



**TAITA TAVETA UNIVERSITY**

A Premier Institution in Education, Training, Research, Innovation  
And Community Outreach

**Centre of Excellence for Mining,  
Environmental Engineering and Re-  
source Management  
(CEMEREM)**

**Biennial Report  
2019 - 2020**

[www.african-excellence.de](http://www.african-excellence.de)

**Centre of Excellence for Mining,  
Environmental Engineering and  
Resource Management**



Compiled and edited by: Prof. Dr. Jan C. Bongaerts  
Prof. Dr. Ulrike Feistel  
Dr. Jiangxue Liu

Designed by: Dr. Jiangxue Liu  
Printed by: TU Bergakademie Freiberg Media Centre

# **Table of Contents**

<b>CEMEREM</b>	<b>1</b>
<b>Education</b>	<b>3</b>
<b>Research</b>	<b>9</b>
<b>Networking</b>	<b>12</b>
<b>Outlook into the Future</b>	<b>19</b>

## About CEMEREM

The CEMEREM project, established as a consortium of Taita Taveta University (TTU) in Kenya, University of Applied Sciences Dresden (Hochschule für Technik und Wirtschaft Dresden (HTWD)) and TU Bergakademie Freiberg, was launched in May of 2016. The project seeks to establish a DAAD African Centre of Excellence for Education on Mining, Environmental and Resources Management in Partnership between Kenya and Germany. CEMEREM's overarching objective consists in a contribution to a sustainable development of the natural resources sector in Kenya and East Africa.

After 5 years development, these goals of CEMEREM have been achieved as follows:

- Curricula have been reviewed

and four new study programmes have been established with the assistance of the German partners.

- The infrastructure and research capacity at CEMEREM has significantly improved.
- Capacity building was in progress. Most courses of the new established study programmes were covered by TTU lecturers
- Contacts with government and industry have been enhanced.
- A project and quality management has been established.
- A sustainable concept has been developed.

From 2021, the CEMEREM project entered into the third phase of its development.



*TTU Campus*

## Infrastructure at CEMEREM

### CEMEREM Building

The government of Kenya spend a considerable funding on the construction of a new CEMEREM building on TTU's campus. The building is partly in use for teaching. The construction will completed in 2021.



*CEMEREM Building*

### CEMEREM Laboratory

Until 2020 four laboratories have been established and are in use for teaching and research: Geotechnical and Water Analysis Laboratory, Water disinfection System (SuMeWa), Biogas Analysis Laboratory.



*Left: Geotechnical and Water Analysis Laboratory  
Middle: Water Densification System (SuMeWa)  
Right: Biogas Analysis Laboratory*

### Teaching Activities of German Partners in 2019

**10 – 19 February** Prof. Feistel of the Hydrology Institute of HTW Dresden gave lectures on “Climate Change”

**10 February – 3 March** Phillipp Marx of the Hydrology Institute of HTW Dresden completed the installation of the weather station and gave training courses on measuring probes

**20 – 23 March** Dr. Weyer of the underground mining institute of TU Bergakademie Freiberg gave lectures on “Ming Ventilation”

**22 – 27 April** Dr. Ibrahim Muritala, associate researcher in German Aerospace Center (DLR) gave lectures on “Petroleum Engineering and Reservoir Engineering”

**2 – 19 September** Prof. Feistel gave lectures on “Engineering Hydrology”

**12 September – 4 October** Gershon Enoch of HTWD gave lectures on “Climate Change”

**7 – 21 September** Ms Kupka of the Institute of Ecology and Environmental Protection of HSZG gave lectures and training courses for MSc Process Engineering students



*Dr. Weyer with the MSc Mining Engineering Students*



*Ms Kupka at SAEES*



*Ms Kupka in the PE Laboratory*

### Visit of a German Delegation to TTU in 2020

**February 2020** A delegation from Germany including Prof. Jan Bongaerts, Erik Ferchau, biogas researcher of TU Bergakademie Freiberg, Susanna Kettner, CEMEREM Co-ordinator of HTWD, Prof. Knut Schmidtke, Professor of Organic Farming of HTWD, Marion Ulrich, Project Administrator of HTWD, Sieghart Hädicke, technical director of faculty Agriculture/Environment/Chemistry of HTWD, travelled to TTU.

