Nexus - GEF CReW+ in Dominican Republic

Detailed design for the rehabilitation of Wastewater Treatment Plants with the **Nexus Approach**

Context

The GEF CReW+ is a cooperative project funded by the Global Environment Facility (FMAM/GEF) and co-implemented by the Inter-American Development Bank (IADB) and the United Nations Environment Programme (UNEP) in 18 countries of the Wider Caribbean Region, including the Dominican Republic. The Project offers innovative, nature-based solutions to mitigate the effects of untreated wastewater on the environment and public health.

In the Dominican Republic, the GEF CReW+ project is being implemented on behalf of the IADB by the *Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH* in partnership with the Ministry of Environment and Natural Resources (MARN) of the Dominican Republic. This project was adopted by GIZ through its global programme Sanitation for Millions, launched in 2016 by GIZ and the German Federal Ministry for Economic Cooperation and Development (BMZ) as lead donor. Sanitation for Millions is a multi-donor initiative implemented in 14 countries in three continents, created to address water and sanitation issues and contribute effectively to achieving Sustainable Development Goals 6, 4 and 3.

Rehabilitation of the WasteWater Treatment Plant (WWTP) in Sabana Yegua, Azua province, and of the Autonomous University of Santo Domingo (UASD), Santiago Campus, in the province of Santiago, were incorporated into the activities of the GEF CReW+ project in the Dominican Republic. Promotion of the water reuse approach is interesting for the project partners in the country, as new regulations related to the topic are being currently formulated. The detailed design, which is being finalised, received funding from the Global Programme "Nexus Regional Dialogues Programme", which is co-financed by the European Union (EU) and BMZ and implemented by GIZ.

GIZ commissioned the detailed design for the rehabilitation of the Sabana Yegua WWTP to TECCA Caribe as of June 2022, and was carried out in collaboration with the National Institute of Drinking Water and Sewerage (INAPA), the Ysura Irrigation Board and the Azua provincial office of the National Institute of Hydraulic Resources (INDHRI). On the other hand, the detailed design for the WWTP of the UASD, Santiago Campus, was developed in collaboration with the UASD, Santiago Campus.

This document aims to summarise some aspects of the Nexus approach that were considered in the detailed design. It includes a brief description of the issues, involvement of the Nexus interrelationships in the design proposal development, some lessons learned and expected impacts.

Issue

The Sabana Yegua WWTP, located in the province of Azua, was abandoned more than 30 years ago. A few years ago, following a water shortage for agricultural irrigation, nearby farmers interrupted the sewage flow and used the raw sewage for their crops, resulting in a considerable health risk. Consequently, the Sabana Yegua WWTP went out of operation. However, based on the dialogue with stakeholders, the prolonged abandonment was largely attributed to the local initial lack of knowledge regarding the risks associated with the raw wastewater that interrupted water flow of the system, as well as the country's weaknesses in water governance, institutions, and in the sanitation sectors. In addition, it is worth mentioning that the WWTP did not incorporate facilities to treat and utilise the wastewater treatment sludge.

Figure 1. Location of Sabana Yegua (left) and recent state of the lagoon at WWTP of Sabana Yegua (right).
Photo: ©GIZ / Antony Torres

Near the Sabana Yegua WWTP there is infrastructure belonging to the YSURA irrigation system, which covers 30,000 ha and manages the water used for agriculture in that area. The irrigation system is developed through flooding of furrows, which implies high variability in the water supply for irrigation, and a lack of control and monitoring of the water used for irrigation purposes. In addition, the distribution network is commonly located in earthen channels, leading to significant resource losses.

Figure 2. In-ground irrigation canal (left) and furrow flooding technique (right). Photo: ©GIZ / Roberto Pepin

On the other hand, the WWTP of the UASD, Santiago Campus, was built in 2004, and has been abandoned since its construction. Currently, due to inadequate maintenance and operation, its infrastructure is highly deteriorated. It also fails to prevent the emission of methane into the atmosphere and, in general, does not incorporate facilities for the treatment and utilisation of the by-products of wastewater treatment (biogas and sludge). In addition, there are abandoned green areas near the WWTP covered with bushes, where some fruit trees, banana trees and other plants grow.

