Solid Waste Management needs of humanitarian sector that could potentially be addressed by bio-based solutions

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Bio-based solutions in humanitarian contexts to address SWM issues

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Welcomed by many in the humanitarian sector, especially if:

- **Sustainable**
  - → addressing **environmental, economic, and social factors**
  - → be adaptable to **local conditions**
  - → provide **long-term benefits** without unintended negative consequences

- Utilize **local resources and knowledge** → **locally appropriate** → local empowerment

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Bio-based solutions in humanitarian contexts to address SWM issues – general examples

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- **Composting systems for organic waste**

  →to reduce the volume of waste going to landfills;

  →to produce valuable fertilizer for local agriculture or reforestation efforts.

- **Anaerobic digestion** of organic waste can produce biogas → a clean cooking fuel or for electricity generation.
- **Biodegradable packaging** (e.g. Materials from plant-based sources like corn starch or sugarcane bagasse, mycelium-based materials (fungal networks), and **products** (e.g. containers made from materials like bamboo, corn starch, or other plant-based sources);

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Bio-based solutions in humanitarian contexts to address SWM issues – general examples

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- **Bioremediation:** microorganisms or plants to break down contaminants in soil or water bodies affected by improper waste disposal.
- **Upcycling organic waste** into useful products like paper from agricultural residues, textiles from fruit peels; constructions material from plastics.
- **Biopesticides and natural fertilizers** - organic waste to produce natural pest control solutions and fertilizers, reducing chemical waste and improving soil health.

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Possible alternatives for humanitarian items (Non Food Items - NFIs)

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- **Construction material** (e.g. mycelium composites for insulation panels, bricks, and other structural components for shelters);
- **Energy production** (e.g. bioenergy such as biodigesters converting organic waste into biogas);
- **Water purification** (e.g. bio-based water filters from e.g. natural fibres);
- **Agriculture and food security** (e.g. bio-fertilizers and soil enhancers from compost and other organic waste products);
- **Textiles and clothing** (e.g. sustainable textiles from e.g. natural fibres).

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Bio-based solutions in humanitarian contexts
Alternatives to petroleum packaging

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Figure 1. Most commonly used alternatives to conventional plastics in packaging.
Source: Joint Initiative for Sustainable Humanitarian Assistance Packaging Waste Management, 2023, p. 4

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Bio-based solutions in humanitarian contexts
Existing bio-based solutions identified through primary data collection

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Bio-based practices of surveyed HOs	Bio-based practices identified in DRC & South Sudan

International HOs
• Use of biodegradable cups and bags (PIN)
• Exploring biogas digesters (Acted, PIN in Zambia)
• Bioremediation (MONUSCO)
National HOs
• Integrated soil fertility management through production of organic fertilizer from household waste and crop residues (CADIBUasbl, ASOV, LM International South Sudan, Actions des Femmes pour les Initiatives de Developpement)
• Set up of biogas digesters in camps to transform biomass into fertilizer and biogas (HF-AFRICA)
• Transformation of charcoal dust into briquettes for cooking (FAPROS)
	• **Animal feed** production
	  ○ Black soldier flies' larvae feeding on organic waste (IITA, UOB, AALI, BK)
	  ○ Fish feed from organic waste (household level; mode of expired food destruction by Provincial Environmental service)
	• **Biogas** production in biodigesters (Diobas, UOB, UNIGOM, Carnak Tobacco)
	• **Bio-charcoal** production from different wastes:
	  ○ Carton (BK)
	  ○ Mixed organic household or field waste (RDG, UNIGOM)
	  ○ Sugarcane husks (GIZ)
	• **Fertilizer** and **compost** from organic waste
	• **Ignition stimulant** produced from paper waste (BK)
	• **Mushroom growing** on agricultural waste.

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Bio-based solutions in humanitarian contexts
Existing bio-based solutions identified through primary data collection

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Methodology of the assessment – research questions

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I. What **types and quantities of waste** exist in humanitarian settings?

