SANWATCE Exchange Programme Report

THE UNIVERSITY OF ZAMBIA

Lusaka

School of Mines

INTEGRATED WATER RESOURCES MANAGEMENT CENTRE

DEPARTMENT OF GEOLOGY

EXCHANGE STUDENT REPORT AT THE UNIVERSITY OF WESTERN CAPE, SOUTH AFRICA

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Degree Programme: Master of Science in Integrated Water Resources Management

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Executive Summary

The NEPAD Water Centres of Excellence sponsored student exchange program at the University of the Western Cape started on 15th February 2020. The program was supposed to last for 60 days until the 14th April 2020 but due to circumstances beyond our control, the exchange program ended on 25th March 2020. During this period, I participated in Hydrogeology and Advanced GIS lecturers and practicals, monthly seminar presentations and 12 hours pumping tests. The university also provided free access to online literature from various publication companies that I am using for my thesis writing. Stable water isotope samples were dispatched to ithemba laboratory and Major ion water samples were delivered to Elsenberg laboratory for analysis. Analysis of the water samples is being conducted and I await the results for further interpretation. The major challenge experienced during the

exchange program was from anion analysis, the 50 ml sample size was not sufficient for all the anions I needed to be analysed. The exchange program was cut short after the outbreak of the COVID-19 that led to the closure of the University.

Table of Contents

Abbreviations

EC – Electrical Conductivity

GIS – Geographical Information System

PhD – Doctor of Philosophy

SADC - Southern African Development Community

UNZA- University of Zambia

UWC – University of the Western Cape

1.0 Introduction.

The NEPAD Water Centres of Excellence (NEPAD Water CoE) is a network of Higher Education- and Research institutions who conduct high-end scientific research on water and related sectors, in order to provide policy guidelines to governments. The NEPAD centre of Excellence consists of seven countries in the SADC-region countries including Zambia. Their mandate encompasses the facilitation and where applicable conduct selective research on water issues. To serve as a Higher Education (PhD; Post-Doc; Staff-Exchange) soundboard to the SADC region on regional water matters and to collaborate with other networks and institutions in specialised areas.

Through their collative network with the University of Zambia in the water sector, I was accorded the opportunity to analyse my water samples at the University of the Western Cape (UWC). The exchange program exposed me to researchers in the water sector who have vast experience in groundwater and surface water studies. I also interacted with researchers in Geographical Information Science and Earth Observation.

The exchange programme exposed me to scholars in the field of water science at UWC and we have been sharing articles and reports that are of importance in our research. I was exposed to other learning methods used at the University of the Western Cape that I will share with my colleagues at the University of Zambia.

Through the knowledge obtained from interacting with various researchers and scholars at the University of the Western Cape, I hope this strengthen linkages and collaborative work between University of Zambia and the University of the Western Cape. This report therefore details my activities during my stay and next steps going forward.

1.2 Objectives

1. To conduct stable isotope and major ion chemistry analysis on water samples
2. To attend classes in Hydrogeology and Advanced GIS
3. To interact with staff and students at UWC working on similar research themes

1.3 Activities

1.3.1 Week One

During my first week at UWC, I participated in class activities and a field excursion. The class was Integrated Water Resource Management module taught by Dr T. Kanyerere. With the topic: Integrated Catchment Management. The other class was Hydrogeology module taught by Dr Israel and the topic was water quality.

Practical

PHREEQC computer program to determine the molarities and saturation indices of different types of water i.e. Coastal groundwater, inland groundwater and rain water. To determine the outcome when inland water mixes with coastal water in a certain ratio and what would happen to saturation if desert conditions (increased temperature and reduced precipitation) were considered.

On Friday 21st February 2020. We had a 12 hours pumping test from 5:00 PM to 5:00 AM the following day at the monitoring boreholes within campus. The water was sampled for water chemistry analysis and onsite reading of temperature, EC, pH and radon-222. Radon-222 in water was measured using a RAD-7 Radon Detector shown in fig.1. The equipment is used to measure radon-222 in air but this particular one was modified to measure radon-222 in water. The units are Becquerel's per cubic meter (Bq/m^3).

Figure 1. RAD 7 Radon Detector.

1.3.2 Week two

In the second week of classes, I participated in the Hydrogeology Module taught by Mr. Siyamthanda Gxokwe. On the last Friday of February, we had Seminar Presentations with Dr Thokozani Kanyerere and his first year Masters students.

