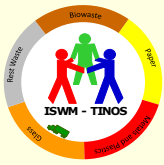


Case study: Implementation and evaluation of MSW management scheme in Pyrgos & Panormos communities in Tinos Island, Greece

V. Panaretou, D. Malamis, K. Moustakas, K. Valta, M. Margaritis, M. Loizidou

2nd International Conference on Sustainable Solid Waste Management
Friday, 13th June 2014, Athens, Greece





Objective of ISWM scheme

Overview of ISWM scheme

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Conclusions

■ Objective:

The development and evaluation of an Integrated Solid Waste Management scheme for municipal solid waste in Tinos, in line with the Waste Framework Directive 2008/98/EC.

■ **Project Location:** Tinos Island, Greece

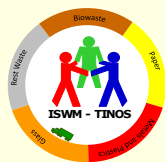
■ **Project Budget:** 1,437,368.00 €

■ **EC Funding:** 718,684.00 € (50%)

■ **Duration:** 46 months, Start: 1.10.2011 End: 31.7.2015

Overall scope: put into practice a viable and environmentally sustainable solid waste management system by setting distinct, target MSW streams and combining waste collection, treatment and subsequent safe disposal methods with the aim of acquiring environmental and economic benefits, as well as social acceptance.





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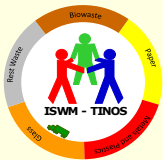
Results

Conclusions

EU Legislative Framework		Greek Legislative Framework	
1) Waste Framework Directive 2008/98/EC 2) Directive 94/62/EC on packaging and packaging waste as amended by Directive 2004/12/EC 3) Directive 1999/31/EC on the landfill of waste as amended		1) Law 4042/2012 (Official Gazette 160/A/16.10.1986) «Protection of the environment through criminal law - Transposition into national law of Directive 2008/99/EC – Framework for the production and the treatment of waste - Transposition into national law of Directive 2008/98/EC – Arrangement of issues related to the Ministry of Environment, Energy and Climate Change»	
		2) JMD* 50910/2727/2003 (Official Gazette 1909/B/22.12.2003) «Measures and terms for the management of solid waste. National and Regional Management Planning»	
		3) JMD 29407/3508/2002 (Official Gazette 1572/B/16.12.2002) «Measures and terms for landfilling of waste» 4) Law 2939/2001 (Official Gazette 179A/2001) «Packaging and alternative management of packaging and other products - Establishment of the National Organisation for the Alternative Management of Packaging and Other Waste and other provisions » as amended by JMD 9268/469/2007 and Law 3854/2010	

* JMD: Joint Ministerial Decision





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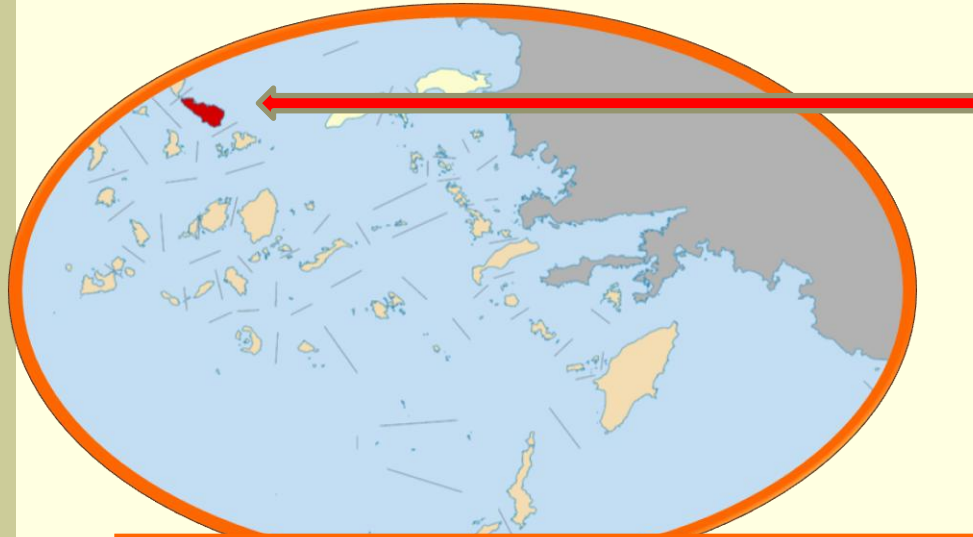
Conclusions

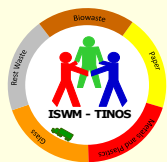
Target area:

**Municipality of Tinos
South Aegean Prefecture,
Greece**

Target Population:

**The ISWM scheme
serves 100 households
&
industrial,
commercial and
institutional
facilities
located
in Tinos Island**





**Objective of
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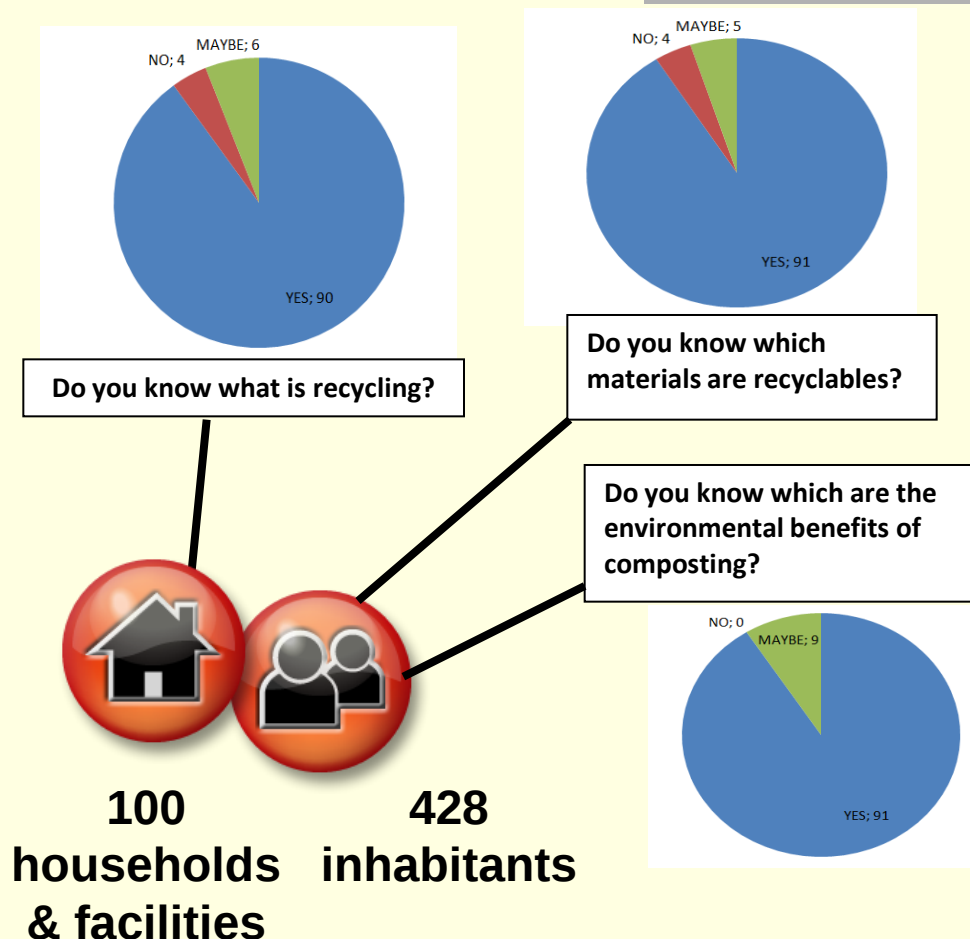
Methodology

Results

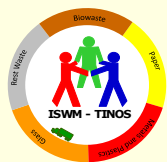
Conclusions

Why this target area?