II. What is the **current state of SWM** (infrastructure and systems) in humanitarian settings?

III. What are the **challenges and opportunities** for SWM in humanitarian settings?

IV. What are the **main needs** of HOs regarding SWM?

V. What are the **opportunities** for making operations of HOs greener and more environmentally friendly?

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Methodology of the assessment

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- The preparation, conduct and report writing from March 2024 to July 2024

Secondary data:

Literature review, including grey literature:

- Reports from humanitarian actors: international HOs, ICRC, IFRC, RC, UN agencies, clusters, donors;
- SWM manuals, guidance, standards and toolkits;
- Donors' environmental requirements and recommendations documents;
- Recordings and transcripts from different environmental sessions and meetings;
- Data from global and national clusters;
- Baselines mainly published by WREC and Joint Initiative on Sustainable Humanitarian Assistance Packaging Waste Management (JI);
- National, provincial, and local legislation, including bills and by-laws, regulating SWM in South Sudan and DRC – published by the office of the president, national ministries, and provincial governorate office (Provincial sub-law).

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Methodology of the assessment – Primary data (South Sudan and DRC)

- **Quantitative survey with International and National HOs**

	DRC	South Sudan	EU-level	Total
National	10	9	-	**19**
International	3	2	5	**10**
Total	**13**	**11**	**5**	**29**

International: Acted, ACF, CRS, Christian Aid, Malteser International, MONUSCO, PIN, PAH, Save the Children, and Tearfund

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Methodology of the assessment – Primary data (South Sudan and DRC)

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- **Qualitative KIIs and FGDs with representatives of 5 stakeholder groups (DRC, South Sudan, global)**

5 different settings – global, urban, semi-urban, rural, and Internally Displaced People (IDP) camps

Method & respondent	DRC	South Sudan	Global	Total
KIIs with academia	4	2	-	**6**
FGDs with communities	7	1	-	**8**
KIIs with local leaders	4	1	-	**5**
KIIs with local government	3	5	-	**8**
KIIs with national/provincial government	3	2	-	**5**
KIIs with humanitarian actors	5	6	2	**13**
KIIs with businesses	6	1	-	**7**
FGDs with businesses	-	1	-	**1**
Total	**32**	**19**	**2**	**53**

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Methodology of the assessment – Primary data (South Sudan and DRC)

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- **Observations of solid waste**

	Urban	Semi-urban	Rural	IDP camp	Total
DRC	2	1	1	4	**8**
South Sudan	3	7		1	**11**
Total	**5**	**8**	**1**	**5**	**19**

- ✓ 6 official landfills (Musigiko in DRC; Jansuk, Rwonyi, Yei road and Nimule road in South Sudan)
- ✓ 6 unofficial landfills/accumulated waste (Bulengo IDP camp, Juba Way Station IDP camp, Yei)
- ✓ 2 observations of WMA (waste management area / *zone de déchet*) in health facilities (Kamanyola HC, Lemera GH)
- ✓ 3 humanitarian waste collections (Juba, Yei)
- ✓ 1 observation of waste from a distribution located at HO premises
- ✓ 1 observation of plastic transformation business located in an IDP camp

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Main SWM challenges identified in humanitarian context

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- Lack of **SWM infrastructure and services** (e.g. recycling) with either non-existent or nascent official waste transformation system;
- Lack of **national policies** regulating SWM, or their **enforcement**;
- No **strategic planning** for SWM;
- Lack of **coordination/linkages among SWM stakeholders** (including HOs) and actors tend to work in silos, e.g. waste collectors do not create linkages with waste transformers.
- Lack of **financial and human capacities and policies** of HOs to implement sustainable SWM (not a priority);
- Lack of **sustainable humanitarian procurement/supply chains**;
- **Technical capacity** of all actors in SWM is low;
- General **lack of quality waste data**, monitoring and research both on the side of governments, academia, private sector and Hos;
- Lack of **SWM awareness & mentality** – low perception of responsibility.

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Waste in humanitarian settings

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Humanitarian waste interconnected with global waste in humanitarian settings

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- Humanitarian waste X general waste in humanitarian settings

- Humanitarian trends

a) **cutting the use of HOs' logos** on aid supplies and infrastructure;

b) replacing distribution of non-food items by **cash (cash and voucher distributions)** → the waste generated by the purchases at local markets can also by extension be considered as humanitarian waste.

