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Building climate resilience in the sanitation value chain through innovative technologies towards circular economy

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Highlights:

- **Sanitation systems are vulnerable to impacts of extreme climate change related disasters and events**
- **Climate change negatively affects sanitation systems and undermines progress made thus far**
- **There is a need to move towards climate resilient and circular sanitation solutions**
- **Progress in South Africa towards climate resilient and circular sanitation solutions**

Keywords: Sanitation; Resilience; Circular

INTRODUCTION

In South Africa, the majority of those with access to sanitation services use the flush toilet and are connected to South Africa's vast sewerage network. However, many areas across South Africa are water scarce, and do not have access to the sewage network, preventing the development of full waterborne systems. In these cases, alternative sanitations, utilizing low or no water, can be implemented. These technologies incorporate circular economy principles and considers climate resilience in their design.

In the event severe flooding, damaged toilets and sanitation systems can spread waterborne disease across communities and settlements. In area affected by drought, non-resilient sanitation systems contribute to water stress or can stop functioning, causing people to settle for open defecation. The impact of climate change will result in regress on the progress made over the years in the sanitation sector, hence the need for sanitation systems to be resilient to ensure universal access to safely managed sanitation for all as per the SDGs.

There are innovative solutions that can contribute to addressing the challenge of access to sanitation in informal and rural communities. These solutions can provide full on-site sanitation solutions which include generation and containment, as well as treatment of waste in areas without access to sewer systems and water supplies. These inventions can be suited to residential

consumers, schools, public spaces, commercial settings and clinics. The technologies, developed both locally and abroad, incorporate aspects of resource efficiency, energy efficiency and the idea of no longer viewing human waste, as simply waste.

METHODOLOGY

Water Research Commission (WRC) has prioritized research and innovations that links climate change, circular economy and sanitation through the South African Sanitation Enterprise Programme (SASTEP). Through SASTEP, WRC is evaluating and demonstrating non-sewered sanitation (NSS) technologies that are off grid and promotes circular economy within sanitation value chain through water efficiency, water reuse and nutrients recovery from human waste. The technologies being demonstrated by WRC can be categorized as follows:

- **Recovers or recycles water**
- **Beneficiate sludge (fertilizer, energy, biogas, biochar etc…)**
- **Collect urine to recover nutrients**
- **Recover water and beneficiate sludge**

RESULTS AND CONCLUSIONS

1. Technologies that recover or recycles water

1.1Clear Recycle Toilet Description

The Clear toilet uses a full water recycling process for treatment of the sewage. An advanced unique "Biofilm MBR" treatment process is employed as the core technology for treatment, producing a stable and clean effluent that is further disinfected to ensure safety of the effluent for reuse.

1.2 Aquonic Tank Recycle Toilet description

The Aquonic is a modular and decentralised wastewater treatment plant that turns blackwater and greywater into pathogen-free reusable water that can be used for toilet flushing and irrigation. It treats wastewater through a series of biological processes and electro-chemical disinfection.

1.3 Dewdrop Nature Based System description

The DEWdrop is a decentralized ecological wastewater treatment system with a modular design that provides convenient reuse greywater for toilet flushing, car washing and garden watering. The treatment process includes the anaerobic baffled reactor, a constructed wetland, tree filters and biochar filters.

2. Technologies that beneficiate sludge

2.1 LaDePa Description

LaDePa is a machine that provides a containerized method of processing sludge into a nutrient rich soil conditioner. The technology removes the detritus, pasteurizing and drying the sludge to beyond the sticky phase.

2.2 Enhanced Hydrothermal Carbonisation (EHTC) Description

Enhanced Hydrothermal carbonisation (EHTC) converts sludge predominantly into a carbon-rich hydrochar solid products using high temperature and high pressure. The feed sludge can be digestate, sewage sludge, municipal organic waste and other carbon rich wastes.

3. Technologies that collect urine to recover nutrients and water

Diamond Reactor description

An automated nutrient recovery system which recovers high value fertilizer and water from urine without the need for connections to sewers, treatment plants, water supplies or continuous electricity.

4. Technologies recover water and beneficiate sludge

NEWgenerator Recycle Toilet description

The NEWgenerator a compact, portable, and modular resource recovery machine that eliminates waste while recovering fertilizer nutrients, renewable energy and clean water. It consists of an anaerobic baffled reactor as well as a nanomembrane filter which allows the generation of liquid fertilizer and biogas that can be collected and harvested for cooking/heating.

The above technologies, being demonstrated by WRC, incorporates both mitigative and adaptive aspects in relation to climate change and can also fast track achieving circular economy in the sanitation value chain. These technologies been demonstrated in various settings such as schools, informal settlements and rural areas. However, the uptake still low currently. Water has been an easier resource to recover from human excreta and the recycled water is mostly used for flushing.

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