SUPPLEMENTARY MATERIALS

Article

Solid waste management in a context of sustainability, Sahuangal-Pichincha community, Ecuador

Supplementary Materials:

Table S1. Households survey regarding practices of physical solid waste characterisation.

Dear participant:

Thank you for your willingness to participate in this survey conducted by the **Universidad Estatal Península de Santa Elena (UPSE, an acronym in Spanish)** and the **Escuela Superior Politécnica del Litoral (ESPOL, an acronym in Spanish**) of Ecuador. This survey aims to gather relevant information on physical solid waste characterisation and local practices in the community of Sahuangal, in Pichincha province, Ecuador.

We request your authorisation to participate in this scientific article, the objective of which is to develop a strategic plan for solid waste management based on community participation, to promote guidelines that strengthen the separation, recovery and use of waste generated, incorporating diagnostic tools, technical evaluation and economic analysis.

Personal data protection- Consent form

The personal data collected through this survey will be processed by the researchers responsible for the study, in their capacity as data controllers, and will be used exclusively for academic, research, scientific and statistical purposes related to the study entitled:

'Solid waste management in a context of sustainability, Sahuangal commune – Pichincha, Ecuador'.

The information provided will be treated confidentially. The results of the study may be disseminated in technical reports, scientific articles, theses, or other academic media; however, the data will be presented in aggregate and anonymised form, so that it will not be possible to identify individual participants.

The legal basis for the processing of personal data is the free, specific, informed and unambiguous consent of the data subject, given by voluntarily agreeing to participate in this survey.
As the owner of the personal data, you may exercise your rights of access, rectification, updating, deletion, and withdrawal of consent at any time by writing to any of the following email addresses: bryan.coellochoez9328@upse.edu.ec ; grisherrera@upse.edu.ec ; lkbravo@espol.edu.ec
By selecting the 'AGREE' option, you consent to the processing of your personal data as described above.
Please select one option below:
☐ Agree
☐ Disagree

No.	Question
	Section 1. Respondent consent
1	**Do you authorise the use of the information provided in this survey for academic and research purposes?** a) Yes b) No
	Section 2. General information
2	**In terms of race or ethnicity, which of the following do you identify with?** b) Indigenous c) Black or African American d) White e) Prefer not to respond
3	**How many people currently live in your household, including yourself?** Please indicate the number: _____
4	**What is your highest level of education?** a) Incomplete primary education b) Complete primary education

	c) Incomplete secondary education d) Complete secondary education e) Higher education (technical, technological or university) f) Other (please specify): _____
5	**Which age range do you belong to?** a) Under 18 years b) 18–29 years c) 30–39 years d) 40–49 years e) 50–59 years f) 60 years or older
6	**Which of the following options best describes your gender?** a) Male b) Female c) Prefer not to answer
7	**How long have you lived in this community?** a) Less than 1 year b) 1–5 years c) 6–10 years d) 11–20 years e) 21–30 years f) More than 30 years
8	**What is your main socio-economic activity?** a) Agriculture b) Livestock farming c) Trade d) Formal employment (public or private sector)

	e) Informal employment f) Student g) Unemployed h) Other (please specify): _____
9	**Do you know what organic and inorganic waste are?** a) Yes b) No
	Section 3. Physical solid waste characterisation
10	**What type of waste is generated most frequently in your household?** Please specify: _____
11	**Do you know the meaning of organic waste?** a) Yes b) No
12	**Do you know the meaning of inorganic waste?** a) Yes b) No
13	**Which types of solid waste do you generate most frequently in your household?** Please rank from 1 (most frequent) to 3 (least frequent): a) Organic (food waste, crop residues) b) Recyclable inorganic (plastics, paper) c) Non-recyclable inorganic d) Other (please specify): _____
14	**What are the main sources of your organic solid waste?** Please rank from 1 (most frequent) to 3 (least frequent): a) Food waste (eggshells, vegetable scraps, fruit peels) b) Agricultural crop residues (plantain, cassava, cocoa peels) c) Other (please specify): _____
15	**What are the main sources of your inorganic solid waste?** Please rank from 1 (most frequent) to 5 (least frequent):