**27 February** An ideas brainstorming workshop took place at TTU Voi, Kenya. 57 participants, including staff, researchers, experts and students in different fields attended the workshop. The purpose of the brainstorming workshop was to raise and collect innovative ideas for the continuation of the CEMEREM project for the years 2021 – 2025.

**28 February – 08 March** The delegation travelled to the School of Agriculture, Earth and Environmental Sciences (SAEES) to complete the installation of Agro PV and Biogas plants (see page 5, 6). Prof. Knut Schmidtke gave a lecture on “Biological Cultivation” at SAEES.



*Ideas Brainstorming Workshop*



*Measurement of biogas in the gas laboratory*



*Installation of the soil moisture sensor for the Agro PV project*

### 3rd Summer School 2019

**14 – 21 July 2019** Twenty CEMEREM teachers and students from four departments at TTU participated in the 3<sup>rd</sup> Summer School with the topic “Water, Mining and Agriculture”. The Summer School started with a lecture session given by Prof. Bongaerts, Prof. Grischek, Prof. Feistel, and Dr. Liu.

After the excursion to LMBV in Leipzig related to redevelopment and recultivation of mining landscapes, participants were gathered into three groups based on their background. Groups with mining, engineering and business background visited the laboratories of the Faculty of Agriculture/ Environment/ Chem-

istry of HTWD, the underground mine at “Reiche Zeche” and the laboratory of the Surface Mining institute. The group with agricultural background visited Agrargenossenschaft in Clausnitz, an agricultural cooperative with biogas plant, vegetable oil production, windmills and PV panels, and the organic farm “Vorwerk Podemus”. All participants spent a full day at Einsiedel water dam and the nearby drinking water factory and, after lunch, at a drinking water storage and distribution plant in Chemnitz. In this way, they had the opportunity to move along and see the entire drinking water supply system.



*Left: Visit to the LMBV  
Right: Visit to the Water Dam Einsiedel*

### 4th Summer School 2020

**16 – 21 November 2020** Forty teachers and students of TTU attended the CEMEREM summer school.

Since 2017, summer schools were held in Germany but, due to the COVID-19 pandemic, this year’s summer school was held in Kenya. The theme of the summer school in 2020 was “sustainable mining and the food-energy-water nexus”.

Sustainable mining refers to the production of mineral products without exhaustion or by considering the next generation that will still benefit from the same mineral products. The Summer School began on the 16<sup>th</sup> of November 2020 with keynote speeches by the Deputy Vice-

Chancellors and the Vice-Chancellor of the University. More presentations were made by various invited guests to identify specific issues surrounding mining operations and possible solutions. In the following days, participants visited CEMEREM laboratories of TTU, presented their research posters, heard lectures by various experts on mining and the environment and went on several excursions to artisanal mines, a mine rehabilitation site, a crater lake and a wildlife sanctuary. Especially the field excursions and lectures were important for practical learning and participants had the opportunity to visit places they had never been to before.



*Left: Visit to the Machine-Cut Stone Quarry in Taita  
Right: Visit to the Mwaluganje Elephant Sanctuary Kwale*

## Training of TTU Lecturers

**20 – 26 October 2019** Two lecturers of TTU, Phyllis Mbinda and Eric Munene Kinyua, were trained at HSZG focussing on lab experiments at Process Engineering. Prof Schoenherr and Ms Kupka of the Institute of Ecology and Environmental Protection of HSZG gave training courses on Practicing Lab-Experiments, and organised an excursion to the steel and metal scrap recycling facility of Scholz Recycling GmbH in Espenhain. At the end of their stay, both lecturers gave presentations to students of HSZG on “Socio Impact of Mining in Mkuki County, Kenya” and “Mining Education in Kenya”.



*Group Photo at HSZG*

The training of TTU lecturers, especially in process engineering, has enhanced capacity building in teaching and practical experiments. It establishes also a long-term perspective for the CEMEREM study programmes.