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Humanitarian waste

Non-hazardous waste	Hazardous waste
Plastic waste (mostly from packaging) 1 PET (Polyethylene Terephthalate) (e.g. oil, water bottles, packing strap) 2 HDPE (High-Density Polyethylene) (e.g. milk bottle, detergent recipient, buckets, plastic pallet) 3 PVC (Polyvinyl Chloride or Vinyl) (e.g. window frames, pipes, cables) 4 LDPE (Low Density Polyethylene) (e.g. shopping bags) 5 PP (Polypropylene) (e.g. woven bags, bins, brooms, cables, plastic pallet, packing straps, bottle tops) 6 PS (Polystyrene) (e.g. cups and plates, egg cartons) and EPS (Styrofoam or extended polystyrene) (e.g. plates and cup containers, trays, packaging bubble wrap) 7 OTHER (Miscellaneous) (e.g. DVDs, computer cases, nylon, car parts) Aluminium laminate plastics (e.g. sachets) *In the absence of plastic numbers, better to check the recyclability of plastics with the local waste collectors or recycling companies.* Metal waste • Aluminium (e.g. drink cans, food cans, aluminium tray and foil) • Steel (e.g. Vehicle Spare Parts • Tin • Copper Glass waste • Bottles and jars • Auto glass • Window glass Paper& Cardboard: • Cardboard (e.g. packaging boxes, eggs tray) • Paper (e.g. office paper, paperbags, envelopes, newspaper) Organic waste • Food waste (e.g. peelings, food scraps) • Vegetation waste (e.g. branches, leaves, scrap wood) Wood • Broken pallets (wood) • Furniture • Bamboo scraps	E-waste: • IT Hardware (e.g. servers, routers, external drives, CPUs) • Telecoms equipment (e.g. deskphones, radios, mobile phones, computers, laptops, monitors, keyboards, Scanners, printers, copiers, toner cartridges) • Household/office appliances (e.g. Air conditioners, fridges, generators) • Lighting equipment (light bulbs, switches, fluorescent lamps) • Electrical and electronic equipment (e.g. cameras, smoke detectors, drills, medical devices) • Solar Photovoltaic equipment (e.g. PV panels, inverters) Batteries of different types (e.g. lithium ion, lead acid) Medical Waste: • Pharmaceutical products (e.g. expired and unused medicines and vaccines, pills, creams) • Used sharps (e.g. needles, razors, scalpels) • Infectious items (e.g. Infected with body fluids) • Etc. Fleet management waste: • Used engine oil • Oil Filters • Lubricants • Tyres Chemicals: • Solvents • Acids • Detergents • Paints • Varnishes • Inks • Glues • Non-empty packaging waste that contains hazardous substances Pesticides Asbestos

Figure 3: Non-hazardous and Hazardous Waste classification
Source: WREC, 2023, p. 9

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Waste in humanitarian settings

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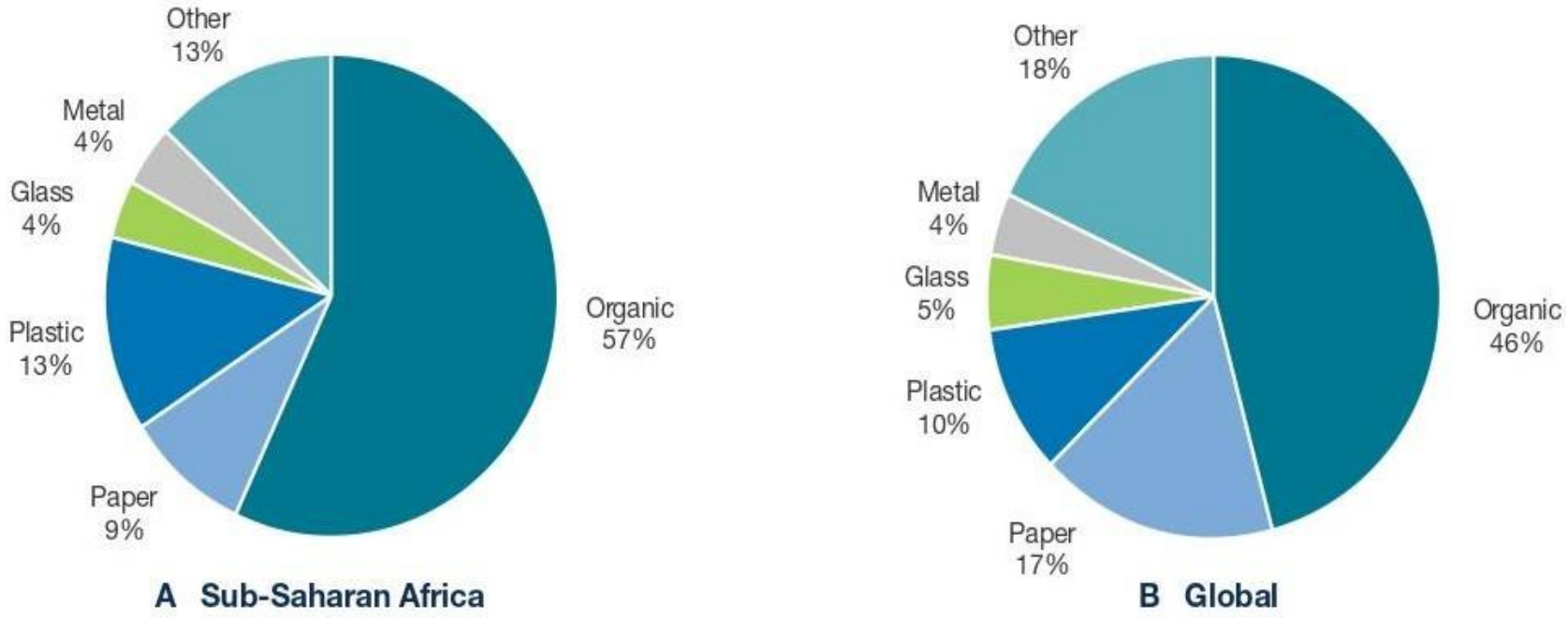
In Sub-Saharan Africa, the municipal solid waste is 57% organic, 13% plastic, 9% paper, 4% metal, 4% glass, 13% other.