	a) Plastics b) Paper/cardboard c) Glass d) Metals e) Other (please specify): _____
	Section 4. Current Solid Waste Management (SWM) Practice
16	**What do you do with the organic waste you generate?** a) Use it for composting or fertiliser b) Leave it for collection with general waste c) Burn it d) Do not give it any specific use e) Other (please specify): _____
17	**What do you do with recyclable inorganic waste?** a) Separate it and sell or donate it b) Mix it with general waste for collection c) Burn it d) Do not separate it or give it any specific use e) Other (please specify): _____
18	**What do you do with non-recyclable inorganic waste?** a) Bury or burn it b) Leave it for general collection c) Do not give it any specific management d) Other (please specify): _____
	Section 5. Perception of SWM
19	**Do you consider it important to separate organic and inorganic waste in your household?** a) Yes

	b) No
20	**What barriers do you identify for implementing waste separation in your household?** a) Lack of information on how to do it b) Insufficient space c) Lack of a separate collection system d) Lack of interest e) Other (please specify): _____
21	**Would you be willing to participate in a community-based waste management programme (separation, composting, recycling)?** a) Yes b) No
22	**If you had access to a community compost bin, would you use this service for your organic waste?** a) Yes b) No
	Section 6. Circular Economy Criteria in SWM
23	**Have you previously participated in recycling programmes?** a) Yes b) No
24	**Which recyclable materials would you be willing to separate and deliver to a recycling system?** a) Plastics b) Paper and cardboard c) Glass d) Metals e) Other (please specify): _____
25	**Would you be willing to sell recyclable materials at affordable prices to generate income for the community?** a) Yes b) No

26	**What recommendations do you have regarding solid waste management as residence?** Please specify: _____
27	**Have you received any training, talks or support related to organic solid waste management from the government, local authorities or other institutions?** a) Yes (please specify): _____ b) No

Table S2. Physical characterisation data sheet for solid waste in the typical household of Sahuangal Commune.

Components	Weight (kg)				Total percentage (%)
	Gross weight (Week 1)	Gross weight (Week 1)	Tare / Plastic bag	Total	
Mixed Paper	0.00	0.00	0.00	0.00	0.00
High-Grade Paper	0.00	0.00	0.00	0.00	0.00
• Computer Printouts	0.00	0.00	0.00	0.00	0.00
• Other Office Paper	0.00	0.00	0.00	0.00	0.00
Newsprint	0.00	0.00	0.00	0.00	0.00
Corrugated Cardboard	0.00	0.00	0.00	0.00	0.00
Plastic	0.00	0.00	0.00	0.00	0.00
• PET Bottles	0.46	0.60	0.00	1.06	6.14
• HDPE Bottles	0.00	0.00	0.00	0.00	0.00
• Film	0.00	0.00	0.00	0.00	0.00
• Other Plastics	0.00	0.00	0.00	0.00	0.00
Food Waste	1.17	0.99	0.00	2.16	12.58
Wood	0.00	0.00	0.00	0.00	0.00
Other Organics	0.00	0.00	0.00	0.00	0.00
• Green Peelings	1.24	1.19	0.00	2.43	14.12

• Cassava Peelings	0.78	0.84	0.00	1.62	9.43
• Fruit Peelings	1.76	2.25	0.00	4.01	23.32
• Other Peelings	0.91	0.87	0.00	1.78	10.36
Ferrous	0.00	0.00	0.00	0.00	0.00
• Tins	0.00	0.00	0.00	0.00	0.00
• Other Ferrous Materials	0.00	0.00	0.00	0.00	0.00
Aluminium	0.00	0.00	0.00	0.00	0.00
• Tins	0.39	0.39	0.00	0.78	4.54
• Aluminium Foil	0.00	0.00	0.00	0.00	0.00
• Other Aluminium Materials	0.00	0.00	0.00	0.00	0.00
Glass	0.00	0.00	0.00	0.00	0.00
• Clear/Transparent	1.56	1.79	0.00	3.35	19.51
• Brown	0.00	0.00	0.00	0.00	0.00
• Green	0.00	0.00	0.00	0.00	0.00
Other inorganic compounds	0.00	0.00	0.00	0.00	0.00
TOTAL	8.26	8.92	0.00	17.18	100.00

Tabla S3. Survey of expert panel for AHP method regarding Solid waste management in Sahuangal Commune

Thank you for your willingness to participate in this survey conducted by **the Universidad Estatal Península de Santa Elena (UPSE, an acronym in Spanish)** and the **Escuela Superior Politécnica del Litoral (ESPOL, an acronym in Spanish**) of Ecuador. The survey aims to gather relevant information on solid waste management in the community of Sahuangal, in Pichincha province, Ecuador. The results will support an academic study focused on analysing current practices, community perceptions and opportunities for improvement in environmental and sustainability matters.