*Left: Visit to the SCHOLZ scrap recycling facility  
Right: Training in the iTe Laboratory*



## Students Exchanges

**19 May – 20 June 2019** Levent Köksal, a bachelor student of the Institute of Ecology and Environmental Protection of HSZG worked on his research topic related to Sustainable Waste Management System for a Kenya Municipal Site. The objective of this research is to develop a cultural related, decentralized, sustainable low technology in the management of waste collection, treatment, recycling, and removal concept for the municipal district in Kenya.

**19 November – 18 December 2019** Five students from TTU visited TU Bergakademie Freiberg for a one month research stay. The purpose of the visit was to develop their concepts of their Master Thesis. During the research stay, the students worked with their supervisors on

their concept and gained additional skills on using different software. They went on excursions for a better understanding of underground mining technologies and the utilization of biogas as a renewable energy source.

**25 November – 6 December 2019** Five students of MSc Environment Engineering of TTU had a two weeks intensive course related to “Water, Analysis and Engineering Hydrology” at HTW Dresden. They had lectures and practices in laboratories related to water treatment and water quality assessment. They learned about technologies applicable to small scale water treatment and Decentralized Sewage Treatment Technology. They visited the Hosterwitz Water Treatment Plant to gain first hand practical experience.



*Left: Presentation Day at the Surface Mining Institute at TU Bergakademie Freiberg  
Right: Visit to the Saxon Mining Bureau in Freiberg*



## CEMEREM Projects

In order to provide more training and research opportunities to the students, CEMEREM initiated the

### Gemstone project (M)

The Taita Taveta Region is famous for its gemstones known as Tsavorites: in terms of gemmology, these are classified as “green” (not red!) garnets and they are both rare and unique on a worldwide basis. The region also delivers other gemstones. Mining is done by Artisanal Small Scale Miners (ASM) who have little knowledge in terms of geology, technology and marketing. The Project aims at capacity building in all three areas in an integrated manner. The first step consists in the design and implementation of a web based platform for the trading of locally mined gemstones, which enables artisanal miners to entre in direct



following research projects in the areas of (i) Mining (M) and (ii) Environmental Engineering (EE):

contact with their ultimate clients, i.e., cutters and polishers anywhere in the world. The platform is embedded in a virtual sales platform. It operates with a cloud and a Blockchain technology. First analytical steps were taken to design the internet platform and select appropriate software. Contacts for co-operation have been established with a local association of artisanal gemstone miners and with gemmologists in Germany.

### Mining student projects (M)

With the first generation of Master’s students approaching the end of their study times, an opportunity has been created to set up student research projects resulting in Master’s Thesis work. Current topics include.

Design and management of mine tailings, improved energy efficiency in minerals processing, renewable energy in mining operations, avoidance of mercury in artisanal gold mining.

### Biogas project

The project was initiated in 2017 to increase the energy efficiency through the use of biogas generated from local natural resources. In 2018, four Smart Biogas Plants have been installed at TTU main campus and at the campus of the School of Agriculture, Earth and Environmental Sciences (SAEES). One of them is used in the gas laboratory for training students and research. Another one is used in the kitchen for the processing of kitchen waste and other biomass. The other two will become operational in 2020. These biogas



plants will not only used for the research about biogas production. More importantly, they will be used as a demonstration plant for local farms and entrepreneurs around the campus and beyond.

### Agro-Photovoltaics

This project was started up at SAEES for the investigation of different climatic and soil conditions for plant cultivation under solar panels. Since February 2019, twenty four solar panels are installed above arable land to generate electricity and to modify cultivation conditions for crops through soil improvements, better water management and less evaporation. In addition, a weather station has been built for the measurement of the air temperature and humidity, the radiation intensity and the precipitation. Three Bachelor students and a Postdoc of SAEES



were trained to maintain the measurement system and set up a database of the measurement. The SAEES students analyse the date regarding the plant grow and the Environmental Engineering students analyse the data regarding water balance and groundwater recharge.