Research participants confirmed that the most ubiquitous waste is **organic and plastic**.

Figure 3.4 MSW composition, sub-Saharan Africa and global



Source: Hoornweg and Bhada-Tata (2012)

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Waste in humanitarian settings

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Domestic / household waste	Waste from food preparation, packaging, cleaning, fuel burning, old clothing, furnishings, appliances, and reading materials	It may also include human excreta in cases where e.g. disposable nappies and bucket latrines are used.
Commercial waste	From markets, shops, stores, offices, hotels, restaurants etc.	Typically, it consists largely of packaging materials, used office supplies, and food waste.
Institutional waste	From schools, hospitals, government offices etc.	Generally, it contains more paper than food. It can contain hazardous waste and chemicals (hospitals).
Industrial waste	Includes packaging materials, food waste, metal, plastic, textiles, fuel burning residues (e.g., ash), and used processing chemicals.	It may also contain hazardous chemicals. When industrial wastewaters are treated to reduce water pollution, the hazardous substances become concentrated in sludge, which is sometimes also classified as solid waste.
Agricultural waste	Can be included in industrial waste or be a separate category.	
Abattoir waste	This is mainly organic but often very socially objectionable and attracts vermin.	
Street sweepings	Includes dirt and litter, animal excreta, dead animals, and spilled loads.	It may also encompass other types of waste, such as household and commercial waste, that are dumped in the street. In areas with

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Packaging waste

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The most commonly used packaging of relief items is plastic packaging (44%):

- Polyethylene terephthalate (PET) – used for oil/water bottles;
- High-density polyethylene (HDPE) – used in vegetable oil containers;
- Polypropylene (PP) – used in woven bags for commodities such as rice and sorghum
- Paper and cardboard (43%);
- 81% of HOs consider packaging and/or plastic as the biggest problem in terms of waste streams, followed by medical waste (in the wake of the Covid-19 pandemic).

Box 1. Packaging Definitions

In humanitarian assistance, packaging can be understood and defined at three distinct levels:

- ***Primary packaging*** is understood as the packaging components in direct contact with the products at the smallest unit of distribution (e.g., a single bag of grain).
- ***Secondary packaging*** contains multiple primary packaged products together (e.g., a crate of six bags of grain).
- ***Tertiary packaging*** is the freight and logistics packaging used to facilitate shipping and storage (e.g., a stretch-wrapped pallet of 16 crates of bags of grain).

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Main challenges linked to bio-based implementation in humanitarian settings

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Technical challenges:

- Ensuring **proper conditions for biological processes,** e.g. biodegradation (e.g., temperature, moisture, pH levels)
- Maintaining **consistent quality of outputs** (compost, biogas, etc.)
- **Scaling up** from small pilots to larger operations

Resource limitations:

- Lack of **initial funding** for equipment and infrastructure
- Limited access to **necessary materials or technology**
- **Shortage of skilled personnel** to manage and maintain systems

Environmental factors:

- **Climate extremes** affecting biological processes (e.g., very hot or cold temperatures)
- **Limited space** in crowded camps or urban settings
- Potential for **environmental contamination** if not managed properly

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Main challenges linked to bio-based implementation in humanitarian settings

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Social and cultural barriers:

- **Resistance to handling or separating** certain types of waste
- **Lack of community buy-in** or participation
- **Cultural taboos** related to waste or waste products