Practical

Hydrogeology practical with Mr. Siyamthanda Gxokwe using Pumping Test Pro to determine the Storativity and Transmissivity of the monitoring boreholes from the 12 hours pumping test conducted the previous week.

1.3.3 Week three

In the third week, I participated in Advanced GIS module taught by Prof Timothy Dube. During the lecture session, we reviewed papers with the Honours students. Two papers were reviewed, one by Zhou et al., 2013 ‘Groundwater-dependent distribution of vegetation in Hailiutu River catchment, a semi-arid region in China’ and the other by Li et al, 2014 ‘Analysis of Landsat-8 OLI imagery for land surface water mapping’.

Water Analysis

Water samples were dispatched to Bemlab for major ion analysis. The laboratory could only analyse for cations because the volume (50 ml) was not sufficient for anions.

1.3.4 Week four

In the fourth week, I participated in Hydrogeology module taught by Mr. Siyamthanda Gxokwe under the topic: Numerical flow modelling. Followed by a practical for groundwater modelling using MODFLOW-2005 for simulation.

Water Analysis

Major ions

Mr. Evan the chief technician at the department of Environment and Water Science agreed that his laboratory could analyse some of the anions with the 50 ml sample volume but there was need to buy reagents and consumables as the department had run out of the supplies they had.

Stable Isotope

We contacted Mr. Mike Butler from Ithemba Labs, who agreed to conduct the stable isotope analysis provided we showed him proof of registration and the approved proposal. We later sent the documentations and he gave a go ahead to transport the samples.

1.3.5 Week five

In the fifth week, we had no lectures because the honours students were writing their end of team tests.

Major ion

We concluded that the water samples be analysed from Elsenburg Laboratories. Because they were able to analyse at least two anions in the 50 ml and it was better for one laboratory perform all the major ion analysis. We later contacted Bemlabs to cancel the analysis and during the course of the day, we collected the water samples. The water samples were packaged and sent to the post office for courier to Elsenburg.

Stable Isotope

The stable water isotope samples had to be repackaged in 1.5ml bottles as seen in fig.2 and sent to Ithemba laboratories because Mr. Mike Butler only required that much volume of sample for stable isotope analysis. The water samples were transported and Mr. Butler gave confirmation of receipt. The remaining sample volume was sent to Elsenburg laboratory to be used for anion analysis.

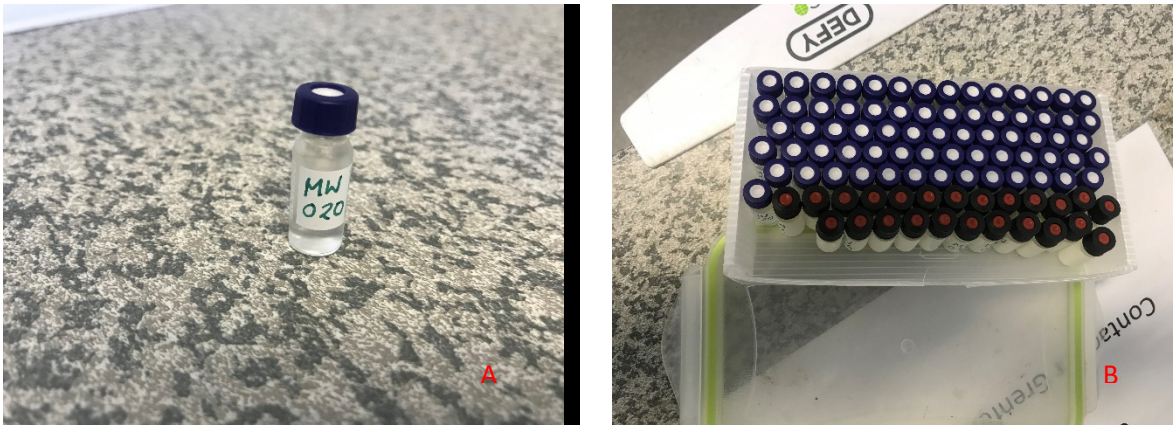

Fig. 2 A. showing a single bottle and B. Showing all the 93 bottles.

Both labs confirmed receipt of the water samples and commenced analysis.

1.3.6 Week six

In the sixth week, The University of the Western Cape was closed due to increased cases of COVID-19 in South Africa and Western Cape in particular.

