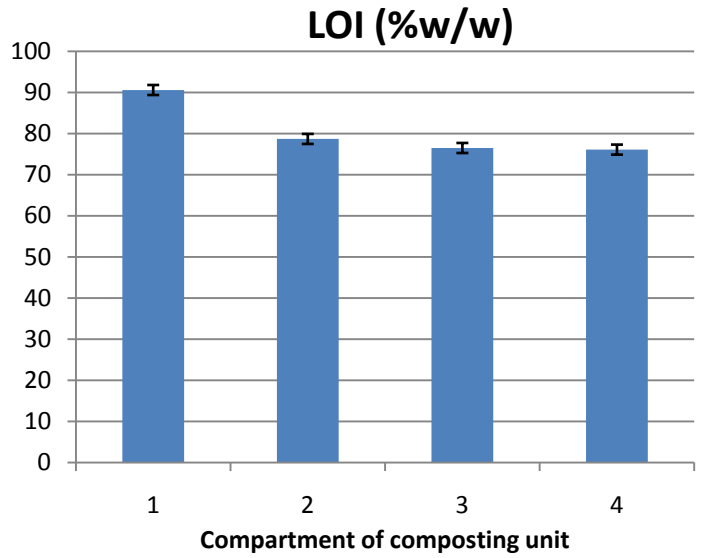
✓Second (2nd) stage

✓Third (3rd) stage

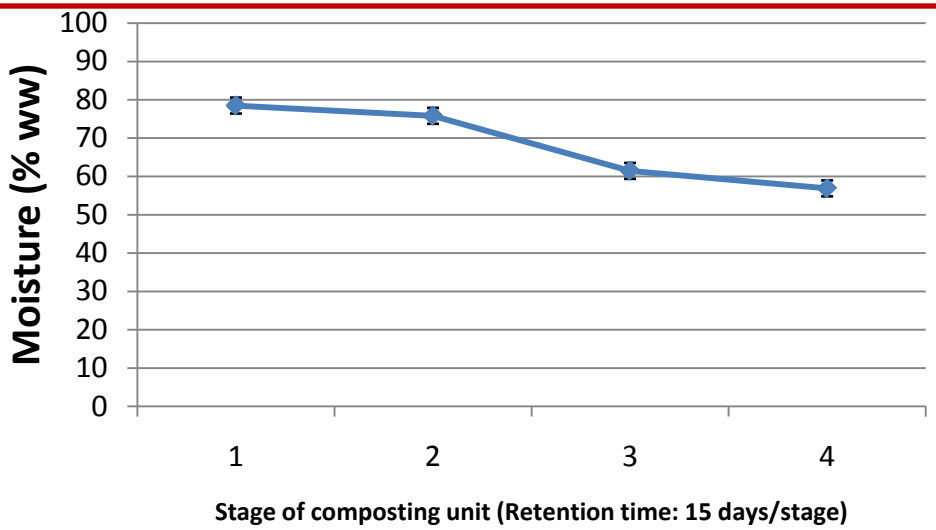
✓Fourth (4th) stage

Monitoring of the operation of the prototype unit and the composting process





Days: 0-15 16-30 31-45 46-60



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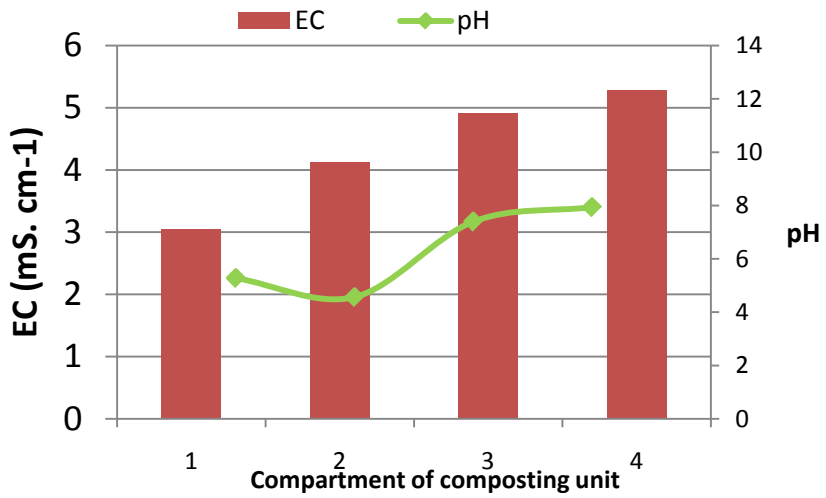


