How can sanitation adapt to the new conditions posed by climate change through resource recovery?

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Highlights:

- Ecosan technologies enhance resilience through independence from precipitation and targeted monitoring in resource-constrained regions.
- Transforming sanitation by-products into biogas and nutrients mitigates emissions and reduces reliance on fossil fuels and fertilizers.
- Ecosan recycling practices help manage water scarcity and nutrient availability with strategies like reservoirs for excess rainfall storage.
- Successful ecosan requires policy and community support, integrating local practices with global guidelines for sustainable solutions.

Keywords: Ecosan; Climate adaptation; Climate policies.

INTRODUCTION

Climate change poses challenges for sanitation due to altered temperature and precipitation patterns, potentially diluting or concentrating effluents. Adapting existing systems and promoting sustainable practices is crucial (WATERAID, 2024; WHO, 2022). Ecological sanitation (Ecosan) offers a climate-resilient solution by promoting decentralization and recycling sanitation byproducts (MARQUES et al., 2021). Ecosan is based on increasing the circularity, thus incorporating natural cycles for resources generated by sanitation, such as water, energy, and nutrients, saving energy (WERNER et al., 2009).

Recently, ecosan has been pointing towards smaller centralizations, such as multiple residential units for in-loco treatment (SIMHA & GANESAPILLAI, 2017). However, discussions over the impacts and solutions for climate change are usually at the federal level, meaning they are for larger areas with reduced adaptability to local diversity. Thus, this work aims to present a discussion on the current stage of ecosan and its aspects that reinforce the need to think of alternative models such as ecosan so that sanitation could increase resilience in the face of climate change.

METHODOLOGY

This discussion abstract was performed through literature research using the terms “climate change,” “ecological sanitation,” “ecosan,” and “adaptative measures” on Google Scholar, Web of Knowledge

®, and Scopus. Grey literature publications by relevant global stakeholders such as the United Nations and World Health Organization (WHO) were also included since they present greater insights into what is being applied *in loco,* possibilities proposed by an interdisciplinary group, and our contributions to the debate.

RESULTS AND CONCLUSIONS

Implementing well-designed Ecosan approaches for recovering and recycling biogas, nutrients, and water from sanitation by-products is recommended to preserve these natural resources. Applying ecosan to everyday activities such as fertilization and irrigation is one of the main goals. Further elaboration on the topic is described in the key ecosan applications below. They were segregated into six topics that are currently discussed as focal points for the rapidly changing future regarding dealing with the consequences of the new world already in the present. These topics are:

- **Resilience**: Some ecosan technologies, like urine-diverting toilets, are resilient to precipitation changes since they do not rely on water to flush the excreta. However, wetlands may be affected by water runoff alterations either by being overflowed with intense precipitation or the plants being exposed to more intense climate conditions (WERNER et al., 2009). Enhanced monitoring of impacted systems can boost resilience by preparing themselves for unexpected conditions, especially in regions with limited historical monitoring data, thus depending on new data for the management plans.

- **Closing the Cycle**: Using ecosan, you save water and resources in two ways: the first by reintroducing a resource in the cycle, and the second by avoiding generating emissions to collect, mine, or harvest conventional fertilizers. Transforming sanitation by-products into valuable resources like biogas for energy and nutrients for fertilizer can mitigate greenhouse gas emissions from fossil fuel energy production and mineral fertilizer manufacturing (OUIKHALFAN et al., 2022; KARMAKER et al., 2020).

- **Adaptation Strategies**: During the adaptation stage, it is important that the resources could be used as close to the generating source as possible, avoiding overcharging one region to the detriment of the emitter losing these resources. Ecosan can aid in water management by addressing water and nutrient scarcity through techniques like excreta recycling and local water storage solutions like reservoirs or CSO systems (MARQUES et al., 2021). This technique could provide a greater independence from outside resources for a given region, that might be affected by climate or socio-political tensions.

- **Community Engagement**: Successful sanitation systems require policy and community support. When lacking formal guidance, countries may follow WHO guidelines on ecological sanitation, considering aspects like health, economics, and implementation (WHO, 2006). As seen in organizations like SOIL in Haiti, community involvement can enhance acceptability through approaches like Community-Based Participatory Research (CBPR) (Duke, 2020). When the community is gathered by feeling themselves as parts of the processes, the results can be long-lasting and provide an occupation for people from a given community who would otherwise be unemployed.

- **Local Practices and Global Policies**: Local actions are essential alongside global initiatives to combat climate change. As WHO guidelines outline, aligning local practices with global policies can be a starting point for impactful change (WHO, 2006). When considering climate change impacts, it is common to reflect on global impacts and regulations that have been widely established and discussed. However, local action is of great importance for managing and mitigating climate change. Using global policies and guidelines

- **Integration with urban areas**: While most ecosan applications are targeted towards rural areas where conventional sanitation has not been reached successfully, it is crucial to highlight the possible applications for the urban context. Highly frequented spaces such as public buildings, educational institutions, and sports stadiums are good examples of decentralized sanitation as they gather great amounts of urine and feces. The management of the excreta is optimized when applied in a place where great volumes are generated, meaning that resource extraction is more advantageous than collecting in single-family homes.

While various ecosan technologies offer solutions, there is no one-size-fits-all approach to the climate crisis. It is not productive to mitigate the impacts on the global south with technologies developed for the global north and vice-versa. While wetlands could work all year in tropical and subtropical climates, they need different management. Each region must tailor solutions to its specific needs, and regulatory bodies must adapt swiftly to address the urgent need for action in a rapidly changing world.

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