Final evaluation report with a comparative analysis of the results in both territories

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1. Introduction

Environmental, economic and social impacts of the pilot actions implemented in Fossalto and Ist Island to improve the organic waste management have to be evaluated in a sustainability perspective, according to WP5 of the NETWAP project. The comparison of the results achieved in both territories is helpful for validating the replicability and effectiveness of the implemented actions. In this deliverable the results obtained from the environmental, economic and social assessment of baseline and NETWAP scenarios, in Fossalto and in Ist Island, thoroughly described in Deliverable 5.2.1, are compared in order to pave the way for a deeper understanding of the benefits that can be gained by means of local composting. Deliverable 5.2.1 is the reference for further details about the applied methodology and about the assessment results. The current systems for treating the organic fractions of municipal waste are profoundly different in the targeted territories. In Fossalto, the separate collection of organic waste is already in place, with a door-to-door collection system, and wastes are transported to a composting facility located far from the village and managed by a regional company. In Ist Island, organic fraction is not sorted, therefore it is collected, transported and treated together with mixed waste. Transport of waste by ferry is necessary because waste treatment plants are not present on the island and so they need to be transported near Zadar, where mixed waste are landfilled. Therefore, the pilot actions implemented in the framework of the NETWAP project impact differently on the reference baseline scenarios.

2. Comparative analysis of the Life Cycle Assessment (LCA) results

The total characterised impacts, generated by the treatment of 1 ton of organic waste in the baseline scenarios of Fossalto and Ist Island on a selection of impact categories (namely, Global warming potential – GWP, Fine particulate matter formation potential – PMFP, Terrestrial acidification potential – TAP, Freshwater eutrophication potential – FEP, Marine eutrophication potential – MEP, Human carcinogenic toxicity potential – HTP_c, Mineral resource scarcity potential – MRS, Fossil resource scarcity potential – FRS, Water consumption potential – WCP), are listed in Table 1. The impacts have been quantified by means of the professional software SimaPro v.9.0.0.48 (Pre-Consultants), coupled with the EcoInvent v.3.5 database, selecting the ReCiPe Midpoint (H) impact assessment method (see D5.2.1 for further details).

Table 1. Characterized impacts generated from the treatment of organic waste in the baseline scenarios in Fossalto and Ist Island, referring to the selected FU (1 ton of treated organic waste).

Impact category	*Unit*	*Fossalto*	*Ist Island*
GWP	kg CO_2 eq	2783.58	1575.56
PMFP	kg PM2.5 eq	2.70	0.97
TAP	kg SO_2 eq	6.92	2.11
FEP	kg P eq	0.30	0.23
MEP	kg N eq	0.03	1.15
HTP_c	kg 1,4-DCB	89.70	75.76
MRS	kg Cu eq	15.62	18.40
FRS	kg oil eq	903.66	254.69
WCP	m^3	5.50	2.74

Even though of the same order of magnitude, the impacts generated in Fossalto baseline scenario are generally higher than the impacts in Ist Island, except for MEP and MRS impact categories. As highlighted in D5.2.1, transportation of waste (by truck) is the main hotspot in the baseline scenario of Fossalto. Therefore, the higher distance run in Fossalto generates an higher environmental load. Surprisingly, the transportation by ship needed for the organic waste in Ist Island does not affect the investigated impact categories at the same level as transportation by truck. Only the impact categories mostly affected by landfilling and by the temporary storage of waste on the island (MEP and MRS, respectively) result less impacted in the baseline scenario of Fossalto.

These results confirm that, from the environmental point of view, it is urgently needed a waste management system in which transportation is reduced. Likely, the solution proposed within the NETWAP project not only reduces the transportation by truck and eliminates the transportation by ship, but also affect the other identified hotspots in the Ist Island baseline scenario, such as the temporary storage of waste and the landfilling. With these premises, the implementation of the NETWAP organic waste management system is expected to achieve relevant environmental benefits in both pilot territories.

Table 2 shows the characterized ReCiPe Midpoint (H) impacts generated on a selection of impact categories by the treatment of 1 ton of organic waste in the NETWAP scenarios of Fossalto and Ist Island, in which the local composting is assumed to be regularly running.

Table 2. Characterized impacts generated from the treatment of organic waste in the NETWAP scenarios in Fossalto and Ist Island, referring to the selected FU (1 ton of treated organic waste).

