A system for leachate valorization based on renewable energy sources and minimized chemicals use - Social impact assessment

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Introduction

Landfilling is the predominant method of solid waste disposal, accounting for 80% of waste in developing countries. This process produces a liquid fraction called leachate. Leachate is formed when water percolates through the waste, picking up various dissolved and suspended substances. Generally, it can be characterized by high concentrations of organic and inorganic pollutants, but its' properties can vary significantly.

Europe produces large amount of leachate, which has a significant impact on the environment due to its composition. For every 115 tons of solid waste, approximately 10 m^3 of leachate is generated.

The LIFE LEACHLESS system, as a universal solution independent of the leachate composition, aims to treat leachate in situ via evaporation/condensation and forward osmosis in combination with a Renewable Energy Source (solar energy, biomass).

The system results in reducing the environmental impact associated with leachate generated at waste management activities. In addition, the system valorizes pollutant effluents by completely reusing the streams generated in the treatment process, with the minimum amount of chemicals.

The operation of LEACHLESS System was tested in two demonstration locations, in Greece and Spain and a Social life Cycle Assessment was implemented.

Exploring the LEACHLESS Technologies

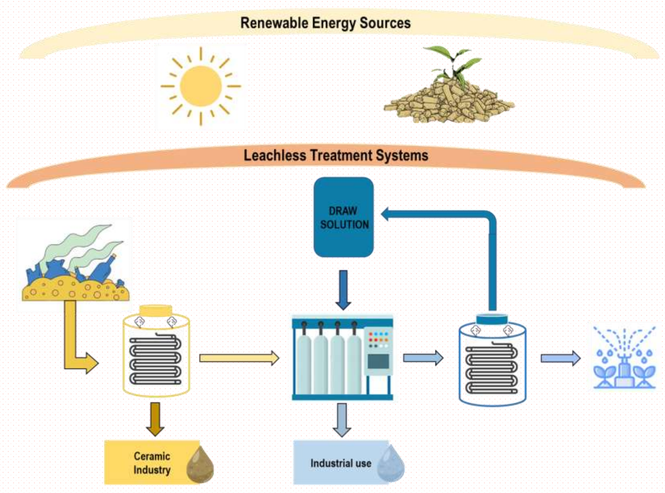


Figure 1: Flow diagram and end products of the leachate treatment system.

Results & Discussion

After 15 weeks of operation in a Greek Landfill, the treatment process resulted in an effective reduction of various pollutants in the final treated water. Parameters such as TSS, BOD_5, COD, total phosphorus, total nitrogen, and heavy metals were significantly reduced, with the majority of the analyzed values in the final effluent being within the permissible limits according to regulations. In addition, no E. coli was detected in the final effluent, indicating the successful elimination of harmful bacteria (Table 1).

	Limits	Leachate	Final Effluent
BOD_5 (mg/L)	25	1589	13
TSS (Total Suspended Solids)	35	1766	1.09
Copper (mg/L)	0.2	0.01	N/D
Cadmium (mg/L)	0.01	0.01	N/D
Chromium (Cr3+) (mg/L)	0.1	0.05	N/D
Manganese (mg/L)	0.2	0.13	N/D
Nickel (mg/L)	0.2	0.39	N/D
Lead (mg/L)	0.1	0.1	N/D
Zinc (mg/L)	2	0.17	N/D
Conductivity (mS/cm)	70-300	30	N/D
Total Nitrogen (mg/L)	15	4175	836
E.Coli (EC/100 ml)	<=5	99	N/D

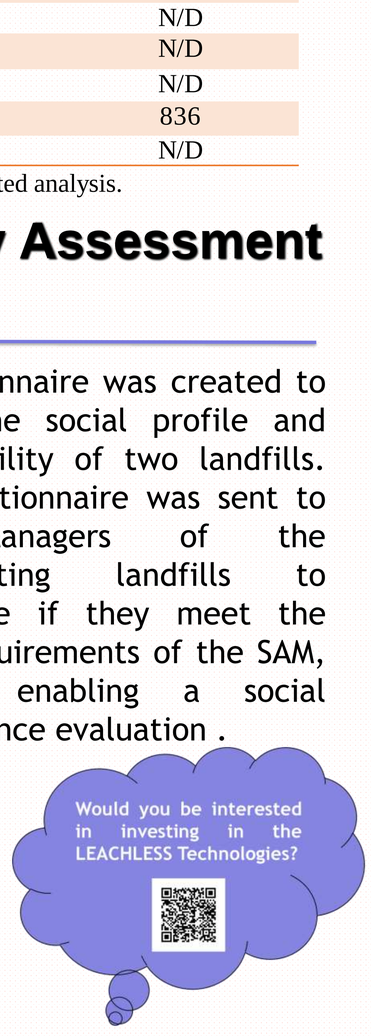
Table 1: Limits of irrigation water in comparison with the implemented analysis.

Site-Specific Analysis - Subcategory Assessment Method

Stakeholder	Impact	Indicator	Ano Liosia landfill	Zonzomas Environmental Complex
Worker	Child Labor	Percentage of working children under the legal age or 15 years old	A	A
	Working Hours	Number of hours effectively worked by employees (at each level of employment)	A	A
	Health and safety	Number/percentage of injuries or fatal accidents in the organization by job qualification inside the company	NA	NA
		Preventive measures and emergency protocols exist regarding accidents and injuries	A	A
		Appropriate protective gear required in all applicable situations	A	A
Local Community	Local Employment	Percentage of workforce hired locally	C	A
		Strength of policies on local hiring preferences	A	A
		Percentage of spending on locally based suppliers	A	A
	Secure Living Conditions	Number of legal complaints per year against the organization with regard to security concerns	C	C
	Access to material resources	Organizations and suppliers should meet environmental standards or certification schemes	A	NA

Table 2: Site-Specific Results

A questionnaire was created to assess the social profile and responsibility of two landfills. The questionnaire was sent to the Managers of the collaborating landfills to determine if they meet the basic requirements of the SAM, thereby enabling a social performance evaluation .