Final product (compost) characteristics

Parameter	Unit	Tinos island – rural area (Source separation)	Athens – Urban –suburban area (Source separation)	Literature data
pH (1/5)	-	7.94	8.29	6 - 8.5
Conductivity (1/5)	mS cm^{-1}	5.27	3.14	3.69 - 7.49
Moisture	%	56.89	29.55	30 - 60
Density	g/cm^3	0.32	0.33	-
Total Organic Carbon (TOC)	% TS	37.29	39.89	-
Organic Matter (LOI)	% ww	64.8	66.57	>15 % dm (EoW 2014)
Total Nitrogen (TN)	% ww	1.71	1.73	0.7 - 4.5
C/N	-	21	23	

Final product (compost) characteristics

Heavy Metals content (mg/kgTS)					
	Cd	**Ni**	**Pb**	**Cu**	**Zn**
Italy (D.lgs 75/2010)	1.5	100	140	230	500
Germany (RAL GZ 245)	1.5	50	150	100	400
UK (BSI 2005)	1.5	50	200	200	400
France (NF–U44-051, 2006)	3	60	180	300	600
Sweden (SPCR 120)	1	50	100	600	800
EoW 2014	**1.5**	**50**	**120**	**100**	**400**
Tinos island (ISWM TINOS Life+ project)	**0.43**	**28.66**	**74.42**	**76.30**	**255.82**
MBT Mixed Compost	0.94	47.63	182.9	214.36	433.81

Final product (compost) characteristics

Hygienic parameters	**Pathogens**	**Unit**	**ISWM TINOS Life+ project**	**EoW, 2014**
	Salmonella sp.	in 25 g sample	absence	absence of Salmonellae
	E.Coli	CFU/g fresh mass	<10	<1000
Biological parameters	**Plant response - Phytotoxicity**			
	Lattuga Romana verde	Indicator Plant growth score	95	non phytotoxic
Undesired ingredients and properties	Contents of Germinable seeds and plant propagules	seeds/L of compost	0	<2

Conclusions

➢The prototype composting unit can receive greater quantities of biowaste so as to operate at its maximum capacity and accomplish the full optimization of the composting process. This can be achieved by incorporating additional communities in the separate biowaste collection scheme.

➢ The physico-chemical and biological characteristics of the final product satisfied the limits set by EoW 2014 for biodegradable waste subjected to biological treatment (compost & digestate):

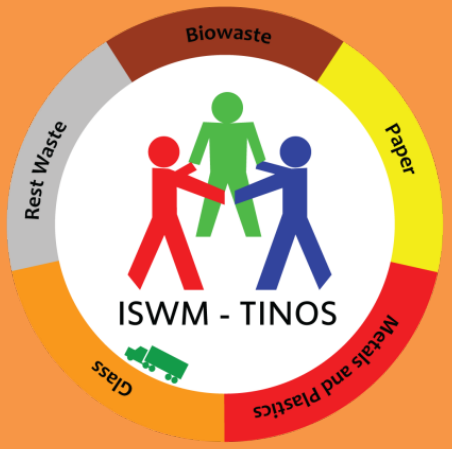
-No pathogens
-Low heavy metals content in comparison with compost produced from mixed waste collection

➢Source separation is of significant importance, especially for the sensitive MSW fraction of biowaste, since separately collected organics exhibit high purity levels so as to facilitate any further treatment and thus the products received (compost) have better quality and greater value.

➢The recorded low impurities content (~2-3%) demonstrate that the participating households practice effectively the source separation of the generated biowaste.

I would like to acknowledge the financial support of LIFE+ instrument

Thank you for your attention!



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