Impact category	*Unit*	*Fossalto*	*Ist Island*
GWP	kg CO_2 eq	1380.55	666.20
PMFP	kg PM2.5 eq	1.37	0.68
TAP	kg SO_2 eq	3.52	1.65
FEP	kg P eq	0.18	0.08
MEP	kg N eq	0.02	4.73E-03
HTP_c	kg 1,4-DCB	85.40	20.43
MRS	kg Cu eq	2.69	3.21
FRS	kg oil eq	442.39	216.76
WCP	m^3	2091.75	1495.72

Also in these scenarios, the impacts generated in Fossalto baseline scenario are generally higher than the impacts in Ist Island, except for MRS impact category, due to the transportation phase that, although reduced in comparison with the baseline scenarios, remains the main hotspot. However, if we look at the reductions of the impacts shifting from the baseline to the NETWAP scenarios, a similar trend can be observed in both pilot territories (Figure 1).

In the NETWAP scenarios, the reduction of the impacts is particularly relevant (83% for both Fossalto and Ist Island) in the MRS impact category and similar reductions are achieved also in the GWP category (50% in Fossalto *versus* 58% in Ist). A relevant difference can be noticed in the HTP_c impact category: in Ist Island the reduction of the impact amounts to 73%, while is limited to 5% in Fossalto. Analogously, the impact on MEP category is totally cancelled in Ist pilot, while only reduced by 38% in Fossalto. On the contrary, Fossalto gains slightly higher savings than Ist Island in PMFP, TAP and FRS impact categories. For both pilots, the increase of the impact on the WCP category is evident: as detailed in D5.2.1, it is due to the electricity requirements of the local composting, but is very sensitive to the selected electricity flow.

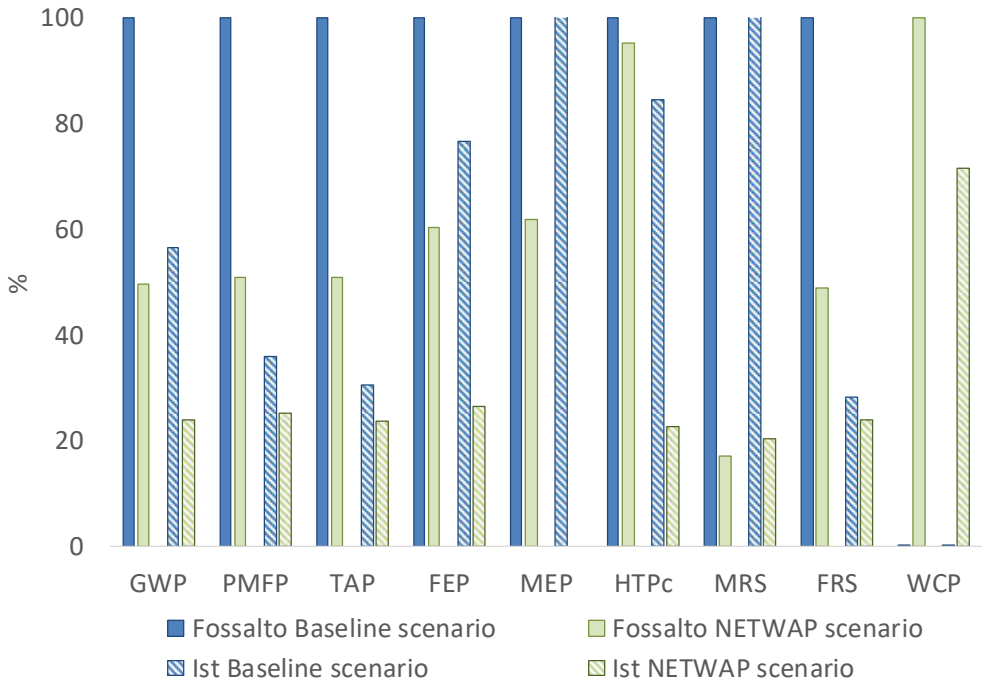

Figure 1. A comparative analysis of the baseline and NETWAP scenarios investigated in Fossalto and Ist Island pilot territories.

