Paper 5: Sanitation and climate in Lusaka

Climate change is one of the biggest challenges of our time. The water and sanitation sector is particularly vulnerable to variations in weather patterns, and the looming threat to availability and quality of water resources is recognised in Zambia, where the National Water Supply and Sanitation Council (NWASCO) has been advocating for a proactive response to climate change risks. Commercial utilities (CUs) are being encouraged to consider adaptation measures to protect water security.[1] Increasing resilience is a first and necessary response, but it is as important to scrutinise the role the global water and sanitation sector plays in contributing to an increase in global warming. Water and wastewater services can play a significant role in releasing greenhouse gas (GHG) emissions, both during construction of facilities as well as normal operations. It is estimated that the water and sanitation sector contributes 3%-5% of global and up to 15% of local GHG emissions.[2] In some cities it is likely to be even higher than that, mainly due to high emissions from poorly managed on-site sanitation systems.

Climate change thus becomes a twin challenge of adaptation and mitigation: services must adapt to cope with future changes, the likely impact of which can be highly uncertain, but providers must also strive to reduce their GHG emissions so as to limit their own contributing effects on climate change. In Lusaka, where sector stakeholders were still reeling from the devastating impact of cholera outbreaks linked to extensive flooding, a first challenge was to develop an understanding and appreciation of the interlinkages between water and sanitation, GHG emissions and climate change. The environmental impact of inadequate sanitation was a serious cause for concern, though rarely viewed from an emissions angle. Energy efficiency had been introduced as an operational performance indicator in 2016, drawing attention to energy consumption as part of utility operations.[3] However, energy and CO_2 emissions from machinery (notably pumps) and the fleet of Lusaka Water and Sanitation Company (LWSC)[4] vehicles are only part of the contributing factors to GHG emissions. Powerful GHGs such as methane and nitrous oxide are formed during containment, treatment and disposal of wastewater and faecal sludge.[5]

Activities and progress

LWSC taking on a greater role in sanitation offered a window of opportunity to develop business models and technical solutions that would also consider faecal sludge management (FSM) from a climate perspective. Many of the activities of the GIZ project CFS-Lusaka (e.g. baseline mapping, technology testing and support to establishing a formal framework for on-site sanitation (OSS) and (FSM) were designed to lay firm foundations for sustainable sanitation practices that could ultimately contribute to climate mitigation efforts.

More intensive and extensive flooding is one of the high-impact events that is associated with climate change, and erratic heavy rainfall events resulting in more frequent

1) A Climate Risks Screening Guideline was introduced as a framework for a systematic identification of climate hazards and mitigation measures during design and implementation of water services projects.
2) GIZ/WaCClim. 2019. Assessing Energy Performance and Carbon Emissions of Water and Sanitation Systems with ECAM. Training Workshop Report.
3) NWASCO has been promoting better monitoring of utilities' energy usage with the aim of developing strategies to use it more efficiently and sustainably. However, this is mainly driven by a desire to reduce operational costs (electricity and fuel) and not explicitly presented as a climate mitigation strategy. NWASCO 2016 and 2018. Urban and Peri-Urban Water Supply and Sanitation Sector Reports 2016 and 2018. NWASCO: Lusaka.
4) All commercial utilities in Zambia were officially renamed 'Water Supply and Sanitation Companies' in 2019
5) Even when treated, the breakdown of human waste produces significant quantities of CO_2 (carbon dioxide), CH_4 (methane) and N_2O (nitrous oxide) emissions from sewers, containments and treatment plants. CH_4 and N_2O are by-products of biological conversion processes, 34 and 298 times more powerful than CO_2 respectively, but emissions also occur as part of energy use during other operational activities. In the case of on-site sanitation, transport-related emissions (fuel) are of particular relevance.