- Meets population criteria.
- Homogeneous and permanent population throughout the year.
- Cohesive and distinct settlements.
- Population has a strong local identity feeling.
- It has a very recent experience in local matters administration.
- It is a famous destination and a strong cultural brand name.



Outcome: HIGH level of environmental awareness!



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Applied method for MSW management: Separation at source

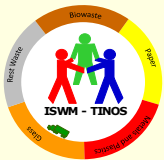
Phase	Grouping of MSW streams on ISWM plan	Colour
1 st	Separate collection of paper/paperboard	Yellow
	Separate collection of glass	Orange
	Commingle collection of plastic & metal	Red
2 nd	Separate collection of biowaste	Brown

Collection system: curbside collection scheme

Network: 30+ waste collection points located in public areas at the periphery of the selected communities

The grouping of the target waste streams has been based on the expected effectiveness of the source separation and the subsequent processing efficiency of the materials.





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INDOOR EQUIPMENT

BIOWASTE



Biodegradable bag
10 & 40 L caddies

**DRY
RECYCLABLES**
Paper
Glass
Metal & Plastic



10 L reusable bags

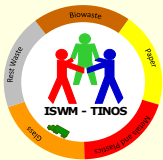
OUTDOOR EQUIPMENT



120 L wheelie bin



240 L wheelie bins



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OUTDOOR EQUIPMENT

BIOWASTE

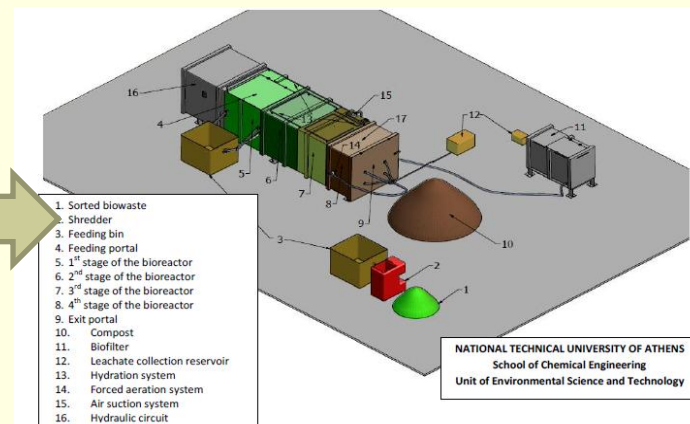


120 L wheelie bin

**DRY
RECYCLABLES**
Paper
Glass
Metal & Plastic



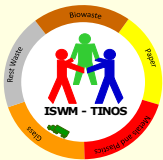
240 L wheelie bins



Composting system



3 containers



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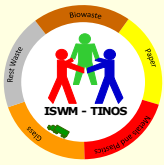
Conclusions

Steps followed for the implementation of the developed ISWM scheme:

1. Setup (purchase and preparation of equipment, organization of collection, transportation and processing of pre-sorted materials, raise of public awareness and training of local authorities, equipment distribution & scheme launching)

2. Monitoring (collection and measurement of primary data, related to the practice of source separation of MSW and the subsequent processing of the pre-sorted materials)

3. Evaluation (quantification and assessment of specific set of indicators, evaluation of the performance of source sorting scheme)



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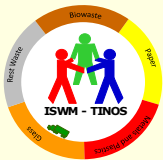
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1. Setup activities (Purchase of the source separation indoor and outdoor equipment)

EQUIPMENT		Capacity (L)	Units Purchased	Colour	Waste Type
INDOOR	Caddies	10 or 40	113 22	Brown	Biowaste
	Biodegradable bags	10 or 40	38,000 7,200	White	Biowaste
	Reusable bags	10	640	Yellow	Paper/paper-board
				Red	Plastic & Metal
				Orange	Glass
OUTDOOR	Wheelie Bins	120	30	Brown	Biowaste
		240	100	Yellow	Paper/paper-board
				Red	Plastic & Metal
				Orange	Glass



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1. Setup activities (Preparation of the source separation indoor and outdoor equipment)

- Calibration of the outdoor waste collection bins (division of inner surface into eighths)
- Codification and labeling of the outdoor waste collection bins

08 023

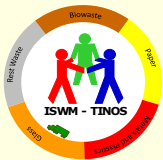


ΧΑΡΤΙ/ΧΑΡΤΟΝΙ
PAPER/PAPERBOARD

ΓΥΑΛΙ
GLASS

ΠΛΑΣΤΙΚΟ & ΜΕΤΑΛΛΟ
PLASTIC & METAL

ΟΡΓΑΝΙΚΑ ΑΠΟΒΛΗΤΑ
ORGANIC WASTE



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1. Setup activities (Specially designed data recording sheet)



ISWM-TINOS
LIFE 10/ENV/GR/000610

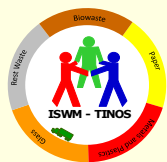
ΕΝΤΥΠΟ ΚΑΤΑΓΡΑΦΗΣ ΠΟΣΟΤΗΤΩΝ ΣΤΕΡΕΩΝ ΑΠΟΒΛΗΤΩΝ

ΑΡΙΘΜΟΣ ΣΗΜΕΙΟΥ ΣΥΛΛΟΓΗΣ	ΗΜΕΡΟΜΗΝΙΑ ΑΠΟΚΟΜΙΔΗΣ	ΚΙΤΡΙΝΟΣ ΚΑΔΟΣ Χαρτί/χαρτόνι	ΠΟΡΤΟΚΑΛΙ ΚΑΔΟΣ γυαλί	ΚΟΚΚΙΝΟΣ ΚΑΔΟΣ μέταλλο & πλαστικό	ΚΑΦΕ ΚΑΔΟΣ βιοαπόβλητα	ΟΝΟΜΑΤΕΠΩΝΥ ΜΟ ΧΕΙΡΙΣΤΗ
	ΗΗ/ΜΜ/ΕΤΟΣ	0 1/4 1/2 3/4 4/4	0 1/4 1/2 3/4 4/4	0 1/4 1/2 3/4 4/4	0 1/4 1/2 3/4 4/4	
	ΗΗ/ΜΜ/ΕΤΟΣ					
	ΗΗ/ΜΜ/ΕΤΟΣ					
	ΗΗ/ΜΜ/ΕΤΟΣ					
	ΗΗ/ΜΜ/ΕΤΟΣ					

Type of data
collected:

Direct recording,
prior to collection
of:

- Volume of the sorted materials
- Date of collection
- Code of waste collection bin
- Comments of ISWM operator



