The responsibility for public water supply and sanitation in Rwanda lies in the hands of the nationwide operating public utility Energy, Water and Sanitation Ltd. (EWSA). Looking back at a successful cooperation of the water utility of Hamburg and the Rwandese water utility for more than 20 years, the decision was made consequently in 2010 to establish a long-term partnership following the idea of the International Water Association (IWA) for Water Operator Partnerships (WOP). Being key factors for sustainable development capacity building with a focus on staff training is a central element in this cooperation. To bring the partnership to life, a project application was placed under the ACP-EU Water Facility Restricted Call for “Partnerships for Capacity Development in the ACP Water & Sanitation Sector” in 2010. The project entitled “Optimization of Water Supply Using Performance Indicators” was selected for funding. The methodology and results achieved shall be presented here.

Approval and objectives
General objectives of the EU-financed project
Though Rwanda is a fairly green, agricultural country with regular rainfall and a good amount of surface water available (lakes, rivers), the surface water is usually faecally contaminated, the access to clean drinking water is very limited, and waterborne diseases are wide spread and also responsible for a very high child mortality. Therefore, this project aims not only at improving the capacities of EWSA but also enhancing the access to clean water of the population of Rwanda and to improve the technical and economic efficiency of the water supply system in the urban centres of Rwanda, with a special focus on the capital of Kigali. To follow the optimization also in the future,

Fig. 1: Raw water from the river, intake water treatment plant at Gisenyi
a performance indicator system for selected processes of special importance for the technical and economic performance of the water supply system is developed and implemented by the partners. The three main objectives are:

- **Reduction of chemicals used in water treatment**
  The urban water supply in Rwanda uses mainly surface water, which can only be treated with a considerable use of chemicals. Treatment chemicals such as coagulants, flocculants, and hypochlorite have to be acquired at high costs on the international market. Especially during the rainy season and when raw water is abstracted from the rivers, it shows an extremely high turbidity (1,000 -> 2,000 NTU) which can only be removed by adding high amounts of chemicals. The modern application of treatment chemicals drastically reduces the chemical demand and allows treating efficiently even raw water of extremely high turbidity. The result is a higher water production and better water quality at less cost (Fig. 1).

- **Increase of energy efficiency of supply systems over the entire chain of core processes of water abstraction, water treatment and water distribution**
  Due to the geographical situation (“Land of a Thousand Hills”), the distribution of water is coupled with high energy consumption. High energy efficiency requires well designed pumping stations and network systems planned and operated under energy efficiency aspects. The cost of energy is an increasingly important cost factor for the country having very limited own energy resources and thus being highly dependent on energy imports. There is very limited production of hydropower in the north of the country, and the extraction of methane gas from Lake Kivu was started again. But this is not at all sufficient to meet the growing energy demand, and many local power plants are using expensive diesel fuel.

- **Reduction of technical losses in water distribution**
  With technical losses of higher than 35 per cent (2010) in some areas, the need is evident to optimize the network structure and network development as well as the network maintenance and organization.

**Project methodology**
The special approach of the project is to achieve a sustainable know-how transfer by combining comprehensive staff training with the execution of optimization measures in the different technical fields, all in close cooperation of the partners. The methodology for the optimization of water treatment as an example shows the following list:
In step 1 (baseline assessment) process performance is evaluated to set the right priorities for the optimization measures. For water treatment the main focus is on water treatment plants with a high demand or inefficient use of treatment chemicals. Filter performance and filter backwashing are also important aspects of the process optimization. During the phase of optimization measures, step 2, chemical application is systematically improved together with the plant staff. Accompanying theoretical and practical trainings ensure a better process understanding including options for process enhancement. Also, further investment needs to be identified and considered in the strategic budget planning of EWSA.

For selected top experts and the EWSA management, tailor-made on-the-job trainings in Hamburg (step 3) offer an improvement of their technical and managerial qualification. Direct involvement in the processes of planning or operation gives an insight view into a big modern water supply company and allows to form a lasting network between experts of EWSA and HAMBURG WASSER. Also for the execution of identified investment measures, these trainings present a valuable input. Short-term missions of experts from Hamburg (step 4) accompany and support the execution so that the final evaluation (step 5) can be done using objectively verifiable indicators (OVI), mostly key indicators of the process performance indicator system (PPSI).

Results of optimisation measures
Immediately after the project start in January 2013 baseline assessment of water treatment plants (WTP), pumping stations and pilot areas in the water distribution began and quickly led to priority optimization measures that were started in parallel. For water distribution, the top priority was seen in the redesign of pressure zones in Kigali using a hydraulic model to be developed within this project.

After more than one year of the 3-year-project, the baseline assessment have been completed and optimization measures and trainings have started in all technical fields. As examples of these activities, the optimization of Muhazi WTP east of Kigali and the trainings in pumping station evaluation and design are described in more detail.

Chemical reduction at Muhazi WTP
Surface water treatment plants often follow the typical design of the period of their construction but not the requirements of the raw water that may be different and vary between the dry and rainy season. Significant reductions in the use of chemicals are possible, especially when the dosing regime is critically reviewed according to the modern water treatment practice and to the given water quality. Then tailor-made solutions ensure a maximum efficiency. In the case of Muhazi WTP, the plant is receiving a raw water of comparatively low turbidity from Lake Muhazi.

The raw water was treated in several steps: coagulation, flocculation, and two-stage filtration. As a result of full scale testing, no benefit was seen to continue the dosing of coagulant in the flocculation stage. Due to the raw water quality, the flocculation stage was skipped and the chemical dosing was shifted. A reduced dose of aluminium sulphate before the filters...
modifies the process to coagulation filtration, resulting in a stable and efficient treatment process with a chemical reduction of 75 per cent.

**Energy audits of pumping stations**

Energy audits of the pumping stations clearly identify the energy saving potential (Fig. 3).

They also reveal requirements for improved operation or investments in redesigned pumps. After the energy audits have been completed for the priority pumping stations, the EWSA staff is trained on energy efficiency to continue the energy saving programme for pumping stations in all parts of the country (Fig. 4).

**Outlook**

After more than a year, in which the baseline assessment could be completed, the optimization measures were started and the accompanying trainings did involve a significant number of EWSA staff, an intermediate evaluation of the project progress is possible. The concept of the execution of the first project steps in close cooperation between EWSA and HAMBURG WASSER has proven itself in practice. A network between the experts and responsible representatives of both utilities has been created. During baseline assessment an interesting number of optimization measures to be realised with only minor investments or by modifying operational procedures has been identified. After the execution of the most interesting measures excellent and cost saving results have been gained. The staff of plants and stations in Rwanda could improve their understanding of the system and the processes in their field, including possibilities for the enhancement of process performance.

On this solidified basis the project partners look forward to the coming project activities that will include trainings in Rwanda and Germany as well as the execution of identified measures for the strengthening of the water supply system.

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