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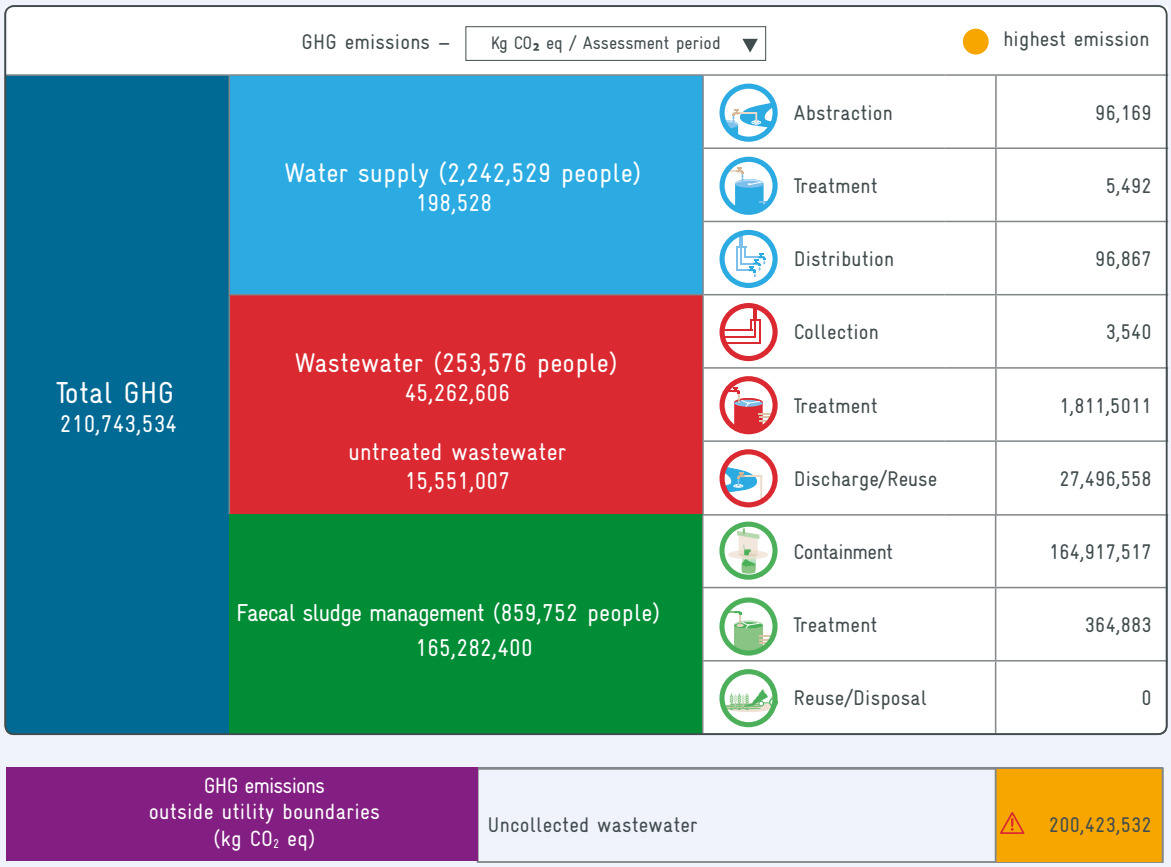
Preliminary GHG emissions summary of LWSC (2018)



