Management and Monitoring of agricultural waste disposal by Local and Regional Authorities

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Two categories of agricultural wastes

- 1. Traditionally used (AW-TYPE1) applied mainly as soil improvers (manures, composts)
- 2. Potentially hazardous or hazardous wastes (AW-TYPE2), e.g. olive mill wastes, wastewater and sludge from food processing, a.o.

An Eight Steps strategic approach for managing AW at local/regional level

Traditionally used wastes (AW-type1)	Potentially-hazardous or hazardous wastes (AW-type2)
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- Step 1: Development of regional action plans and establishment of quality criteria
- Step 2: Physical, chemical, biological characterization of the organic materials
- Step 3: Adoption of soil quality indicators and thresholds
- Step 4: Development of Land Suitability Maps
- Step 5: Soil characterization-analyses
- Step 5: Assessment of risk level and development of remediation or landspreading plan
- Step 6: Quantification of cultivation targets and definition of cultivation practices
- Step 6: Quantification of landspreading-Doses estimation
- Step 7: Ensure safe reuse/disposal-Health protection and safe production
- Step 8: Periodical monitoring and risk evaluation during and after landspreading

Doula, M.K., Sarris, A., Hliaoutakis, A., Kydonakis, A., Papadopoulos, N.S., Argyriou, L.: Building a Strategy for soil protection at local and regional scale-the case of agricultural wastes landsprading. Envir. Monit. Assess. 188 (3), 1-14 (2016)



STEP 1 : Development of regional action plans and establishment of quality criteria

Recording areas' current status-Development of databases (inventories)

- Parameters: natural areas' characteristics, current and past land use, environmental status socioeconomic parameters aesthetic of the areas, social life
- Soil sampling following a well designed sampling campaign-Development of soil thematic maps
- Set local or regional priorities, quantified targets for each one of the parameters of priority, establishment of a set of appropriate indicators to be monitored

Development of local/regional plans

Definition of the appropriate land use Definition of level of quality that must be kept constant or improved



STEP 2 : Physical, chemical, biological characterization of the organic materials

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🕞 Quic	k Rating				ille:
			Measurement	Values	
	Organic Matter (OM), %		Boron (B)	mg/kg (ppm) 🗸	
	Organic Carbon (OC), %		Manganese (Mn)	% (g/100g) 🗸	
ŭ	pH		Cadmium (Cd)	mg/kg (ppm) 🖌	
	Electrical Conductivity (EC)	mS/cm (dS/m) 🗸	Chromium Total (Cr tot)	mg/kg (ppm) \vee	
	Moisture, %		Hexavalent Chromium (Cr VI)	mg/kg (ppm) 🗸	
5	O Dry Matter, %		Copper (Cu)	mg/kg (ppm) 🗸	
Wat	Total Nitrogen (N)	% (g/100g) 🗸 🗸	Mercury (Hg)	mg/kg (ppm) 🗸	
	Phosphorus (P)	% (g/100g) 🛛 🗸	Nickel (Ni)	mg/kg (ppm) 🖌	
	O Phosphorus Pentoxide (P2O5)	% (g/100g)	Arsenic (As)	mg/kg (ppm) 🖌	
ateria	Potassium (K)	% (g/100g) 🗸 🗸	Lead (Pb)	mg/kg (ppm) \vee	
ic M	O Potassium Oxide (K2O)	% (g/100g)	Molybdenum (Mo)	mg/kg (ppm) 🗸	
Orgar	Foreign Matter, %		Zinc (Zn)	mg/kg (ppm) 🗸	
	• Iron (Fe)	% (g/100g) 🗸 🗸	Selenium (Se)	mg/kg (ppm) 🗸	
	O Iron Oxide (FeO)	% (g/100g)	Fluoride (F)	mg/kg (ppm) 🗸	
	Sodium (Na)	% (g/100g) 🗸 🗸	Ammonium (NH4)	% (g/100g) 🗸	
	Chloride (Cl)	% (g/100g) 🗸 🗸	Phosphate (PO4)	% (g/100g) 🗸	
	• Calcium (Ca)	% (g/100g) 🗸 🗸	Sulfate (SO4)	% (g/100g) 🗸	
					Report
Agr Strategies					CMMT: Agrostrat Default Server