Objective of
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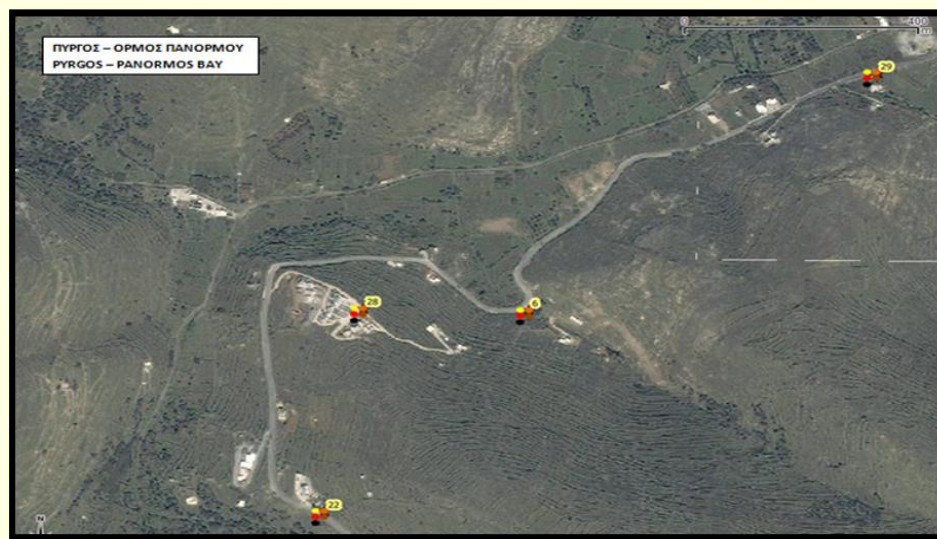
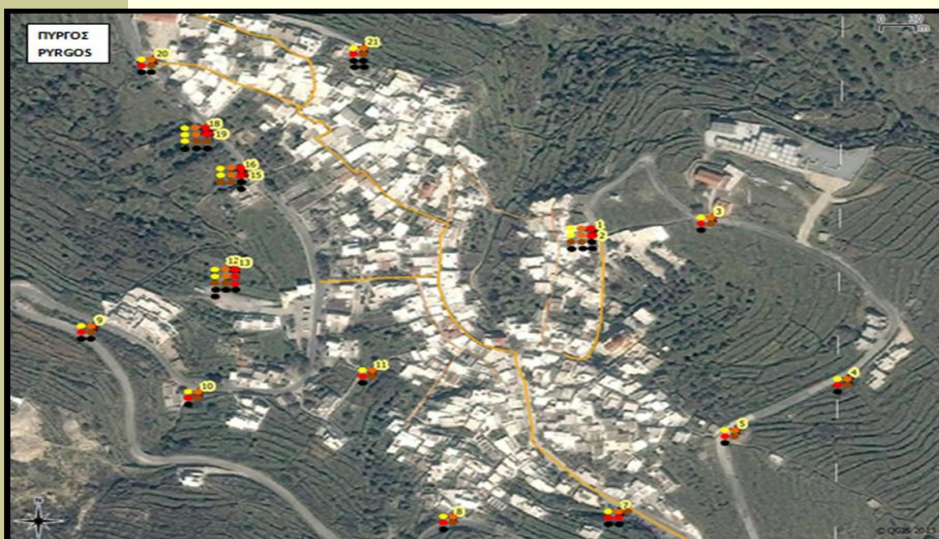
Overview of
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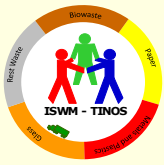
Methodology

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1. Setup activities (Network of waste collection points)





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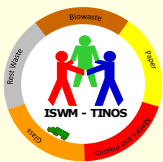
1. Setup activities (Development of time schedule for waste collection)

- **Paper/paperboard** collection: every 4 days
- **Glass** collection: every 25 days
- **Plastic & metals** collection: every 4 days



**Satellite vehicle for
waste collection**

The waste collection frequency was designed with flexibility and, consequently it might be subjected to alteration and optimization during the implementation phase of the source separation scheme, as indicated by the recorded waste data.



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1. Setup activities (Training of involved local authorities & participating public)

□ 1st training session:

-addressed to the operators of the scheme (i.e. waste collection vehicle operator, helpline operator)

- aiming to provide guidelines and enhance motivation of the staff

so as to ensure the successful sorting of waste and for the subsequent effective processing of the materials.

Means:

- Informative documents focused on clear service information
- Specially designed sheets for waste collection data recording

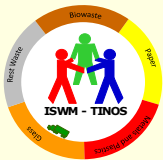


FAQ
document



Telephone number in all
dissemination documents





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1. Setup activities (Training of involved local authorities & participating public)

□ 2nd training session (Raise awareness event, June 2013):

- addressed to participating households of the scheme
- aiming to overcome people's barriers to participation and
- inform and educate the participants on source separation method of dry recyclables (paper, plastic, glass, metal) and biowaste.



Brochure for adults



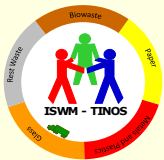
Brochure for schools



Informative cards for adults



Informative cards for students



Objective of
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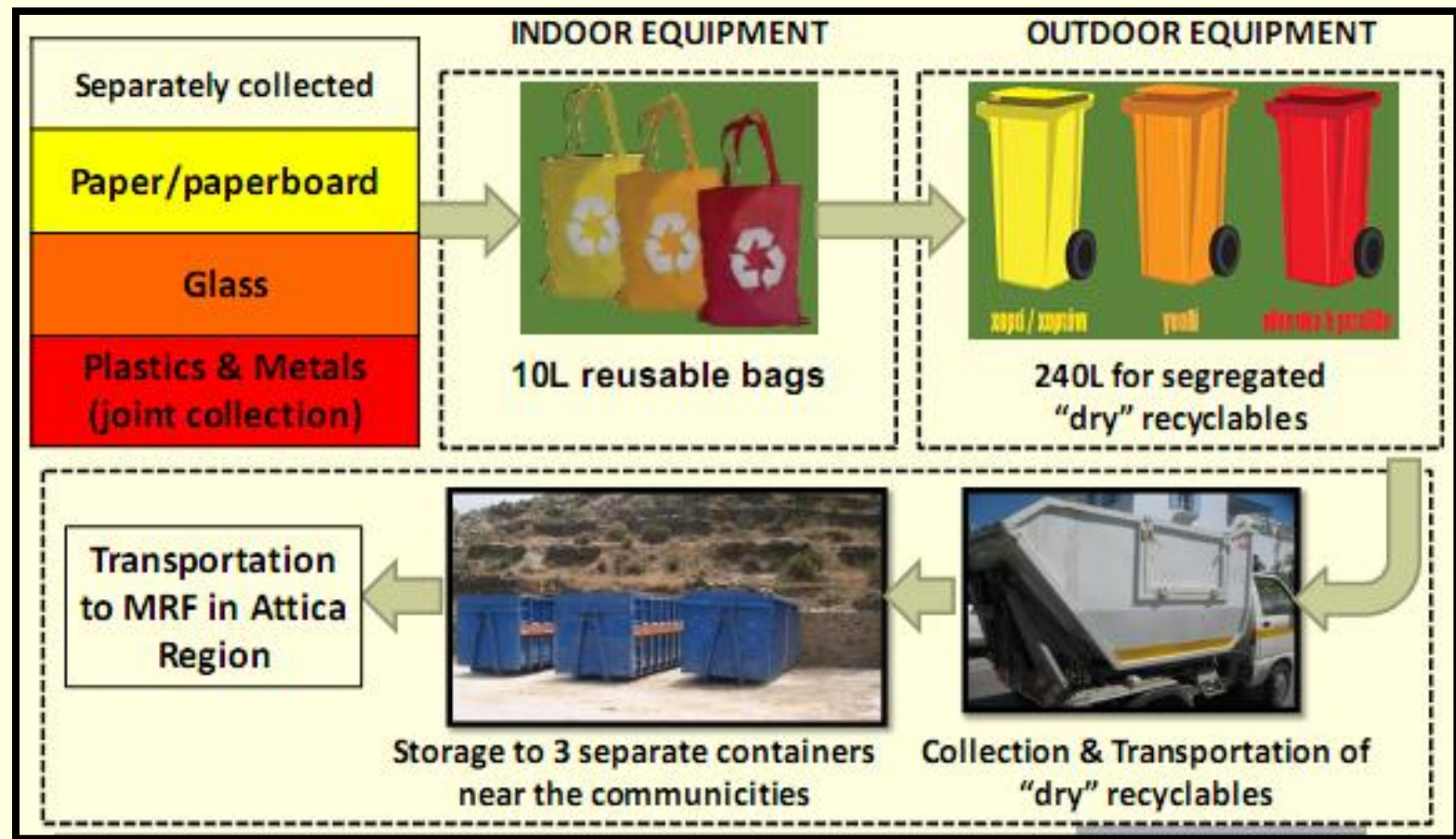
Overview of
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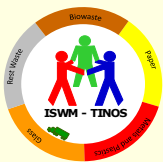
Methodology