3. Comparative analysis of the Life Cycle Costing (LCC) results

As far as the LCC results are concerned, the internal costs of the investigated systems resulted strongly differing, amounting to 270.89 €/FU for the Fossalto baseline scenario and to 2019.23 €/FU for the Ist Island baseline scenario. The need of transporting waste by ship from Ist Island to the landfill on the mainland toughly affects the internal costs. However, this costs will not be sustained anymore, once the NETWAP pilot action will be regularly running, and the difference between the pilots will be softened.
Regarding the generated externalities, the environmental damage costs, referred to the selected FU (1 ton of treated organic waste), are shown in Table 3 for the baseline and NETWAP scenarios of Fossalto and Ist Island. The total environmental damage cost of baseline scenarios amounts to 5847 €/FU in Fossalto *versus* 7644.57 €/FU in Ist Island, while the values are reduced to 877.10 €/FU and 1147.05 €/FU in Fossalto and Ist Island NETWAP scenarios, respectively. In all the investigated systems, the safeguard subject of Abiotic resources determines most of the external costs. In detail, the effect of the materials

used for the containers of the deposit station, where organic waste is temporarily stored on the island, is strong enough to make the externalities of Ist Island higher than in Fossalto. Nevertheless, since most of the externalities are generated by the transportation of waste, as already highlighted for the environmental impacts by LCA, the implementation of the NETWAP pilot actions lower the total damage costs generated in both territories.

Table 3. Environmental damage costs for the baseline and NETWAP scenarios in Fossalto and Ist Island, referring to the selected FU (1 ton of treated organic waste).

Safeguard subject	*Unit*	*Fossalto baseline*	*Fossalto NETWAP*	*Ist Island baseline*	*Ist Island NETWAP*
Ecosystem services	ELU	10.47	5.42	2.68	2,60
Access to water	ELU	0.65	0.33	0.16	0,16
Biodiversity	ELU	0.04	0.02	0.01	0,01
Human health	ELU	473.36	222.12	132.54	111,51
Abiotic resources	ELU	5362.15	649.21	7509.17	1032,78

4. Comparative analysis of the Social Life Cycle Assessment (s-LCA) results

The two pilot cases analysed in the project present both similarities and differences in terms of geographic and socio-economic context and motivations for the implementation of the new technology; consequently, this should be considered when developing S-LCA.

From a technological and management point of view, NETWAP project suggested a similar organic waste management system for Fossalto and Ist Island. In both cases, organic waste is sorted by citizens and collected by door-to-door system, then waste is treated via composting plant located in the village and managed by the local authority. Both communities will benefit from a reduction of tariff for waste management and a reduction of emissions related to organic waste transport that will be treated locally. Moreover, new job position will be created for the new composting facility.

However, the main differences between the two pilot cases rely on the motivations and expectations related to the implementation of the new technology and management system. Ist Island is a touristic area and the high demand for more sustainable tourism is one of the main drivers for technological improvements; therefore, the main reasons for the implementation of the organic waste collection in Ist Island is to be attractive as eco-tourism location and to be in step with the current national programme

of islands' sustainability. Consequently, in addition to the direct benefits for citizens expressed before, a direct relation between sustainability improvements on the island and economic growth for the local population is expected in the mid-term. As for Fossalto, the new organic waste management system represents one of the first example of local action toward sustainability, so its role is to increase the environmental sustainability awareness of population as a first step. Consequently, it is too early to define potential benefits expected by citizens and local authorities in the mid- and long-term.

Outcomes from the three steps approach - identification of the method and suggested social topics, a desk research target to the sector, and interviews to partners - were integrated toward a clear and comprehensive list of stakeholders and social topics that could be considered to evaluate social impacts of the new waste systems. In terms of relevance, both case studies identified the same social topics, listed in Table 22 of Deliverable 5.2.1. In the case of Fossalto, the relevance of local community is not evident for the moment as in the case of Ist Island where local community is represented by actors of tourism sectors. However, as the level of awareness increases, this topic is likely to become important also in Fossalto case study. In terms of nature of effects – positive or negative - that are expected concerning the social topics, the two pilots provided different answers which are summarized in Deliverable 5.2.1. In some case, it is still not possible to identify the effect that will be produced by the new organic waste management system.

In conclusion, the Social LCA evaluation carried out for the pilot cases provided the following outcomes:

- A clear and comprehensive list of stakeholder and social topics relevant for the sector, that have been retrieved by the combination of literature research and interviews to project's partners;
- A list of indicators to monitor potential social issues that might arise when the two composters will be up and running, and a related reference scale for their scoring;
- A preliminary overview of the potential benefits related to the new organic waste management system in the two pilot cases – Fossalto (Italy) and Ist Island (Croatia).

In addition to results delivered by means of this deliverable, an excel worksheet (named "SOCIAL INDICATORS FOR NETWAP PROJECT") has been prepared including the comprehensive list of social topics and related indicators is provided as excel worksheet.