Social Hotspot Analysis of the LEACHLESS System Commodities- Social Footprint

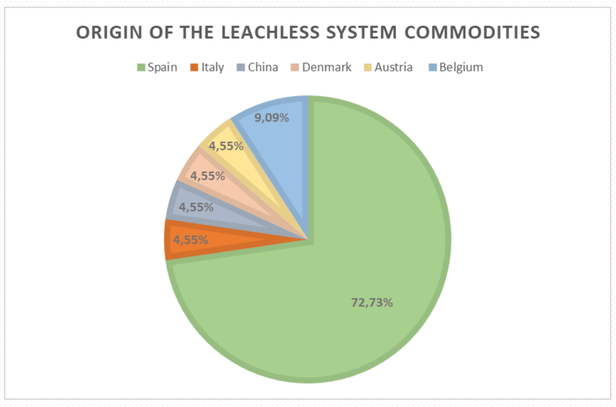


Figure 2:Origin of the LEACHLESS System Commodities

As seen from Figure 2, nearly 96% of the system's commodities are imported from European countries.

As seen from Figure 3, the social impact of the system's commodities is mainly influenced by Ferrous Metals.

26 55,845
Fe
Iron

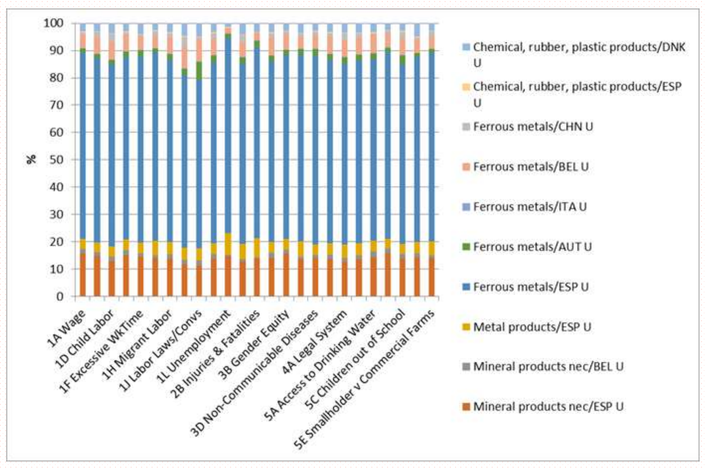


Figure 3: S-LCA results

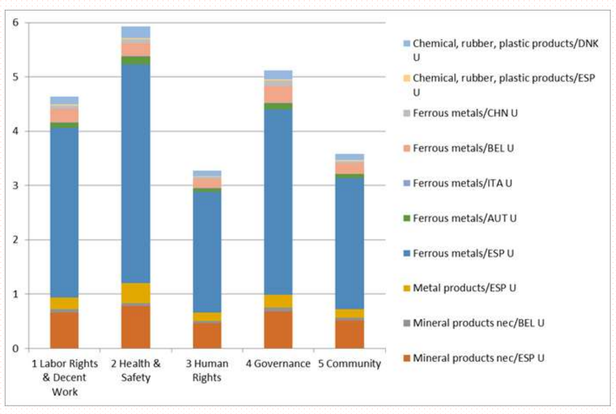


Figure 4: S-LCA Results

As seen in Figure 4 the social risks are distributed across all the impact categories, with Health & Safety and Governance, exhibiting the highest risks

Conclusions

Operational Results:

- The analysis of the final effluent showed that most of the values were within the permissible limits according to the regulation. The BOD_5 value was usually half of the prescribed limits, the TSS value was very low, and the heavy metals were usually not detected (less than 0.02 mg/L). In addition, E. Coli was not detected in the final effluent.
- The main problem of the final effluent seem to be the total nitrogen (TN), which was above the limits with concentration of 740-990 mg/L. To achieve lower levels of TN a pretreatment stage should be considered.

S - LCA Results:

- Based on the SAM scores, both landfills meet the basic requirements for the worker stakeholder groups. The Ano Liosia landfill demonstrates strong policies on local hiring and equal opportunities/discrimination, while the Zonzomas Environmental Complex scores lower due to a lack of annual hiring frequency.
- In both Spanish and Greek case studies, approximately 96% of the system's commodities are imported from European countries. Spain stands out as the primary supplier contributing around 72.73% of the system commodities. Belgium, Italy, China, and Austria contribute each 4,55% of the system's commodities.
- The social impact of the System is mainly influenced by Ferrous metals sourced from Spain, which have the greatest contribution. They affect all selected indicators in a similar manner, ranging from 61% to 69%. Additionally, Mineral products from Spain also play a noteworthy role, contributing between 11% and 15%. Ferrous metals from Belgium also make a significant contribution, although their impact on indicators such as Unemployment, Injuries, and Fatalities is relatively lower.
- The risk is evenly spread across various impact categories. with Health & Safety, Governance, and labor rights & decent work showing the most significant risks. In contrast, "Human Rights" presented comparatively lower risks. For instance, the overall financial value associated with "Ferrous Metals" from Spain is considerably larger (three to four orders of magnitude) than that of other commodities. Spain, as the origin country of these "Ferrous Metals," exhibited negative social impacts across all endpoint indicators.

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