Integrated Water Resources Management – Pilot Project "Middle Olifants" in South Africa

Our current century is characterised by global environmental problems. Surface water and river water pollution is of special importance as clean water is the foundation of life. It therefore requires special attention in terms of quality. Regional authorities are requested to prepare measures for the improvement of water quality to establish its provision. In order to secure sustainability, in international projects local authorities in cooperation with foreign companies and institutions develop innovative solutions for the safety of water. Lately, a variety of such joint projects has been realised around the world. The German Federal Ministry of Education and Research sponsors projects that especially base on the cooperative partnership between industry and science such as the IWRM South Africa.

SPONSORED BY THE

Federal Ministry of Education and Research

MOSA
INTEGRATED WATER RESOURCES MANAGEMENT
MIDDLE OLIFANTS SOUTH AFRICA

FONA
Research for Sustainable Development
BMBF

Author Details:
Dr. Wolfgang Genthe,
Dr. Tatyana Karasyova,
Dipl.-Ing. Rafael Jechorek
LAR Process Analysers AG
Neukoellnische Allee 134
12057 Berlin
Germany
Tel: +49 30 278 958-59
E-Mail: sales@lar.com

The integrated water resource management (IWRM) itself is a process which promotes the coordinated development and management of water, land and related resources. Its aim is to maximise the economic and social welfare in a fair way and in respect of the sustainability of vital ecosystems. The project IWRM South Africa refers to a region around the Middle Olifants, a river catchment northeast of Pretoria. This region is characterised by a large quantity of users with high water consumption. Among households, large scale irrigation farming, mining (including the world's biggest platinum mine) and quickly growing settlements, the Olifants River is linked to touristic values. Hence, the river water is precious, being food, habitat, and manufacturing resource. For the efficient, ecological and economical monitoring of water quality, analysis systems are required that are characterised by low costs of operation and environmental friendly methods.

The IWRM South Africa project of MOSA (Middle Olifants South Africa) is divided in several components and phases. Currently, it is in phase II focusing on the implementation of technical and legal structures to assure sustainable operations. During phase I available and usable water resources were investigated. It turned out, however, that the existing data basis of water quality was not sufficient or reliable enough. Unfortunately, until now the measurement points have been too far away from laboratories so that the samples were falsified by chemical and biological reactions during transportation. These measurement data could not serve the South African authorities as basis for the IWRM.

The IWRM Modelling – the third component of phase II – is the practical use and review of the model developed during phase I including updates, refinement of the model to the present situation and integration of new data. Besides tools such as the web-based geographic information system, an online analysis and data transfer system shall be developed in close cooperation with the South African supervisory authorities.

Figure 1: The project IWRM South Africa refers to a region around the Middle Olifants, a river catchment northeast of Pretoria.

Figure 2: The online analysis and data transfer system has been practically implemented in form of a mobile laboratory that will be set-up at different measurement points along the Olifants River.

This online analysis and data transfer system has been practically implemented in form of a mobile laboratory that will be set-up at different measurement points along the Olifants River for the direct on site water monitoring. Its results will be provided directly via internet to the South African authorities and for further updates and evaluation of the IWRM model by the project partners. In May 2013 the mobile lab, of which LAR Process Analysers AG, Berlin, is responsible for the conception and operation, has been field-tested for ten days in the MOSA project region. The measurement equipment was tested successfully in practice.

Based on the metrological requirements of the project and the analysis of the specific external conditions on site (climate, working conditions, logistics etc.) an appropriate container was selected, designed, constructed and equipped alike a chemical laboratory. Additional equipment such as anti-theft devices, burglar alarm systems as well as safety measures for the environmental safety are indispensable in this region. The mobile lab, furthermore, has an autonomous power supply and is ready for operation on site very quickly.

The autonomously working containerised laboratory is a compact stand-alone solution for the

Figure 3: The mobile lab is equipped with state-of-the-art analysers and measurement methods and is able to automatically monitor 23 parameters in total.

determination of water quality – either online (24/7) or for single measurements. Being directly connected to the internet (a special secured server was set-up) the mobile lab can be controlled and monitored via remote control and the data transfer is affected directly after the measurements. The measurement results of all sensors, electrodes and analysers are hence immediately accessible for the project partners in order to update of the measurement data of phase I. Thus, the overall aim of this project part being the development and demonstration of an adapted, decentralist applicable online measurement and data transfer system has been put into practice successfully.