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1. Setup activities (Collection and transportation of the source separated dry recyclables)





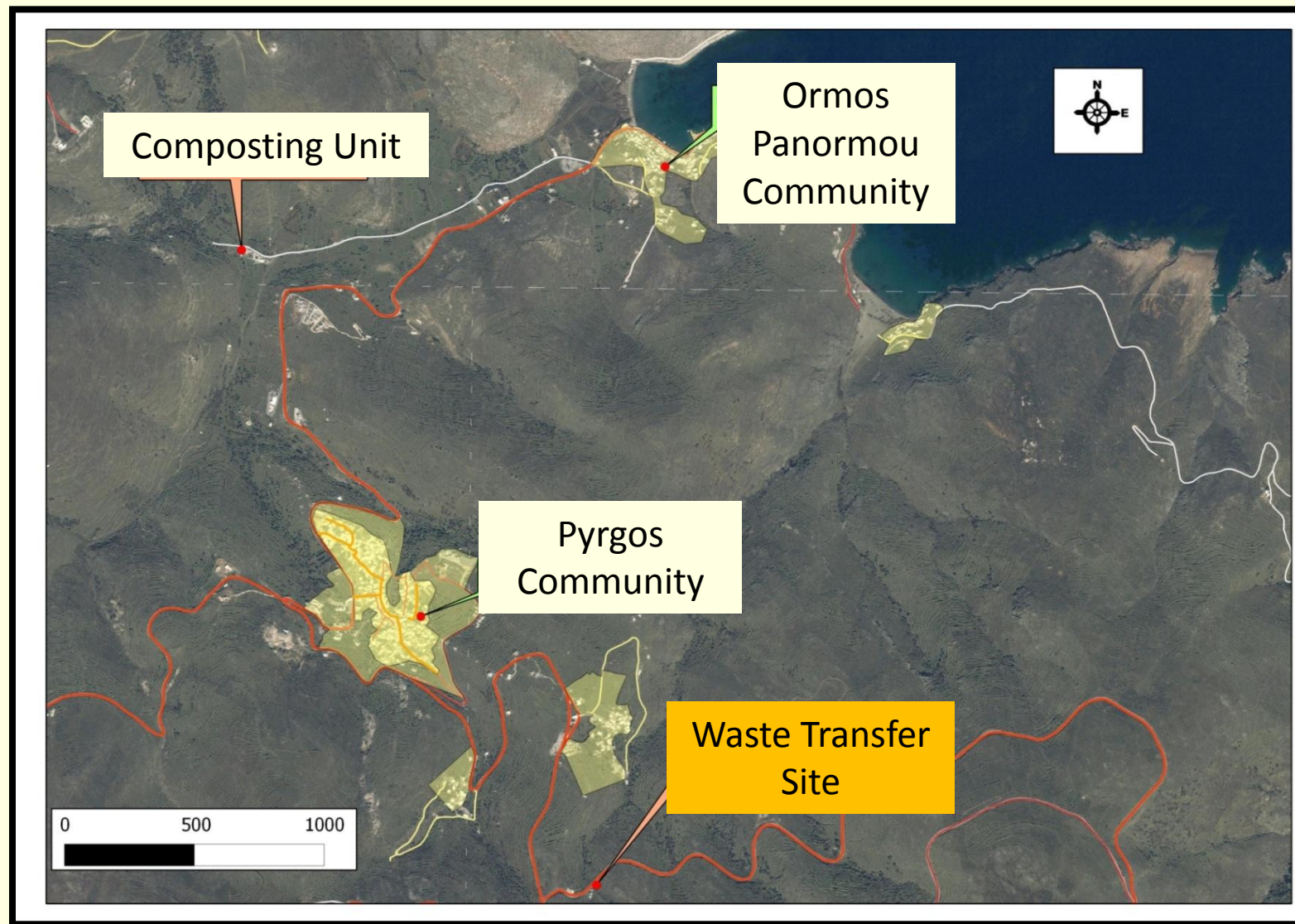
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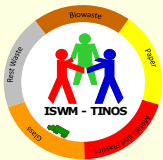
Overview of
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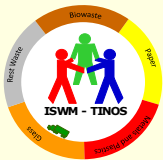
Results

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1. Setup activities (Processing of sorted materials)

At the RSC of Koropi Municipality, the mechanical sorting of the segregated MSW materials is accomplished, resulting in different material categories such as: **packaging paper – cardboard, liquid cartons, print paper, plastic packaging (PET, HDPE), plastic film, other plastics (PP/PS), glass bottles and containers, aluminium and tinplate packaging items**. Then, the waste materials are compacted (with the exception of glass), baled and forwarded to the corresponding industry sectors in order to be further recovered.