Figure 3. Location of UASD, Santiago Campus (left) and recent status of the Anaerobic Upflow Reactor (right). Photo: ©GIZ/ Gustavo Cubero

A Comprenhensive Solution:

Enganging the Nexus Approach

Water for Food

The **reuse of treated wastewater from the Sabana Yegua WWTP** is proposed for the irrigation of agricultural crops in nearby areas. Therefore, implementing a demonstration unit for sub-foliar sprinkler irrigation on one hectare of banana crops (which has more than 70% coverage in the area) is initially proposed, for developing good practices among producers and organisations involved, such as the Ysura Irrigation Board. Subsequently, scaling up the technology to an area of 30 ha of plantain cultivation is recommended.

The storage volume of treated wastewater for irrigation is 10,583 m^3. The proposal includes the conveyance of treated wastewater to the irrigation points by gravity, mainly through buried PVC piping. In addition, a drainage system will be incorporated which accelerates the evacuation of accumulated rainwater and reduces the likelihood of crop loss. Also, compared to the current technique, a considerable reduction in consumption is foreseen.

Furthermore, at the UASD, Santiago Campus, the intention is to irrigate an area near the WWTP of approximately 2 ha with treated wastewater, which will be adapted for planting ornamental and forestry plants, among others. An irrigation system for treated wastewater with a useful storage of 521 m^3 and a pressurised micro-sprinkler system is hence proposed. As in the previous case, the design considers a drainage system to reduce excessive water accumulation in the soil, thus minimising plant damage.

Another by-product of the above mentioned WWTPs is sludge, which needs to be periodically removed. The sludge contains significant amounts of phosphorus (P) and nitrogen (N) that can be used for plant production. Thus, sludge treatment is incorporated **to generate biosolids that can be used as soil improvers for plants**. Therefore, with the aim of dewatering and stabilising the sludge, drying beds were incorporated in the design of both WWTPs, which will allow the sludge to be dewatered so that it can be composted and finally used as soil improvers for agricultural production.

Water for Energy

The WWTP of the UASD, Santiago Campus, has an Anaerobic Up flow Reactor (AFR), which **generates biogas**, with energy potential **through treatment of wastewater**. It is estimated that approximately 89 m^3 (37 kW [1]) of biogas is generated per day. The design contemplates the infrastructure required for collection of the generated biogas through pre-designed, easy-to-install bags.

The collected biogas is intended to be used for research purposes and as a supplementary energy resource in the use of gas cookers within the campus food centres and canteens of two other nearby academic centres. The surplus biogas will be burned in a flare to reduce the emission of methane released into the atmosphere, which has a higher global warming potential than CO_2.

Energy for Water

The design aimed to reduce the fossil energy consumption required for both treatment plants and their respective irrigation systems. Therefore, in both cases, **the existing hydraulic gradient in the wastewater treatment line was used** for propulsion.

Furthermore, in both cases, **solar luminaires** for lighting the infrastructure of both plants was proposed in order to reduce the use of fossil fuels. In the WWTP of the UASD, Santiago Campus, given the high investment cost of solar panels, electrification of an irrigation pump (3.7 kW) and UV disinfection equipment (1.2 kW) was also proposed. Meanwhile, as mentioned above, the design of the irrigation system with treated wastewater from the Sabana Yegua WWTP was gravity-led, taking advantage of local topography.

Natured based Solutions (NbS)

The design encouraged the use of "Nature-based solutions" in the infrastructure of the WWTPs of Sabana Yegua and the UASD, Santiago Campus. This can be exemplified by the proposal of a **maturation lagoon** that will be used mainly for the removal of pathogens from the wastewater, so that it reaches the required quality for reuse, according to the applicable regulations of the World Health Organisation (WHO).

Thus, continuing the use of the existing anaerobic and facultative lagoon is intended, following their rehabilitation. On the other hand, at the UASD, Santiago Campus, it is proposed to include a demonstration unit of a **subsurface horizontal flow wetland**, which will treat a fraction of the

[1] When considering a calorific value of 8.569 kcal/m3 biogas

effluent from the anaerobic filter, and which will be used mainly for research and other academic purposes at the university. The above technological solutions are based on biological and natural processes, which reduce the impact on the ecosystem, and act in favour of water security.

