

# **Implementation and evaluation of an integrated management scheme for MSW in Pyrgos & Panormos communities in Tinos Island, Greece**

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## **Abstract**

At present, the majority of Greek islands and other remote areas mainly rely on imports of goods and are still heavily dependent on landfilling their waste. This situation is closely related to widely highlighted challenges faced by waste management operators and represents serious risks for human health and the environment (Gidarakos et al, 2006; Falzon, 2012). Given the harsh, on-going, financial crisis in Greece and the huge financial penalties imposed due to numerous landfills which continue to operate in breach of EU waste and landfill legislation, careful consideration is needed in order to develop and implement viable and cost effective alternatives to land disposal, as there is no room for wasting money and time.

The geographical specificities of the islands, mountainous and sparsely populated areas which were recognised as ‘handicaps’, have been taken into particular consideration in the EU legislation. The most common features include the limited natural resources, limited access to economic or administrative centres and/or to the mainland, expensive transportation costs, low population density, seasonal fluctuations of waste due to visitors, limited land availability, unfavourable economies of scale and vulnerable ecosystems. Simultaneously, these territories have significant resources such as unique natural and cultural inheritance as well as great potential to develop tourist industry. To this end, the question is how the aforementioned ‘handicaps’ could be seen as opportunities so as to deal with these pressing demands, while at the same time allowing for local socio-economic development. Waste management is a concept that encompasses and is closely connected to all aspects of the natural and built environment of an area and can strongly affect its development. Thus, it is important to prioritise correctly in order to lead the way towards effective and sustainable solid waste management practices, keeping in mind that no ‘one size fits all’ approach can be followed, especially since island regions are characterised by important diversities (ADE, 2012; Monfort, 2009; Planistat Europe & Bradley Dunbar, 2003). The specific characteristics of each particular case should be examined separately with the aim of creating waste management plans tailored to meet the needs and challenges of the regions under examination. Ideally, based on the requirements of current EU and national legislation and what is considered viable in terms of small scale applications, the principles of ‘proximity and self-sufficiency’ should be the key drivers. To this direction, it is considered more sustainable that waste should be treated or disposed of close to the generation source, aiming to achieve self-sufficiency in treatment and disposal. Decentralised waste management operations are considered more preferable solutions as they can help avoid regional-scale complexity as well as future technological ‘lock-in’ (Chang & Pires, 2015).

The present paper presents a comprehensive methodology on the development and implementation of an integrated solid waste management (ISWM) scheme in line with the basic principles of the Waste Framework Directive 2008/98/EC, in selected areas of Tinos island, as well as the monitoring and evaluation activities applied, during the implementation phase of the scheme. The outcomes of the tailor-made ISWM scheme in the pilot demonstration area (i.e. Pyrgos & Panormos communities) were evaluated in order to provide guidance and develop an up-scaled model plan so as to cover the needs of the whole island of Tinos, possibly replicable for other remote areas with similar characteristics.

More specifically, considering a baseline of absent sustainable MSW practices, the objective of the developed scheme was to introduce a holistic and innovative waste management system in the study area. For this reason, the scheme was focused on the type and quantities of the dominant Municipal Solid Waste (MSW) streams (i.e. dry recyclables and biowaste accounting for more than 80 percent of total generated MSW) in order to employ sustainable collection,

treatment and subsequent safe disposal methods. The applied ISWM scheme was developed to serve a total population of 428 inhabitants, comprising two rural communities of Tinos island, Greece. The separate collection method for dry recyclables and biowaste was chosen, using pre-determined indoor and outdoor equipment by each household/shop/restaurant. The indoor equipment included reusable bags (10L) with different colour for each recyclable material (i.e. paper/paperboard, glass, plastic & metal) and kitchen baskets (10 or 40L) accompanied by biodegradable bags (10 or 40L) for the source separation of biowaste. The source sorted waste materials were transferred by the participants to dedicated outdoor bins of greater capacity (240 L for dry recyclables and 120 L for biowaste). Following, for the temporary storage of the source-sorted dry recyclables, separate containers were used which are transferred periodically to a Recycling Sorting Centre (RSC) in Attica in order to recover valuable materials, whereas the separately collected biowaste are treated on-site, in a prototype composting unit.