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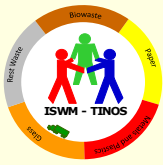
Methodology

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2. Monitoring (Set of Indicators for the ISWM scheme performance)

Indicator	Units	Data
1. Specific Waste Generation Rate	kg capita ⁻¹ ·yr ⁻¹	describes the amount and the type of MSW generated per person per year.
2. Source Separation Ratio (total, individual)	% w/w	reveals the extent to which participants separate their waste and it is formed by the ratio of the total weight of the collected source separated materials over the total amount/weight of MSW generated
3. Ratios of Materials in Residual MSW	% w/w	reflects the percentage of different types of waste fractions in the remaining MSW which have not been sorted
4. Impurities Ratio of Sorted materials	% w/w	presents the purity level of the source separated materials termed as the ratio of the total weight of mis-sorted materials in the recyclables over the amount of collected source separated materials
5. Participation Rate	% w/w	provides an insight on the distribution of the source-sorting activities in the areas where the scheme is applied. However, measuring the participating population is a hard task considering that the implemented ISWM scheme does not include a door to door collection system where the participation rate can be recorded as a set-out rate



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6. The **Sorted dry recyclables - processing** in an RSC will be evaluated using the following equation:

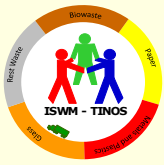
$$\text{RecyclingRate}_{\text{RSC}} = \frac{\text{Weight of RSC input materials} - \text{Weight of materials not recycled in the RSC}}{\text{Weight of RSC input materials}}$$

7. The **Sorted Biowaste - processing** in an in-vessel composting unit will be evaluated using the following equation :

$$\text{RecyclingRate}_{\text{composting}} = \frac{\text{Weight of sorted biowaste} - \text{Weight of impurities in sorted biowaste}}{\text{Weight of sorted biowaste}}$$

8. The **Overall evaluation** and monitoring will be evaluated using the following equation :

$$\text{RecyclingRate}_{\text{TOTAL}} = \frac{\text{Weight of effectively processed materials (composting + RSC)}}{\text{Weight of source separated materials}}$$



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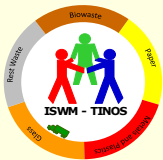
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2. Monitoring (Sources of data acquisition)

For the effective monitoring of the applied recycling scheme, certain steps have been designed to be followed related to three (3) different sources of data acquiring.

- **Data source 1:** waste collection vehicle operator. Telephone communications, emails and fax messages are employed to acquire this type of information on a regular basis.
- **Data source 2:** staff of the RSC located at the Municipality of Koropi. Similarly, telephone communications and emails are employed to acquire this type of information every time a fully loaded container arrives at the facilities of East Attica region.
- **Data source 3:** waste sampling and compositional analysis conduction



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3. Evaluation of the performance of the applied scheme



**Data
source 1
outcomes**

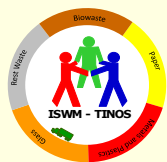
-
**Municipality
Staff**

**Data
source 2
outcomes**

-
**RSC
Staff**

**Data
source 3
outcomes**

-
**Waste
sampling**



Objective of ISWM scheme

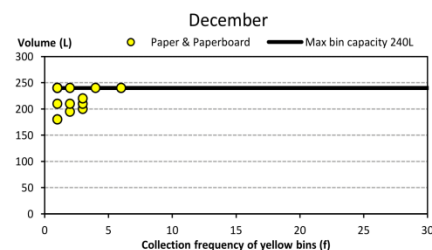
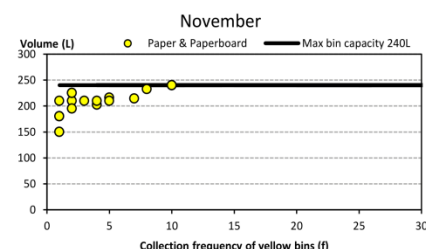
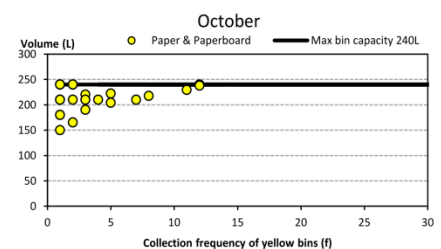
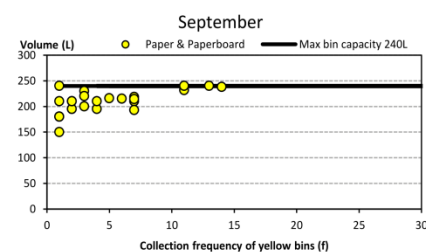
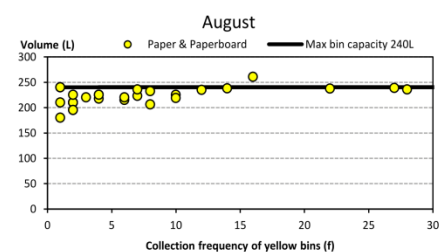
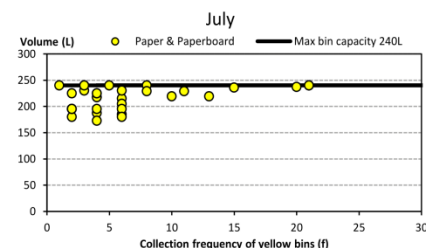
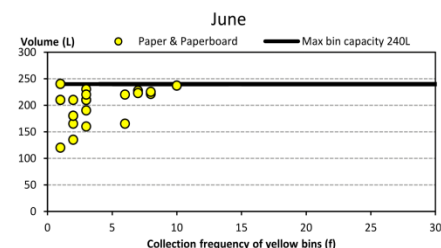
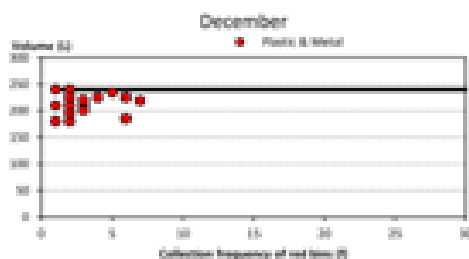
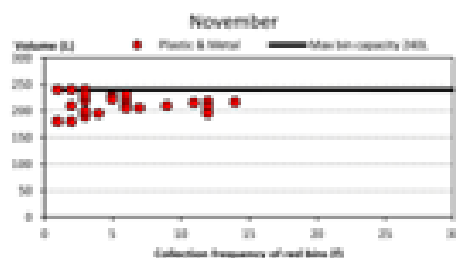
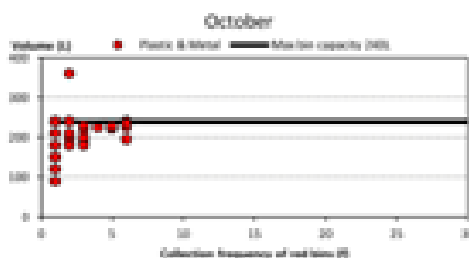
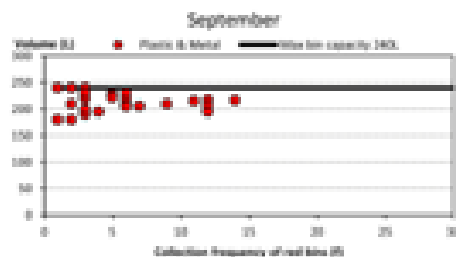
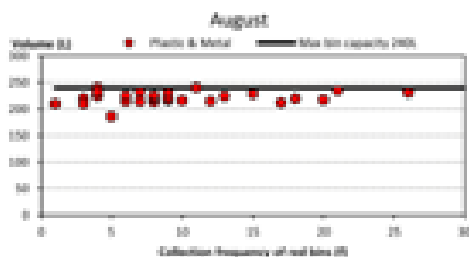
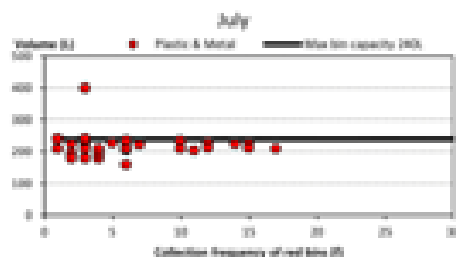
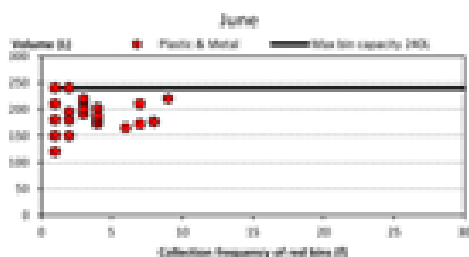
Overview of ISWM scheme