## Macadamia Nut Cracker Project

As a result of initial request from SAEES, a project was started up at TUBAF with the intention to develop a nut cracking machine, especially for macadamia nuts which are characterized by a very hard shell which cannot be opened with existing devices. In 2018, a pilot machine has been built which meets all requirements: high availability, little damages to the nuts, easy operation and robust engineering. Professor Kröger, who developed the machine, visited TTU and a Nut treatment factory in Kenya to identify potentials for manufacturing the machine on a commercial basis. He gave a short



course on cracking of Macadamia nuts at TTU. Various topics for master thesis and project assignment will be provide to students at TTU and in German partner universities. A feasibility study about the production of macadamia nuts is now undertaken in Co-operation with the Taita Taveta County government.

## Water supply and wastewater treatment (EE)

In terms of water supply, TTU's campus is not connected to any drinking water supply system and any waste water collection system. In respect of this, within CEMEREM, a specific technology for purifying locally supplied rain water with solar energy was installed. The electricity is used to extract chlorine from the naturally contained salts in the raw water as a

chemical for sterilization. Students of MSc Environmental Engineering can now be trained for technology transfer. In terms of waste water treatment, a research project was completed dealing with the absorption of nutrients contained in the University waste water by common plants indigenous to the region.

## 2nd CEMEREM Conference on Education in Mining

**17 – 18 September 2019** The Conference was held in Voi Wildlife Lodge at Voi town, Taita Taveta County. Participants were drawn from academia, industry, especially the extractive industry, government, students and alumni of TTU.

The main theme of the conference was entitled: **SUSTAINABLE DEVELOPMENT IN THE EXTRACTIVES INDUSTRY IN AFRICA**

The conference had three sub-themes anchored on the following three priority areas.

- Impacts on environment, economy, health (of the general popula-

tion and immediate workers in the mines) and social well-being;

- Holistic stakeholders' involvement, including local and indigenous communities and women;
- Sustainable mining practices through the provision of financial, technical and capacity-building support to developing countries.

Some prominent guests attended, among them the Chancellor of Murang'a University of Science and Technology (MUST), the Hon Rtd Marsden Madoka and John Omenge, Permanent Secretary of the Mining Ministry, Kenya.



*Group Photo of the CEMEREM Conference*



## International DAAD Alumni Seminar Mining 4.0

**30 April – 5 May 2019** Twenty five Alumni from German universities travelled to Freiberg for the first international Alumni Seminar on Mining 4.0, which stands for the automation and robotization in mining.

The Seminar programme offered a deep insight in the content and the implications for future mine development and mine operation of Automation, Information Technology, the Internet of Things, Cloud and Fog Computing. Lectures by Professors Drebenstedt, Mischo, Joseph and MSc Lösche for Professor Jung illustrated current activities in Research and Teaching of TU Bergakademie related to Mining 4.0 with applications in the development of algorithms, the use of sensors, infor-

mation and communication technology and machine construction for mining, both above ground and underground.

Guest lecturers Prof. Rudy Sayoga Gautama of Institute Technology Bandung, Indonesia, and Prof. Bayanmunkh Myagmagsuren of German Mongolian Institute for Resources and Technology in Nalaikh (Ulaan Baatar District) illustrated the implications of Mining 4.0 for the mining industries on mining engineering education in their countries.

Prof. Juma Ogada, Dean of School of Business, Economics and Social Sciences of TTU participated in the seminar and conducted a survey on the development of Mining 4.0 in developing countries.



*Left: Lecture Day at the Surface Mining Institute at TU Bergakademie Freiberg  
Right: Visit to the Underground Mine "Reche Zeiche" at TU Bergakademie Freiberg*

## DAAD Kontaktseminar in Ethiopia

**11– 15 June 2019** Prof. Bongaerts took part in a Seminar organized by DAAD in Addis Ababa. The seminar offered the opportunity to representatives of German Universities to meet with counterparts of Universities in Ethiopia to introduce themselves and learn about mutual interests, especially with respect to their intention to submit joint proposals for the ERASMUS PLUS programme of the European Union. Before the meeting itself, which took place on 13 and 14 June, Prof. Bongaerts trav-

elled to Mekelle to meet with representatives of the university there and discuss similar joint activities.