The achieved results during the implementation phase are encouraging. The ISWM scheme managed to acquire maximum social acceptance as a result of continuous dissemination activities. The monitoring and evaluation of the ISWM scheme concerning packaging waste (PW), lasted 24 months and the respective quantity recovered at the RSC was 28 tn yr<sup>-1</sup>. The recovery rates at the RSC for each target waste stream was 79% for plastics & metals, 94% for paper/paperboard and 98% for glass, contributing to an overall recovery rate of 90% (impurities 10%). This is considered very efficient given that existing RSC recovery ratios in Greece range between 50-60%. It is worth mentioning that the efficiency difference is mainly related to the source separation of PW in distinctive streams, compared to the commingle PW scheme which is commonly applied in Greece. In addition, the implementation of the project resulted in the following capture rates 22.5 kg cap<sup>-1</sup> yr<sup>-1</sup> for paper/paperboard, 11.4 kg cap<sup>-1</sup> yr<sup>-1</sup> for glass and 21.1 kg cap<sup>-1</sup> yr<sup>-1</sup> for plastics & metals. The related capture rates achieved by the ISWM scheme were 54.9 kg cap<sup>-1</sup> yr<sup>-1</sup> for total PW and 65.8 kg cap<sup>-1</sup> yr<sup>-1</sup> for total recyclables (including 10.9 kg cap<sup>-1</sup> yr<sup>-1</sup> of mixed paper). The source separation ratios achieved have been determined as follows: 90.5% for paper/paperboard (EU target 60%), 78.4% for glass (EU target 60%) and 57.4% for plastics and metals (EU target 22.5 % for plastics and 50% for metals) (Directive 2004/12/EC; Directive 94/62/EC). The source separation ratio for total PW equals to 72.2% (min. EU target 55% by 2012), while this percentage falls to 45.5% (EU target 50% by 2020) when considering total recyclables. In order to meet the EU goal, it is obvious that supplementary recycling methods are required (i.e. green points) to recover further recyclables apart from packaging waste. Furthermore, regarding the 12-month monitoring and evaluation of the ISWM scheme concerning biowaste, the capture rate was 15.5 kg cap<sup>-1</sup> yr<sup>-1</sup>, accounting for just 7% of biowaste generation rate. The low capture rate is attributed primarily to alternative diversion routes (mainly animal feed estimated at about 30% of biowaste) but also to the low participation level of large producers (i.e. restaurants). However, the impurities ratio for source sorted biowaste, was found very low (<1.5%), highlighting the effective source separation practiced by the residents of the study area. The estimated total source separation ratio equals to 82 kg cap<sup>-1</sup> yr<sup>-1</sup> (7% composting and 30% animal feed). Taking into consideration the above, the overall capture rate of the ISWM scheme amounts to 133 kg cap<sup>-1</sup> yr<sup>-1</sup>, accounting for 30.8% of MSW.

Regarding the full scale implementation of the ISWM project in Tinos island, an indicative allocation of MSW production was performed, considering the thirteen administrative Local Communes of the Municipality of Tinos. The current and planned waste treatment schemes which include small scale recycling schemes, restoration of former dumpsites, construction of a Waste Transfer Station for recyclables and mixed MSW baling and temporary storage until the construction of a new controlled landfill were also taken into account. The tonne-kilometers were assessed for each local community in order to correlate the quantity of waste streams produced and the distance required to be transported. Based on the above assessment a management plan for Tinos Island is proposed considering the current EU and national policy measures. For biowaste management, the basic framework for the up-scaled ISWM scheme will encompass methods of on-site management such as home-composting and animal feed practices, whereas source separation for composting is envisaged considering 3 decentralized composting systems, with overall target 40% of 2020 biowaste production. For recyclables, the full scale ISWM scheme will maintain three distinctive streams (i.e. paper/paperboard, glass, plastics & metals & rest packaging) as the source separation of the target materials is considered more effective in terms of further treatment, maintaining high purity levels per waste stream. Waste Transfer Station will serve the scheme for the compaction and temporary storage of the pre-sorted materials, while at the same time the creation of Green points (1 central & 1 small) is expected to enhance capture rates and successfully reach the overall goal of 65% recovery of recyclables. Finally, an issue is raised on the difficulties faced in complying with the provisions of the Landfill Directive which permit only 35% of Biodegradable Organic Waste production to be landfilled (quantity based on 1997 biowaste production) by 2020.

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