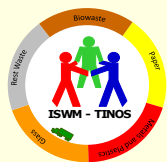
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Data source 1 outcomes – graphs of av. volume funct. collection frequency





Objective of ISWM scheme

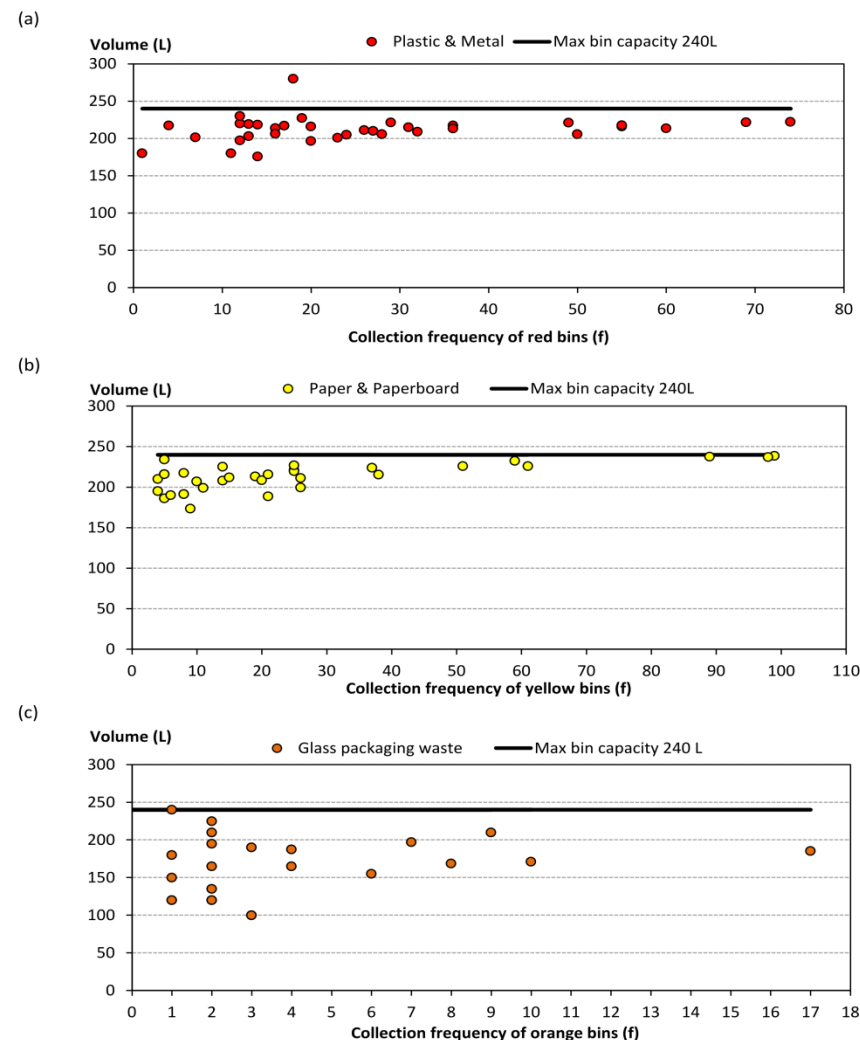
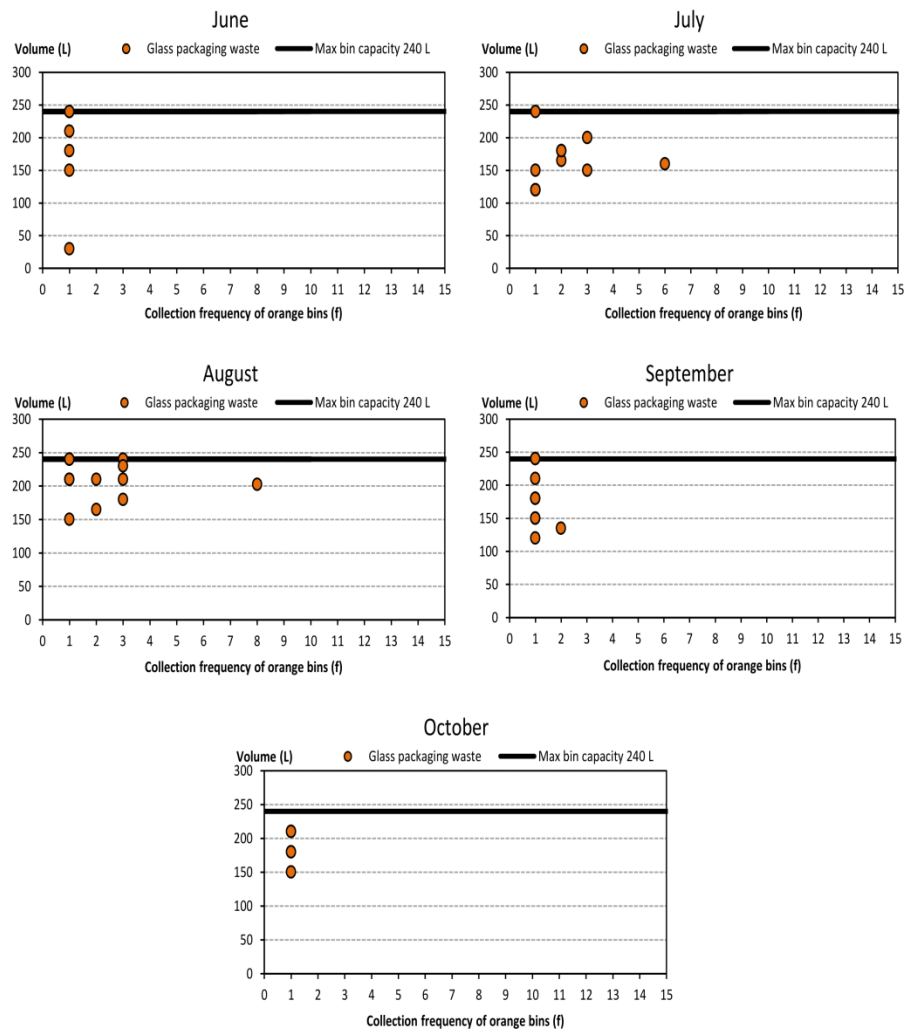
Overview of ISWM scheme

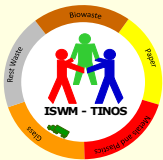
Methodology

Results

Conclusions

Data source 1 outcomes – graphs of av. volume funct. collection frequency





Objective of
ISWM
scheme

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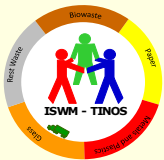
Conclusions

Data source 1 outcomes

Principal remarks from examination period June 2013 – December 2013 (7 months):

- **Plastic & metals (red bin)** and **paper/paperboard (yellow bin)** show much higher collection frequency and volume of materials compared to **glass packaging (orange bin)** which is anticipated due to the lower percentile composition of glass in MSW.
- Collection frequency and average volume of all packaging waste are significantly increasing, during the **summer period**, presenting the peak values in August.
- Despite the high demand for collection & transportation services during the summer period, resulting from the increased number of tourists and visitors in the target areas, the collection of sorted materials is very efficient in terms of quantity and collection frequency.