*Group Photo of the Seminar Participants*

## "Business Meets Africa" in Chemnitz

**19 June 2019** As usual, every year in June, the Chamber of Commerce of Chemnitz – in co-operation with Member of Bundestag Frank Heinrich, organizer this one-day event. It is attended by ambassadors and their staffs of African countries in Germany and by the Business Community of Saxony and beyond. The message of the conference was very clear: the German Government, the public business promotion agencies (including State-owned Development Bank KfW) and the organisations of the Business Community (Chambers of Commerce, German Association of

SMEs and others) consider the African continent as a large and important market for technology transfer, co-operation in manufacturing and in services and job creation. Once again, the German government is increasing its budget for development in Africa, focussing, however, on countries with own policy strategies and policy instruments in those directions. Co-operation is shifting from development aid towards business partnerships, entrepreneurial endeavours and the creation of employment.

## 39th Meeting of Africa Group German Geologists

**29 June – 1 July 2019** Afrikagruppe deutscher Geologen is an informal group of geologist and related scientists with specific interests in all „geo aspects“ in Africa, reaching from paleology, geology, hydrology and water resources, soil science, including erosion and soil improvement techniques, agriculture, especially in arid conditions, use of biomass up to community development. Given the age of many members, the group was almost extinct, until some years ago, a new generation moved in. The meetings are combined with an excursion and individual members act as hosts at their universities. The ex-

ursion took part at two locations. The first location is an archaeological site high above the Danube River now called „Heuneburg“, showing a partly reconstructed town of the Celtic Age (2500–2600 years ago) and the second location is a re-naturalized stretch of the Danube River nearby, illustrating novel concepts to manage floods with natural landscape modelling techniques. The papers given reflect the entire spectre of the group. Prof. Bongaerts gave a presentation about Mining 4.0 reflecting the current trends in atomization and digitalization in the mining industry.

## IMWA 2019 in Russia

**15 – 19 July 2019** The Agenda of IMWA 2019 was “Technological and ecological challenges”. The conference brought together the mine water community in one of the world’s outstanding mining regions in the boarder of Europe and Asia for delegates to present their newest findings on mine water management and treatment, more so discussing about implementing solutions to the potential environmental impact on mine water.

CEMEREM was represented by Dr.

Justin Maghanga, Mr. Shadrack Mwakio and Mr. Athman Chembea. They presented 2 papers and 1 poster on these topics:

- Electrochemical removal and kinetics in the removal of fluoride from underground water in Kenya
- Influencers of adoption of mine water treatment technologies in Taita Taveta County, Kenya
- Environmental impacts of mining: A study of mining communities in Kenya

## Conference in Aberdeen

**1 – 4 September 2019** Upon invitation of Professor Ulrich Schlie of Zentrum für Diplomatie of Andrassy Universität in Budapest, Prof. Bongaerts participated in a Joint Seminar entitled “Current geopolitical challenges and their impact on leadership in a disruptive age”. The Seminar was organized by the Centre for Diplomacy at Andrassy Universität Budapest and the Centre for Global Security and Governance at the University of Aberdeen in Aberdeen, Scotland. Participants were students, PhD candidates and teachers of both universities and of some

German universities. JCB gave a presentation on “Natural resources and the world ahead”, followed by a discussion. The audience appeared to be very interested and surprised by the many facts and figures showing the dual dependency of countries on natural resources. Countries, which have them and mine them, depend on countries who need them. Clearly, especially developing countries depend on the industrial countries for revenues from exports of mined mineral products.

## The 10th Networking Meeting in Dakar

**18 – 21 September 2019** The tenth Network Meeting of Centres of African Excellence was held at the Centre Africain d’Études Supérieures en Gestion (CESAG) in Dakar, Senegal. The topic of the meeting was “Networks for Sustainable Impacts on African Development”. The overall goal was to strengthen internal and external networks between the Centres of African Excellence to enhance capacities, in not only higher education and research, but also concerning applied sciences and innovative technologies.



*Prof Kiptanui Arap Too (in the middle) in the Networking Meeting*

CEMEREM was represented by Prof Kiptanui Arap Too.

## Senegal - German Business Dialogue in Frankfurt

**15 November 2019** Prof. Bongaerts (and Professor Drebenstedt who joined later) accepted an invitation for a “Senegal – German Business Dialogue” in Frankfurt. The meeting was organized by SenGermany e.V., a small NGO of highly qualified professional Senegalese residents in Germany, all extremely fluent in German with the aim of promoting relations and co-operation between the two countries. The topic of the meeting was focussed on the development of the mining sectors and its contribution to economic and social development. One specific aspect related to the use of renewable energy technologies in mining operations.