2.0 Lesson learnt

The main objective of the exchange program was to analyse the water samples for stable water isotopes and major ion chemistry. This objective was met as the water samples are in the designated laboratories and analysis was being conducted before the country went on lockdown.

Part of my exchange program required I learn some modules with the Honours students. Hydrogeology module and advanced GIS module were chosen as the appropriate modules in line with my studies. I attended classes for 4 weeks until the end of the 1st term on 18th March 2020. During my stay at the University of the Western Cape, I was exposed to various software from groundwater software i.e. Aquachem, PHREEQC and Aquifer test pro to groundwater modelling software MODFLOW-2005. The University provided free online access to literature from Elsevier to downloaded articles for my final thesis writing.

The major challenge experienced was from major ion analysis. The volume (50 ml) I took to South Africa was less than the standard required for analysis. Bemlab was the first laboratory we contacted and they required at least 1 litre per sample. Bemlab could only analyse for major cations (Magnesium, Potassium, Sodium and Calcium) from the 50 ml sample but could not analyse any anions (chloride, sulphate, bicarbonate and sulphate). After consultation, we agreed to Bemlab analysing cations as we tried to engage another laboratories to analyse anions. The analysis of Major ions from two different laboratories sparked questions whether I was comparing laboratories. Furthermore, concerns whether the charge balance was going to be less than 15 %, considering different methods used by laboratories for analysis. Elsenburg laboratories was then contacted to analyse the anions, from the quotation received their pricing was cheaper than Bemlabs and they could analyse at most two anions from 50 ml volume. We then contacted Bemlabs to cancel our earlier request to analyse cations and later collected the samples. Elsenberg laboratories required at least 250 ml for the analysis of all the anions. The 50 ml was adequate for one parameter only, so we asked Mr. Butler from Ithemba labs how much volume he required for stable isotopes. Confirmation come through that he only needed 1.5 ml, which I transferred into small cups and the remaining sample was sent to Elsenberg laboratories. Two anions Bicarbonate (HCO_3^-) and Sulphate (SO_4^-) were set as priority in the analysis. If there be leftover sample the lab will analyse Chloride (Cl^-) and Nitrate (NO_3^-). Chlorides and sulphates are essential anions to determine the charge balance. According to Hydro chemists' interpretation of results without determining the charge balance error is regarded as sufficiently unreliable and cannot be justified for scientific purposes.

Due to COVID-19, all the analysis was suspended until further notice. The water samples are with the respective laboratories and will resume analysis as soon as the situation is under control.

Overall, I had a great experience at the University of the Western Cape and I gained a lot of knowledge through classes and interaction with researchers in the water sector. This opportunity broadened my understanding of my study and exposed me to different ways of conducting research.

2.1 Results and knowledge

The results from hydrochemistry will help evaluate hydro-chemical processes responsible for temporal and spatial changes in the chemistry of groundwater and surface water, while the results from stable isotope chemistry will be used to trace the origin, source, sinks and interactions in groundwater and surface water. Hydro chemical and stable isotope

analyses will be coupled to assess and characterize the interaction between groundwater and surface water in the study area.

I intend to use the software's introduced to in the interpretation of the results from the analysis being conducted from the two laboratories. Some of the skills gained will be applied in writing my final thesis but mostly the knowledge will enhance my effectiveness as a researcher and scholar. I hope to eventually become a lecturer and thus be able to pass on these skills to new students and thereby improve the capacity of my university to conduct related research and development.

2.2 Suggestions for improvements of the exchange

It would be important for exchange student to join at the beginning of the term, especially if the student will be participating in classes at the host university.

The network should help sponsor some analysis locally to avoid the inconvenience of transporting bulky samples.

Host University supervisor assigned to exchange students should co-supervise a particular section of the supervisor's expertise in the research.

3.0 Acknowledgement

Many thanks go to Dr Kawawa Banda my supervisor, The NEPAD SANWATCE team Joanna Fatch, Norma Derby and others I did not interact with directly. From the Host university Dr T. Kanyerere, Mrs Chantel Carnow, Dr S. Israel, Prof. T. Dube and Mr Siyamthanda Gxokwe. The Masters students at the University of the Western Cape that welcomed me and kept me in high spirit during my stay at UWC, Jessie Kanyerere, Robert Lebese, Refiloe Maphiri and Ndubuisi Igwebuike. To you all I am very grateful and may God continue blessing you.