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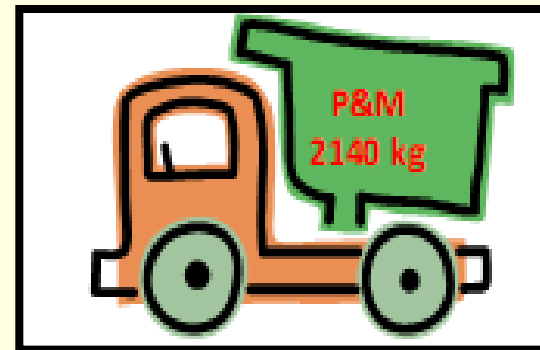
Results

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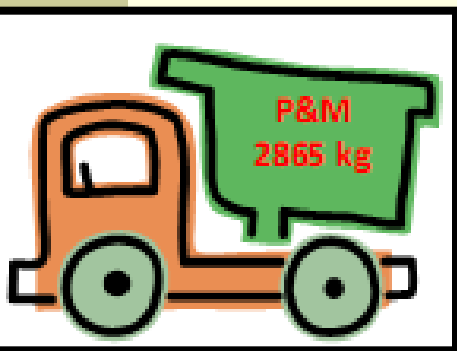
1st transportation
of containers



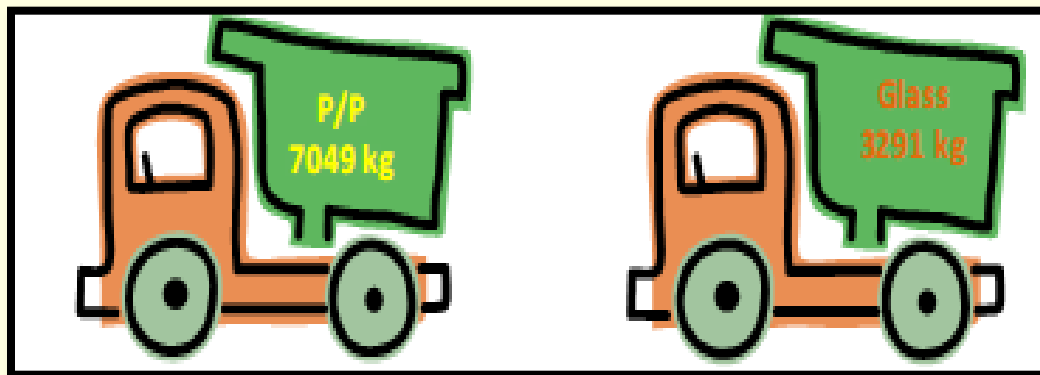
Data source 2 outcomes



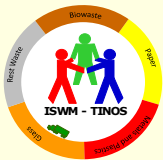
2nd transportation
of containers



3rd transportation
of containers



4th and 5th transportation of containers



Objective of ISWM scheme

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Data source 2 outcomes



3.291 kg glass



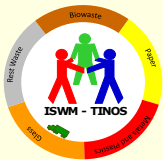
10.889 kg paper/paperboard



7.925 kg P & M

	Period	Days	Quantity received to the RSC (Kg)	Total packaging waste (including <u>mis</u> -sorted packaging) (kg)	Total packaging waste (without <u>mis</u> -sorted packaging) (kg)
1st container Plastic & Metal	10.06.2013 - 05.08.2013	56	2920.00	2366.51	2304.43
2nd container Plastic & Metal	05.08.2013 - 10.09.2013	36	2140.00	1691.74	1641.44
3rd container Plastic & Metal	10.09.2013 - 10.02.2014	153	2865.10	2190.18	2118.23
Total Plastic & Metal	10.06.2013 - 10.02.2014	245	7925.10	6248.43 kg 25.50 kg cap⁻¹ yr⁻¹	6064.10 kg 24.75 kg cap⁻¹ yr⁻¹
1st container Paper/Paperboard	10.06.2013 - 05.08.2013	56	3840.00	3593.44	3593.44
2nd container Paper/Paperboard	05.08.2013 - 14.02.2014	193	7049.10	7005.76	6570.39
Total Paper/Paperboard	10.06.2013 - 14.02.2014	249	10889.10	10599.20 kg 36.30 kg cap⁻¹ yr⁻¹	10163.83 kg 34.81 kg cap⁻¹ yr⁻¹
1st container Glass	10.06.2013 - 07.02.2014	242	3291.19	3225.37	3225.37
Total Glass	10.06.2013 - 07.02.2014	242	3291.19	3225.37 kg 11.37 kg cap⁻¹ yr⁻¹	3225.37 kg 11.37 kg cap⁻¹ yr⁻¹
Total source separated (kg)			22105.39	20625.18	20314.09
Total source separated (kg cap ⁻¹ yr ⁻¹)*			76.48	69.42	67.28
Total purity level (% w/w)			-	90.81%	88.00%

(*Considering a total population of 428 inhabitants within the implementation area of the ISWM scheme)



**Objective of
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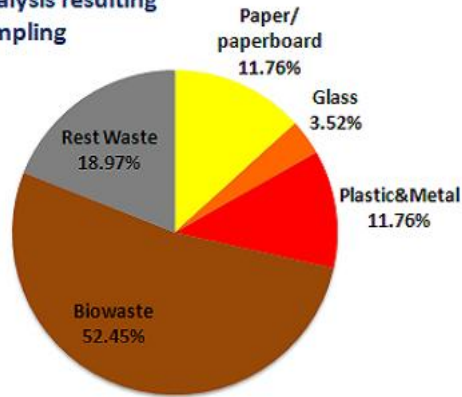
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Data source 3 outcomes

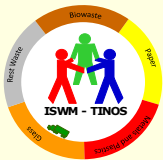
**Waste sampling studies
to collect quantitative and
qualitative data of MSW
generated in target area**

**MSW compositional analysis resulting
from waste sampling**



Waste Sampling Event	MSW	P/P	GLASS	P&M	BIOWASTE	REST WASTE
KG PER CAP PER DAY	1.193	0.158	0.042	0.140	0.626	0.226
KG PER CAP PER MONTH	35.795	4.744	1.260	4.211	18.773	6.790
KG PER CAP PER YEAR	435.503	57.719	15.335	51.236	228.402	82.607
PERCENTAGE OF MSW	100.00	13.25	3.52	11.76	52.45	18.97
TOTAL MSW KG of POPULATION –TARGET*	186,395.46	24,703.59	6,563.32	21,929.12	97,756.23	35,355.71