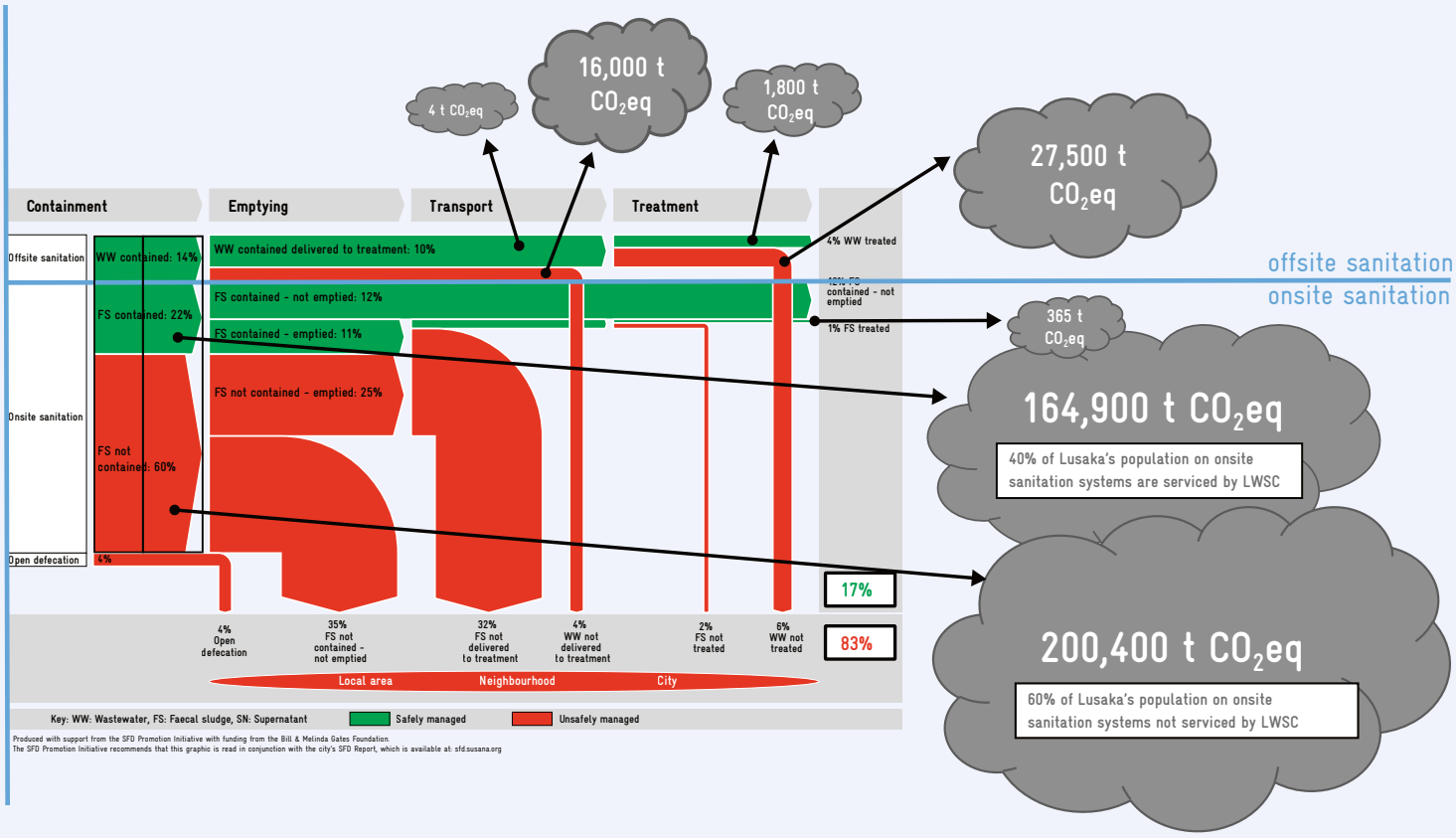
flooding have been observed in Zambia. Especially low-income areas with poor infrastructure are at higher risk. Consequently, interventions in peri-urban areas (PUAs) (through the Lusaka Sanitation Programme - LSP) drew on previous studies, such as groundwater vulnerability maps, to target priority areas and support decision-making, taking into account climate resilience aspects. Investigations into the connection between groundwater and the spread of waterborne diseases had established clear links between shallow groundwater tables and cholera hotspots in marginal, flood-prone areas.[6]

As LWSC and Lusaka City Council (LCC) are only just beginning to implement OSS and FSM components of the Lusaka Sanitation Programme, it is too early to assess their impact with respect to reducing GHG contributions and climate change mitigation in the water and sanitation sector. However, CFS-Lusaka has instigated discussions with partners on necessary actions to increase the resilience of assets in view of the likely impacts of a changing climate.

Flood-proofing OSS containments, especially in the vulnerable PUAs, is a prime consideration that will also significantly reduce cholera outbreaks and protect against groundwater contamination. The latter will additionally have the long-term potential to contribute to the reduction of emissions related to drinking water production on the other side of the business. It is also notable that awareness of the links between water, energy and climate is increasing: LWSC's FSM staff are fully on board with factoring in climate resilience for sanitation infrastructure and services. The unit is also keen to explore the utilisation of by-products of faecal sludge treatment (notably biogas) as an energy source, and it is further envisaged to include energy recovery units within

6) The vulnerability map is a product of a collaboration between Zambia's Department of Water Affairs and the German Federal Institute for Geosciences and Natural Resources (BRG). It primarily assesses risks to groundwater quality, but also identifies areas with high water tables and therefore high risks of contamination (e.g. from inappropriate sanitation). According to the map, the most vulnerable groundwater areas coincide with large low-income neighbourhoods located southwest of the city centre. A report accompanying the updated version, published in 2019, notes that '[i]t is unfortunate that the areas where rapid recharge occurs are in the areas that are subserviced by sewers, which out of necessity forced the poorest people in Lusaka to build pit latrines during the very rapid expansion of the city.'