STEP 3: Adoption of soil quality indicators and thresholds

SOIL: Areas that have been identified as appropriate for waste reuse or disposal

establish a set of soil parameters (i.e. soil indicators for waste disposal) that will **be monitored periodically to assess soil quality**. By considering also legislative restrictions and literature data, authorities can establish a list of thresholds for soil parameters

- 1. sampling strategy should be designed and implemented by experts
- 2. identification of background levels of key soil parameters by using soil survey data of Step 1.
- 3. definition of the soil parameters that are most likely to be affected by waste reuse/disposal.

The Methodology in brief

- identification of background levels of key soil parameters by using soil survey data of Step 1. -establish a list of thresholds for soil
- definition of the soil parameters that are most likely to be affected by waste reuse/disposal. These parameters can be used as indicators for soil quality monitoring.
- collection of additional soil data from areas that already accept waste for almost one or two years.
- soil sampling every 2-3 months to ensure that all activities, which could have a detrimental effect on soil parameters will be recorded and assessed.
- Establishment of or find the thresholds of the selected indicators



STEP 4: Development of Land Suitability Maps

Provides authorities with data to define which areas among the potentially appropriate (Step 1) are indeed suitable to accept waste, in terms of soil quality, site characteristics and targets established during Step 1

Development of GIS-Land Suitability Maps- degree of suitability of each site to accept waste.

Suitability Classes S1 Highly Suitable	Description Land having no significant limitations to sustained application for waste disposal or reuse or only minor limitations. Nil to minor negative economic, environmental, health and/or social outcomes.
S2 Moderately Suitable	Land having limitations which in aggregate are moderately severe for sustained application of waste. Appreciably inferior to S1 land. Potential negative economic, environmental, health and/or social outcomes if not adequately managed.
S3 Marginally suitable	Land having limitations which in aggregate are severe for sustained application of waste. Moderate to high risk of negative economic, environmental, health and/or social outcomes if not adequately managed.
N1 Not Suitable	Land having limitations, which may be insurmountable. Limitations are so severe as to preclude successful sustained waste disposal or reuse. Very high risk of negative economic, environmental and/or social outcomes if not managed.
N2 Not Suitable	Land having limitations which appear so severe as to preclude any possibilities of successful sustained waste disposal or reuse in the given manner. Almost certain risk of significant negative economic, environmental and/or social outcomes

Land Suitability Classes according to FAO

Land Suitability Classes according to FAO (A Framework for Land Evaluation. Soil Resources Management and Conservation Service Land and Water Development Division: FAO Soil Bulletin No. 32. FAO-UNO, Rome.(1976))-Food and Agriculture Organization of the United Nations

STEP 4: Development of Land Suitability Maps

Parameters for land evaluation for pistachio solid waste/sludge disposal

	Property/parameter	Suitability Classes				
		S1	S2	S3	N1	N2
1	Drainage	A, B	С	D, E	F	G
2	Slope, %	A, B	С	D	Е	Е
3	Depth	6, 5, 4	3	2	1	1
4	Erosion	0, 1	2	3	4	4
5	Salinity, dS/m	< 2	2-4	4-8	>8	
6	Infiltration rate, cm/h	2-8	0.1-2.0	< 0.1		
_			8-16	16-50		
7	Cation Exchange Capacity	>15	8-15	<8		
	(CEC), meq/100g					
8	Exchangeable Sodium	0-6	6-10	10-15	15-25	>25
	Percentage (ESP), %					
9	Total Nitrogen, %	< 0.1	0.1-0.3	>0.3		
10	N-NO ₃ , mg/kg	<10	10-20	20-30	>30	
11	P-Olsen, mg/kg	<10	10-28	28-40	40-59	>59
12	Exchangeable K, cmol(+)/kg	< 0.26	0.26-1.2	1.2-2.0	>2.0	>2.0
13	DTPA Cu, mg/kg	<3	3.0-10	10-20	>20	
14	DTPA Zn, mg/kg	<2.9	2.9-8.1	8.1-13	> 13	
15	Polyphenols, mg/kg	<50			>50	