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By selecting the 'AGREE' option, you consent to the processing of your personal data as described above.

Please select one option below:

☐ Agree

☐ Disagree

Number	Question
1	**Do you authorise the use of the data provided in this survey for academic and research purposes?** a) Yes b) No
2	**Select your age range** a) 25 to 35 years old b) 35 to 45 years old c) Over 45 years old
3	**Indicate your years of experience in environmental issues or solid waste management:** a) No experience b) 1 to 5 years of experience c) 5 to 10 years of experience d) More than 10 years of experience
4	**Select the sector in which you carry out your main activity:** a) Public sector b) Private sector c) Academia/research d) Other (specify)
5	**Based on your experience, how important do you consider community participation to be for solid waste management in rural areas? Rate from 1 to 5.** **Scale 1 (not important at all) - 5 (very important)**
6	**What do you think is the main barrier to implementing waste separation in rural communities?** a) Lack of information and training by local authorities

	b) Lack of institutional coordination c) Lack of separate collection systems d) Economic or infrastructure limitations e) Lack of interest among the population f) Other (specify)
7	**Do you consider the implementation of community compost bins in rural communities to be feasible?** a) Yes b) No
8	**If you answered 'No' to the previous question, please specify the reason**
9	**Do you believe that the sale of recyclable materials (plastics, paper, glass, metals, others) can be a sustainable strategy for generating additional income in rural communities?** a) Yes b) No
10	**If you answered 'No' to the previous question, please specify the reason**
11	**In your opinion, what strategy should be prioritised to strengthen waste management in rural communities? You may choose more than one option.** a) Community education and awareness b) Collection systems: separate sorting c) Organic waste recovery (composting) d) Marketing of recyclables e) Other (please specify)
12	**What recommendations would you give to local decision-makers (GAD, state institutions, NGOs) to strengthen solid waste management in rural communities?**

13	**What aspects do you consider most relevant for the design of collection structures for recyclable and organic waste in a rural community? Rank them in order of importance from 1 to 5.** a) Storage capacity b) Ease of access and transport c) Locally available materials d) Construction cost e) Other (specify in the following question)
14	**Specify the aspect I consider relevant in the previous question**
15	**What size of infrastructure do you consider appropriate for a collection facility for recyclable waste in a rural community?** a) Small (suitable for collection by motorbike or small pick-up truck) b) Medium (suitable for collection with a light goods vehicle) c) Large (suitable for collection with a larger capacity municipal collection lorry) d) Not applicable, depends on the amount of waste generated e) Other (please specify)
16	**What type of materials do you consider most suitable for the construction of a community compost bin in a rural community with limited resources? Rank in order of importance from 1 to 6.** a) Wood and cane b) Brick and cement c) Wood and wire mesh d) Recycled materials (plastic, metal, etc.) e) Other (specify)

17	**Which of the following structural characteristics do you consider most important to ensure the effectiveness of a community compost bin in a rural setting?** a) Modular and flexible structure b) Good ventilation to accelerate the composting process c) Accessibility for users (ease of waste management) d) Ease of maintenance and turning of the compost e) Drainage system for leachate f) Other (specify in the following question)
18	**Specify the aspect I consider relevant in the previous question**
19	**In your experience, thinking about low-income rural communities, what alternatives do you consider most appropriate with regard to the composting model and the accessibility of the collection station for recyclable materials (glass, plastic, cans)? Please choose one option for the composting model and one option for the accessibility of the collection station.** a) Composting model: Domestic composting (in each household) b) Composting model: Decentralised community composting (with small composting stations) c) Composting model: Centralised community composting (with a single large composting plant) d) Collection station accessibility: Accessible from all areas of the community e) Collection station accessibility: Accessible only from certain key areas f) Collection station accessibility: Accessible only to certain members of the community g) Other (please specify)
20	**What elements do you consider key to ensuring community acceptance of the use and maintenance of the community compost bin? You may choose more than one option.** a) Education and training in organic waste management.