Preliminary climate SFD: Lusaka citywide GHG emissions along the sanitation chain (2018)



the new wastewater treatment plants (WWTPs) funded by KfW/EIB under the LSP.

Another activity sought to shore up the level of understanding of GHG emissions across LWSC's existing water supply and wastewater business. In association with the WaCCliM project[7], CFS-Lusaka introduced stakeholders in Lusaka to the ECAM (Energy Performance and Carbon Emissions Assessment and Monitoring) tool. This open source tool quantifies and evaluates GHG emissions within the urban water cycle using available utility data. The tool produces graphics to pinpoint opportunities for reducing energy consumption and the overall carbon footprint. As the ECAM tool previously only assessed conventional water and wastewater operations of utilities without analysing OSS systems and FSM, CFS-Lusaka worked with WaCCliM to develop and integrate this third dimension into the tool.

In June 2019, LWSC scientists, engineers and managers from all relevant departments attended an ECAM training workshop, where they used their own data to assess LWSC's energy performance and direct and indirect GHG emissions arising from operations in 2018. This exercise highlighted significant gaps in data availability, especially with regard to on-site sanitation, where (insufficiently managed) faecal sludge nonetheless emerged as the biggest contributor to LWSC's carbon footprint, mainly due to high amounts of methane emitted from the untreated faecal sludge of OSS users. This results in a first estimate of 165,926 tonnes CO_2 equivalent/year and accounted for 78% of total utility emissions in 2018. These preliminary results must be treated with caution, as additional input data (such as electricity consumption, fuel consumption during faecal sludge transport, the characterisation (quantities and qualities) of faecal sludge inside the different containment systems and of the

7) Water and Wastewater companies for Climate Mitigation (WaCCliM) is a joint initiative between GIZ and the International Water Association. https://wacclim.org/
8) Note that the citywide SFD report highlighted a 'significant uncertainty with regards to the gap between sludge produced and sludge that reaches the treatment facility.' (Kappauf, L., Heyer, A., Makuwa, T. and Titova, Y. 2018. SFD Report Lusaka, Zambia, 2018. GFA. p.23)

> 'The utility is now in a better position to support donors to make more targeted investments that will have a meaningful impact on adapting to and mitigating the effects of climate change in Lusaka Province in Zambia; all within the context of the Master Plans.'
>
> Eng. Dennis Malambo, Director of Commercial Services, LWSC, at Stockholm World Water Week, 26 August 2019

treated sludge) and verifications are needed to complete the ECAM assessment.[8] CFS-Lusaka and LWSC are looking to collect the missing data, and a study on the characterisation of faecal sludge has been initiated with the results due to feed into the ECAM tool.

The ECAM tool, in conjunction with the SFD exercises, has added another perspective to improving FSM, and (waste-) water management more generally. Building on shared concerns regarding energy use, the workshop discussions broadened into a greater understanding of GHG emissions from utility operations. The assessment has provided a first insight into where emissions are likely to occur within each system (water supply, wastewater and FSM). In Lusaka, the impact of FSM practices on climate change seems to be far greater than commonly thought, and stakeholders have further reason to improve data, monitor the situation closely and improve their operations. With key staff trained in the use of the ECAM tool and information gaps identified during the workshop, LWSC is now in a position to start collating climate-relevant data and monitor, with an aim to reducing, its GHG emissions. For those parts of LWSC's service area where formal sanitation services have been rolled out, CFS-Lusaka and LWSC have started to create a visualisation of the GHG emissions along the sanitation service chain. By combining emissions data with the citywide SFD, this offers an insight into where the highest emissions occur.

> *"When you know what your GHG emissions are, you can begin talking about them with confidence to the engineers on how to lower them and the funders on how to finance impactful measures"*

Remaining challenges

The uncertainties surrounding the final destination and characterisation of faecal waste contained in pit latrines in Lusaka, as well as the importance of accurate data concerning sludge emptying and transport, have already been remarked on. This information is needed to complete the picture and arrive at a more accurate assessment of GHG emissions for LWSC operations. LWSC recognises the need for GHG emissions reporting – all CUs are required to report to ZEMA, which in turn is responsible for NDC reporting at national level.[8] Assigning responsibilities within LWSC and developing appropriate mechanisms for consistent monitoring (including systematic data collection and verification) and reporting will be the next step.