Being mobile, the laboratory is applicable even at places that are difficult to access. Alongside the river even problematic measurement points can be reached. No long transportation is necessary. The mobile lab is able to analyse the most important pollution sources directly on site – either in online-mode or by single measurements. It is planned to relocate the mobile lab about 20 times per year. The measurement period per location will be between 1 or 2 weeks. During this time a high variety of single parameters such as pH, conductivity or redox, sum parameters like TOC (total organic carbon), COD (chemical oxygen demand), TN_b (total bound nitrogen), effect parameters like toxicity, and substances like ammonia or sulphate will be determined. In total, the mobile lab will be able to monitor more than 20 parameters automatically on site.

All analysers and sensors are part of one water cycle to enable the relevant reference of each parameter and measurement. The cycle starts with the sample taking through a submersible pump that is attached to a buoy. For its protection against wild animals living in the river (e.g. crocodiles) the pump is within a cover pierced with holes. This solution suits optimally different water levels. The submersible pump including the buoy is directly connected to the laboratory, which is equipped with several sample taking systems. They may be used in dependency of the samples' composition and requirements: The centrifugal separator serves the elimination of coarse contamination, the relay-controlled sample taking system by WaterSam is used for additional control samples or reserve samples, and the patented LAR FlowSampler enables the clogging-free sample taking of samples with sediment loads.

In addition, the mobile lab is equipped with state-of-the-art analysers and measurement methods in order to receive accurate and reliable monitoring data. The ultra high temperature oxidation (HTO) at 1,200°C works for instance without any catalysts and determines the total organic carbon (TOC) including particles within a few minutes. Usually, catalysts wear out during operation and may falsify results. Frequent checks and calibrations are the consequence resulting in additional costs. No use of catalysts means saving on operating costs, eliminating the risk of inaccuracy and minimising maintenance efforts. Moreover, LAR's QuickTOC is even able to accurately analyse the most difficult samples containing high loads of particles without clogging or blockages. The special injection unit is specifically developed for such applications. This online analyser is additionally equipped with further detectors and determines the chemical oxygen demand (COD) and total bound nitrogen (TN_b).

The online toximeter determines toxic effects of pollutants on organisms using very sensitive bacteria that are cultivated directly within the unit. The biomass is constantly self-regenerating so that the analyser is ready to measure samples at any time. For each measurement only a small amount of the test organisms are used. The biomass culture within the fermenter is not contaminated. Since there is always enough bacteria it is possible to operate this nitrificant toximeter either in online mode as well as for the analysis of single samples. Usual toxicity tests have a duration of some tens of minutes or even hours. This analyser's response time is about 15 minutes.

MOBILE LAB

Ultra HTO	TOC, TC, TIC, COD, TN_b
Nitrificant Toximeter	Toxicity
ISE + standard addition	NH_4, NO_3, Na, K, Cd, Cl, F
Photometer	SO_4, PO_4, NO_2, NO_3, TN_b, TP, Fe, Al
Electrodes	pH, conductivity, redox
Weather station	Temperature, wind, humidity, air pressure, rainfall

Figure 4: Methods and parameters the mobile lab is equipped with at a glance.

Further methods and analysers allow the determination of single pollutants such as ammonia, sodium, potassium, cadmium, fluoride, chloride, nitrite, sulphate, and more. In addition to the water parameters the lab records the most important parameters of the environmental conditions including various weather parameters such as temperature, rainfall, wind or humidity. Hence, the project partners and local authorities receive full information about the meteorological conditions in addition to the water quality.

The aim of the mobile lab is to support and improve current governmental monitoring systems. It is a stand-alone solution that practically applies the approach of innovative online analysis of water quality and the fast and comprehensive data transfer to all partners and authorities involved in the project. Using the lab inspections and monitoring of diverse discharges from diffuse sources, from households, as well as industrial pollution sources are directly possible. It helps the South African authorities to prepare measures for the improvement of water quality in good time enabling the coordinated development and management of water, land and related resources.