	b) Active participation of community members in the process. c) Direct benefits for the community (e.g., use of compost on crops). d) Other (please specify).
21	**What types of incentives do you consider most effective in encouraging the separation of recyclable and organic waste in rural communities? You may choose more than one option.** a) Economic benefits (sale of recyclable materials and compost) b) Training and awareness-raising on the benefits of composting and recycling c) Implementation of minor penalties for those who do not separate waste correctly d) Other (specify)
22	**Do you consider the composting and collection systems proposed in this study (based on local materials, modular design, with decentralised collection systems) to be viable in the rural context of the Sahuangal community?** a) Yes, entirely feasible b) Yes, but with adjustments c) No, not feasible in this context d) Other (please specify)
23	**If you answered 'Yes, but with adjustments' or 'Other' to the previous question, please specify the adjustments you consider relevant.**

Table S4. Criteria comparison matrix for the design of structures (collection, recycling and composting)

	Criteria Comparison Matrix										Normalised Matrix										Σ	(Wi)	%
Criteria	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10													
D1	**1.00**	1.00	2.44	0.96	0.98	1.32	1.06	0.94	1.55	1.26	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.12	1.15	0.12	12%
D2	1.00	**1.00**	2.44	0.96	0.98	1.32	1.06	0.94	1.55	1.26	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.12	1.15	0.12	12%
D3	0.41	0.41	**1.00**	0.39	0.40	0.54	0.43	0.39	0.64	0.51	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.47	0.05	5%
D4	1.05	1.05	2.56	**1.00**	1.02	1.38	1.10	0.99	1.62	1.31	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	1.20	0.12	12%
D5	1.02	1.02	2.50	0.98	**1.00**	1.35	1.08	0.96	1.59	1.29	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	1.18	0.12	12%
D6	0.76	0.76	1.85	0.72	0.74	**1.00**	0.80	0.71	1.18	0.95	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.87	0.09	9%
D7	0.95	0.95	2.31	0.91	0.93	1.25	**1.00**	0.89	1.47	1.19	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	1.09	0.11	11%
D8	1.06	1.06	2.59	1.01	1.04	1.40	1.12	**1.00**	1.65	1.33	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	1.22	0.12	12%
D9	0.64	0.64	1.57	0.62	0.63	0.85	0.68	0.61	**1.00**	0.81	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.74	0.07	7%
D10	0.80	0.80	1.94	0.76	0.78	1.05	0.84	0.75	1.24	**1.00**	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.92	0.09	9%
Total (N)	**8.69**	**8.69**	**21.20**	**8.31**	**8.50**	**11.46**	**9.17**	**8.18**	**13.49**	**10.91**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**10.00**		**100%**

Table S5. Criteria comparison matrix for the strategic criteria for the SWM pilot plan

	Criteria Comparison Matrix								Normalised Matrix								Σ	(Wi)	%
Criteria	L1	L2	L3	L4	L5	L6	L7	L8											
L1	**1.00**	2.25	0.97	0.97	1.48	3.16	0.97	1.20	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	1.27	0.16	16%
L2	0.45	**1.00**	0.43	0.43	0.66	1.41	0.43	0.53	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.56	0.07	7%
L3	1.03	2.32	**1.00**	1.00	1.53	3.27	1.00	1.24	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	1.29	0.16	16%
L4	1.03	2.32	1.00	**1.00**	1.53	3.27	1.00	1.24	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	1.29	0.16	16%
L5	0.68	1.52	0.65	0.65	**1.00**	2.14	0.65	0.81	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.85	0.11	11%
L6	0.32	0.71	0.31	0.31	0.47	**1.00**	0.31	0.38	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.40	0.05	5%
L7	1.03	2.32	1.00	1.00	1.53	3.27	**1.00**	1.24	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	1.29	0.16	16%
L8	0.83	1.87	0.81	0.81	1.23	2.64	0.81	**1.00**	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1.05	0.13	13%
Total (N)	**6.37**	**14.31**	**6.17**	**6.17**	**9.43**	**20.16**	**6.17**	**7.64**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**8.00**		**100%**

Table S6. AHP consistency analysis for the criteria comparison matrix of collection, recycling and composting structures

Parameter	Calculation / Criterion	Result
λ máx	**Σ (N*Wi)**	10.0029
CI	**(λ máx - n) / (n - 1)**	0.00032
RI	**Saaty**	1.49
CR	**CI/RI**	0.0002
Valid when	**CR < 10**	Valid

Table S7. AHP consistency analysis for the strategic criteria for the SWM pilot plan

Parameter	Calculation / Criterion	Result
λ máx	**Σ (N*Wi)**	8.02
CI	**(λ máx - n) / (n - 1)**	0.0030
RI	**Saaty**	1.41
CR	**CI/RI**	0.0021
Valid when	**CR < 10**	Valid