Whilst the ECAM training has been a good start to obtain a first understanding and a baseline of LWSC's energy efficiency and GHG emissions, the activities need to be extended such that climate mitigation measures can be included from the infrastructure planning stage onwards through to efficient operations of on and off-site sanitation. Especially with respect to citywide GHG emissions, it is worth noting that LWSC's sanitation activities – and hence data availability – remain limited. Significant data gaps exist for poorly and entirely unserviced containment systems as well as the emissions released through informal operations. Given that there has been relatively little research into assessing GHG emissions from faecal sludge and OSS systems, even internationally, tools and methods have yet to be developed; possibly the ECAM tool could be further be refined to capture citywide data in its entire complexity.

Looking at climate adaptation challenges, other than the challenge of upgrading unlined pit latrines as a safeguard against climate-induced flooding, LWSC is experiencing other upstream and downstream impacts of climate change. Given Zambia's reliance on hydroelectric power, changing rainfall patterns pose a risk to national electricity supplies. Recurring shortages are already impairing operations of water and sanitation facilities (in particular WWTPs), which require a continuous power supply. Partly driven by these external threats, LWSC is giving increasing consideration to the environmental impact of its business activities. Current efforts focus on cutting energy use or switching to greener alternatives, such as solar pumps. LWSC is now looking at the climate change adaptation and mitigation potential within the utility. Further discussions and detailed investigations may help to optimise the predominantly reactive stance, which rightly and necessarily responds to climate risks, whilst adding some proactive measures towards reducing GHG emissions.

8) Zambia has committed to making significant reductions in emissions; its target Intended Nationally Determined Contribution (INDC) of 2015 is 47% against the 2010 base year. (Irish Aid. 2018. Zambia Country Climate Risk Assessment Report)

However, addressing climate change needs to be a sector-wide effort, so the call for greater awareness goes out to all sector stakeholders and beyond. NWASCO is working on a climate variability tool that would support and encourage CUs and funding partners to routinely scrutinise project proposals from a climate adaptation perspective and integrate appropriate designs into their portfolios to increase resilience to climate change-related events.

Lessons learnt: insights and recommendations

- Cholera has been a primary driver of sector initiatives in Lusaka, overshadowing the climate-induced factors that may have precipitated the crisis. Awareness of climate change and its implications has nonetheless risen considerably, even if adaptation measures feature more prominently in discussions than any need for mitigation measures.

- The links between sanitation-related diseases and flooding as well as the correlation between reduced GHG emissions, energy consumption and costs can be used to stimulate and promote climate-friendly practices. These can also be communicated in a straightforward way to all stakeholders in the city, including the general public. A climate SFD, once further improved, could be a useful tool for such advocacy.

- Greater climate awareness and positive engagement has the potential to open new funding opportunities, as more finance is becoming available to support climate-friendly initiatives. Harnessing climate change financing to cover future costs of implementing climate mitigation and adaptation measures in the water and wastewater sector should continue to be explored.

- Like any water utility, LWSC will be looking to increase the resilience of its infrastructure. Guarding against floods that cause overflowing sewers and sanitation facilities, or droughts that endanger electricity supplies comes to mind easily. However, it may also become necessary to consider more subtle changes in performance that a changing climate could cause: assets respond differently in different weather conditions, and extreme weather can lead to failure of assets – and in consequence, service failure.
- The move towards mitigation is a challenging one, as there are limited best practice examples in the sector to learn from. The ECAM baseline for energy efficiency and GHG emissions supported by CFS-Lusaka can be a first step to inform the Adaptation and Mitigation Plan for LWSC and inform future investments.

- Existing climate change screening approaches may need to be refined to fully capture the challenges of on-site sanitation vis-à-vis future climate resilience.

- By reducing GHG emissions and therefore its impact on climate change, LWSC will be supporting Zambia's NDC (Nationally Determined Contributions) commitments and targets, serving as a pilot city for scaling up within Zambia. It could also provide a model for better data collection and reporting on national emissions reduction targets by ZEMA.

- In order to support a nationwide assessment of GHG emissions and energy efficiency in the water and wastewater sector, the ECAM tool needs to be further refined and adapted to the Zambian context, especially on OSS and FSM.

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Registered offices
Bonn and Eschborn, Germany

Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany
T +49 61 96 79-0
F +49 61 96 79-11 15
E info@giz.de
I www.giz.de

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Author/Responsible/Editor:
Esther Gerlach
Co-authors: Amanda Mallaghan, Doreen Mbalo, Mintje Büürma,
Trevor Surridge

Design/layout:
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