Operational challenges:

- Integrating **new systems into existing** waste management practices
- Ensuring **consistent waste separation at source**
- Managing **odors and pests** associated with organic waste processing

Economic viability:

- Difficulty in creating **sustainable business models** around bio-based solutions
- **Limited markets for end products** (e.g., compost, biogas) in humanitarian contexts
- **Competition with cheaper**, non-sustainable alternatives

Regulatory hurdles:

- Navigating **complex or unclear regulations** in host countries
- Obtaining necessary **permits** for waste processing activities

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Main challenges linked to bio-based implementation in humanitarian settings

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Knowledge gaps:

- Lack of **local expertise in bio-based waste** management techniques
- **Limited data on long-term effectiveness** in humanitarian contexts

Logistical issues:

- Difficulties in **transporting** necessary equipment or materials
- Challenges in establishing **reliable supply chains**
- Managing **seasonal variations in waste composition and volume**

Stakeholder coordination:

- Aligning **interests of multiple actors** (NGOs, local authorities, communities)
- Ensuring **consistent support across different phases of humanitarian response**
- Balancing **short-term needs with long-term sustainability goals**

Monitoring and evaluation:

- Developing **appropriate metrics** for success in challenging environments
- Adapting **solutions based on feedback and changing conditions**

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Technical barriers to alternatives to plastic packaging (examples)

Challenges associated mainly to alternatives to plastic packaging relate to:

- Cost
- Supply chain logistics → availability
- Performance
- Infrastructure
- Environmental impact
- Community acceptance
- Regulatory barriers

Quality and functionality of packaging (e.g., stability, strength, water resistance) **priority** (food loss and food waste resulting from inappropriate or defective packaging can cause significant carbon emissions).

For **bio-regenerative materials**: e.g. seaweed, hemp, mushroom the main challenge is their **cost** (significantly higher cost than petroleum-based plastics) and **availability** (suppliers not able to supply this in large quantities to meet the needs of humanitarian organizations).

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Technical barriers to alternatives to plastic packaging (examples)

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Biodegradability

- Humanitarian contexts → diverse and harsh conditions.

Biodegradable plastics

- Break down completely **if exposed to specific conditions** (e.g. humidity, temperature) and when discarded into the ocean, it's mostly much slower to degrade than in terrestrial settings.
- Need a **separate collection system**: if they end up in a landfill, their breakdown results in carbon and methane emissions and when collected alongside recyclable plastics, they can contaminate recyclable plastic batches and cause damage to recycling infrastructure.
- Their degradation in natural **environmental conditions is very slow.**
- **Industrial composting** is required to achieve complete biodegradation.
- Some still **partially composed of fossil-based plastic** (bio-PET/starch blends) and **contain chemicals** that make their end-of-life management challenging.

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Why it is important to have a comprehensive approach to bio-based solutions in humanitarian SWM?

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Comprehensive Impact & Environmental and Health Impacts

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- Consider the waste in the context of the whole SWM system and in the context of specific humanitarian crisis.

- E.g. replacing plastic with another material **without considering the local waste processing capabilities** might lead to other environmental issues.

- Ensuring **optimal conditions** (e.g. proper conditions for biological processes such as temperature, moisture, pH levels) for **bio-based solutions poses challenges in humanitarian settings**.

- Waste innovations must consider the **overall environmental and health impacts**.

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Sustainability and Scalability

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- Innovations need to **be sustainable and scalable across different contexts**.

- A solution that works in one area might fail in another **if the entire waste ecosystem is not considered**.

- Understanding **local practices, infrastructure, and cultural attitudes** toward waste is crucial.

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Regulatory and Policy Frameworks

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- Waste management is often governed by **local regulations and policies**.
- Innovations must align with these **frameworks to be implemented effectively and legally**.
- Ignoring these aspects can lead to **non-compliance and ineffective waste management**.

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Beneficiary Involvement

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- Beneficiaries' **behaviours and practices** are integral to the success of waste management innovations.

- Solutions must be designed with **input from the communities** they serve to ensure they are practical and adopted widely.

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Resource Optimization

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- Humanitarian settings often operate with **limited resources**.
- A **holistic approach ensures that innovations are resource-efficient and do not inadvertently waste materials** or effort by focusing too narrowly on one aspect of waste.
- Full SWM system is often considered not humanitarian but **development**.
- SWM system needs **involvement and ownership from authorities and administration**.

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Thank you!

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