The Minister of Mines, Lady Dr.

Aïssatou Sophie Gladima Siby, and the Ambassador of Senegal to Germany, Cheikh Tidiane Sall, attended with presentations. The minister is a very competent geologist herself and a graduate of the University of Dakar. The School of Geology was founded in 1981 and has delivered more than 300 graduates. Senegal has a growing mining sector (large volumes of potassium, a world-class deposit of Ilmenite producing Titanium Dioxide and Zircon, Gold mining and new Gold discoveries in the Birimian Greenstone Belt, substantial offshore discoveries of oil and industrial minerals for the construction industry) but, so far, no academic institution for the education of miners.



*Senegal - German Business Dialogue in Frankfurt*



## DIGI-FACE Kick-off Meeting in South Africa

**2 – 7 March 2020** The Digital Initiative for African Centres of Excellence (DIGI-FACE) is a cooperation project between a network of German and African Universities under the leadership of the University of Kehl in Germany. The German Academic Exchange Service (DAAD) funds this initiative with support from the German Federal Foreign Office (AA). DIGI-FACE aims to strengthen the African Excellence Network via the development of appropriate and user-friendly electronic and blended learning modules and digital tools, so that geographically separated participants become part of a community of learners and practitioners for interactive digital learning progress and reflexive research supervision.

The kick-off-meeting of the DIGI-FACE project was hosted by the Nelson Mandela University in Port Elizabeth in cooperation with University of Kehl. CEMEREM was represented by Prof. Jan C. Bongaerts (CEMEREM Project Leader, TU BAF), Prof. Kiptanui Arap Too (CEMEREM Project Coordinator, TTU), Dr. Nicholas Muthama (CEMEREM Project Manager, TTU) and Mr. Kibwana Zamani (ICT Manager, TTU). CEMEREM now participates in the DIGIFACE Project by exploring the best ways to utilize its outcomes to enhance teaching with a specific focus on STEM.



*Group photo of participants of DIGI-FACE Kick-Off Meeting*

## Outlook into the Future

- **Establishment of new study programmes**
  - PhD Mining Engineering
  - PhD Process Engineering
- **Further development of research projects**
- **Promoting scientific publications**
- **Summer school for TTU students and staff at TTU**
- **Trilateral student exchanges**
- **Establishment of Alumni Network**
- **Development of digitalisation at CEMEREM**
- **Networking and capacity building with government and industry**
  - Training of engineers and resource managers
  - Short courses for practitioners in the extractive sector
  - Networking with industry in research and training
  - Support for young entrepreneurs

## CEMEREM TEAM

### Project Partners

#### University of Applied Sciences Dresden

Project Leader: Prof. Dr. Ulrike Feistel

Email: feistel@htw-dresden.de

Co-ordinator: Dipl.-Hydrol. Susanna Kettner

Email: susanna.kettner@htw-dresden.de

#### TU Bergakademie Freiberg, Germany

Prof. Dr. Jan C. Bongaerts

Email: J-C.Bongaerts@ioez.tu-freiberg.de

Prof. Prof. e.h. Dr. Dr. h.c. mult. Carsten Drebenstedt

Email: Carsten.Drebenstedt@mabb.tu-freiberg.de

Co-ordinator: Dr. Jiangxue Liu

Email: jiangxue.liu@bwl.tu-freiberg.de

#### Zittau University of Applied Sciences

Prof. Dr. –Ing. Jürgen Schoenherr

Email: j.schoenherr@hszg.de

### The Hosting African Institution

#### Taita Taveta University, Voi, Kenya

Prof. Dr. Fred Simiyu Barasa

Vice-Chancellor

Email: vc@ttu.ac.ke

Co-ordinator: Dr. Nicholas Muthama

nicholasmuthama@ttu.ac.ke

### Funded by

DAAD – German Academic Exchange Service

Centres of African Excellence

Kennedyallee 50, 53175 Bonn, Germany

www.african-excellence.de