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STEP5

AW-TYPE 1. Soil characterization-analyses	AW-TYPE 2 Assessment of risk level and development of remediation or landspreading plan
 Farmers must perform chemical analyses to define the level of soil fertility as well as the nutrients that should be supplied for a specific type of cultivation Soil chemical analysis must be carried out annually 	 CONSIDERING land suitability maps Wastes can be applied without limitations in areas characterized as S1 and a management plan should be developed and implemented under the supervision of local authorities and the responsible governmental agencies. For areas belonging to S2, S3, N1 and N2 suitability classes, performance of a risk assessment study is recommended For areas characterized as S2 and S3 and following the results of the risk assessment and the degree of limitations as well as the restricted factors, authorities can decide if these areas can be included in the landspreading plans or if a remediation plan should be developed and applied. N1 and N2 areas must be excluded from the landspreading plans and an improvement or remediation plan should be developed and implemented.
	STEP 6
Quantification of cultivation targets and definition of cultivation practices	Quantification of landspreading-Doses estimation
 Then farmers should define and quantify their targets for the season or/and for longer period. Estimation of the amount of nutrients that must by supplied in order to achieve the defined targets, considering also the concentration of the nutrients in soil 	 Estimation of the optimum amount of each waste type that can be distributed at the suitable areas Ensure that the upper thresholds of the soil indicators (Step 3) will not be exceeded. The concentration of indicators in soil, in waste as well as the respective indicators' threshold should be known





STEP 9: Periodical monitoring and risk evaluation during and after landspreading

Monitoring the impact of AW disposal on soil through a systematically planned sampling scheme and aims to identify and continuously record the impact of waste landspreading on soil quality and the environment in the short and in the long term.

Authorities in cooperation with scientists and local waste users:

- Must design an effective **monitoring strategy** and implement it.
- Monitoring **soil quality indicators once a year** and preferably before wastes distribution (soil sampling and analysis). A technical report should be submitted to the responsible authorities. The report should also include a detailed description of the wastes' distribution plan (amount, timing, equipment used). Depending on the evaluation results, the responsible authorities may permit wastes disposal or not.
- Inventory establishment of each disposal site, which will be updated annually with all data submitted by the owners or/and the results of surveys performed by the authorities. This will facilitate the immediate identification of risky areas as well as, will provide data regarding history of the site, specific local geomorphological characteristics, amounts of waste that have been disposed each year, results of waste and soil chemical analyses and any other data that are considered useful and necessary for the effective protection of soil quality and function.

STEP 9: Periodical monitoring and risk evaluation during and after landspreading



A web GIS based application for soil data collection, processing and evaluation





The application provides temporal evaluation of the cultivated areas through comprehensive charts, or statistical data analysis on a spatial scale analysis, potential to visualize the analysis results and produce local/regional maps. The platform allows individual users to communicate through the "Cultivation Management Software" with the responsible local/regional authority and request directives and guidance about their cultivated fields or discharge areas.

STEP 9: Periodical monitoring and risk evaluation during and after landspreading



monitoring of the impact of AW disposal on soil through a systematically planned sampling scheme and aims to identify and continuously record the impact of waste landspreading on soil quality and the environment in the short and in the long term.



The application uses **interpolation surfaces** that indicate **the distribution of the different chemical parameters in the area of interest**, so the user can rapidly obtain an idea of the **diffusion of the chemical parameters and the degree of risk** in the vicinity of the waste disposal areas

Thank you for your attention

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