*Considering 428 inhabitants in the examined areas in Tinos Island



**Objective of
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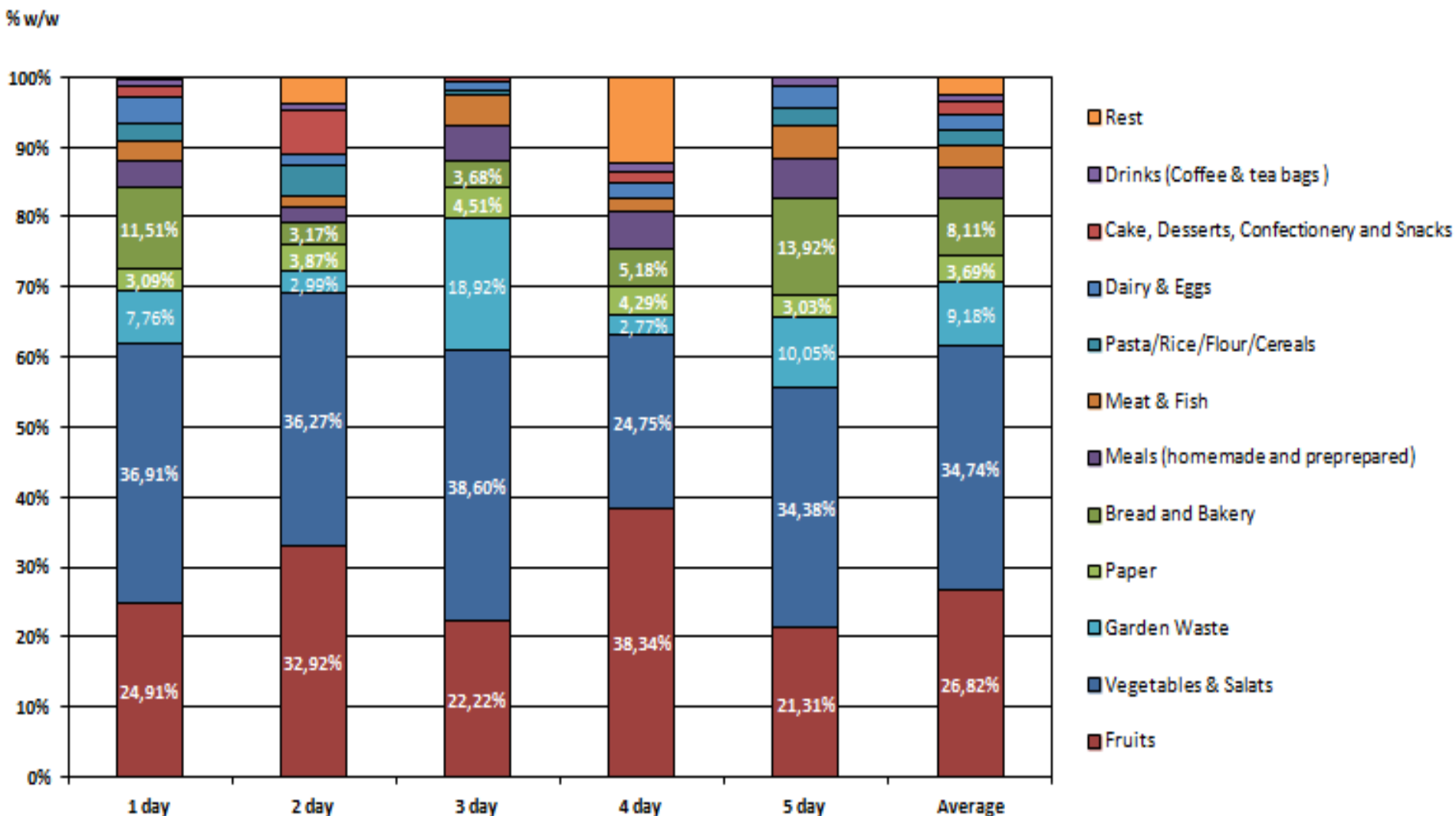
**Overview of
ISWM
scheme**

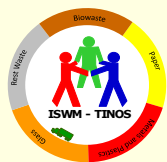
Methodology

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Data source 3 outcomes – Compositional analysis of biowaste





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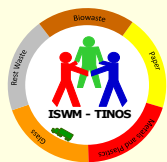
Results

Conclusions

Conclusions (1/2)

- ✓ The **total source separation ratio** of packaging waste during the examined period is equal to 15.45% which is considered satisfactory given the fact that 67.29 kg cap⁻¹ yr⁻¹ of the produced dry recyclables (i.e. packaging waste) is being effectively sorted.
- ✓ The 67.01 kg cap⁻¹ yr⁻¹ of segregated packaging waste in Tinos pilot scale scheme corresponds to an **overall recycling rate** of 54.14 % of generated packaging materials, which is lower than the EU-27 average of 62.5 % in 2011 and very close to the 2008-target of 55 % w/w.
- ✓ The packaging waste demonstrate an overall contamination rate equal to 12.00% w/w. This shows a satisfactory **purity level** regarding the effective treatment and recycling of waste materials.
- ✓ The participation rate was estimated at about 55% which indicates that the ISWM scheme working teams shall further encourage people to participate actively in the recycling program





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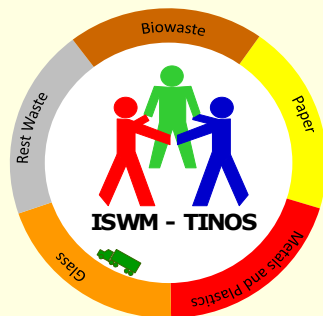
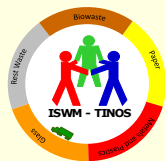
Conclusions (2/2)

- ✓ It is **expected that the participation level will increase** since after the set up of the bio-waste segregation scheme followed by appropriate training and awareness sessions, aiming to promote the updated scheme and to enhance the inclusion of more households to the existing recycling system.
- ✓ The **overall amount of packaging waste** that has been delivered to the RSC amounts to 22.1 tn, 2.0 tn of which is non recyclable impurities, while 0.6 tn is packaging material which has been mis-sorted (e.g. paperboard waste that was misplaced in the glass or plastic & metal packaging waste collection bin). Since the Recycling Sorting Center is able to treat commingled packaging waste, the overall Recycling Rate equals to 90.81% w/w, instead of 88.00 % w/w, indicative of the increased performance of the ISWM scheme in terms of packaging waste recycling.
- ✓ It can be concluded that the ISWM scheme is progressing effectively taking also into consideration that the recycling rate in existing Greek source separating schemes for packaging waste applied in various municipalities is between 50 to 60

% w/w .

ISWM-TINOS LIFE10 ENV/GR/000610





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

Thank you for your attention!

website:

<http://uest.ntua.gr/iswm-tinos/>