Lessons Learned

Summarized below are some of the key lessons learned from the detailed design of the rehabilitation of Wastewater Treatment Plants (WWTPs):

- **Outreach with beneficiaries** is fundamental in the design of a sanitation system. Identification of their needs and expectations allows identification of risks and opportunities at different stages of the project, which facilitates its management, thus favouring the probability of success and identifying strategies for project sustainability.
- C**reation of inter-organisational agreements** is necessary for the proper management of treated wastewater reuse systems for agricultural irrigation in the Dominican Republic. Their operation and maintenance overlap the responsibilities of organisations, which until now, have not been directly linked. For example, in the wastewater reuse project in Sabana Yegua, there is a need to formally agree on roles and responsibilities between the national water authority (INAPA) and the local Board of Irrigators (Junta de Regantes YSURA), who manage the water for agricultural activities in the area.
- For private wastewater design companies, it allows them **to replicate the experience of designing** integrated sanitation systems, where their by-products are used, and with a circular economy approach. In this way, it favours **strengthening of the capacities** of private companies in this area.

Expected Impact

The elaboration of the detailed design will provide the national counterpart with aspects to be considered for **replicability** of similar studies. T**he capacities** of governmental institutions involved in the issue of wastewater reuse for agricultural irrigation **are strengthened**. In addition, it helps identify **opportunities in policy formulation** to improve sustainability of WWTP projects. In particular, the detailed design identified the need to establish **new responsibilities and agreements** between the institutions involved to guarantee the proper functioning of the reuse system. In synthesis, as this model for the reuse of treated wastewater for crop irrigation is one of the first advances in the country, best practices of the design process should be adapted and improved in the design of wastewater reuse systems for agricultural irrigation in the Dominican Republic.

On the other hand, is expected that the implementation of the proposed design will have an impact on the areas of intervention, among them:

- There is a reduction of pollution to the Caribbean Sea. The discharge per year of up to **33 tons COD** into the Arroyo Copey and up to **16 tons COD** into the Yaque del Norte River would be mitigated.
- **Creation of dialogues** in the management of wastewater reuse projects (Nexus approach) between organisations such as INAPA, INDHRI, Ysura Board of Irrigators, Ministry of Environment and Ministry of Agriculture.
- Development of **a country-wide model** of wastewater reuse for agricultural activities, which incorporates a circular economy vision and where value is given to its by-products. This project would reinforce the reuse regulations that the Dominican Republic is seeking to establish. Also, the implementation of the project could generate inputs for feedback once it enters into force.

"This project (rehabilitation of the Sabana Yegua WWTP) is going to be very important, because it will be replicated. It will serve as an example so that it can be implemented in other provinces, because sometimes we have periods of low water in the first days of the year, so that would help" (María de León Pepen, Ministry of Environment and Natural Resources).

- In the UASD, Santiago Campus, the project will create annual savings of **221,000 m³** of water for human consumption. In Sabana Yegua, the direct water reuse for agricultural irrigation is expected to reduce at least **946,000 m³** of water consumption from surface sources. This will increase water availability, reduce pressure on the resource, and constitute a measure of adaptation to climate change.
- The project is expected to generate up to **2,040 kg of phosphorus and 9,060 kg** of nitrogen for landscape improvement at the UASD, Santiago Campus, in production of ornamental and forestry plants, among others. In Sabana Yegua, up to **2,649 kg** of phosphorus and **20,596 kg** of nitrogen well become available for nearby banana crops. In both cases, there is the possibility of generating economic and environmental benefits by reducing the use of fertilisers or commercial fertilisers.
- Annually at the UASD, Santiago Campus, the direct emission **of 21 tonnes of methane** into the atmosphere (**448 tonnes COe**) would be avoided due to the biogas released by the RAFA.
- Up to **14,849 people** in Sabana Yegua will be benefited, while, in the province of Santiago, the implementation is expected to benefit **more than 15,000 people,** including students, civil servants, administrative and support staff.

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