Centre for Water Resources Research
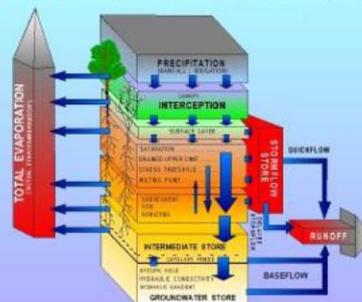
Post-Graduate Research Opportunities:
2023

Developing Future Hydrological Scientists

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INSPIRING GREATNESS

MSc/PhD/Post-doc Opportunities at the University of KwaZulu-Natal
Centre for Water Resources Research

NATIONAL FLOOD STUDIES PROGRAMME
[Note: Limited funding is currently available from research projects funded by the Water Research Commission. Scholarships (by individual application) are offered by the South African Committee on Large Dams (SANCOLD). Funding from the South African National Roads Agency (SANRAL) and mining industry may be available]

Scholarship description
Many of the techniques and approaches currently used in South Africa to estimate design floods required for the design of hydraulic structures are based on methods developed in the 1970s and 1980s and which utilised data and computing technology available at the time. With currently available longer periods of records, computing power, GIS and national scale databases, the potential exists for updating the methodologies and/or developing new approaches to design flood estimation, which could include the potential impacts of climate change on the estimation of design floods in South Africa. As a consequence, the South African Committee on Large Dams (SANCOLD) and the Water Research Commission (WRC) have initiated a National Flood Studies Programme (NFSP) to modernise methods used for flood estimation. The NFSP programme is also supported by the Department of Water and Sanitation (DWS) and the South African Roads Agency Limited (SANRAL).

Recently completed and current research activities include the following: (i) using continuous simulation modelling for design flood estimation in South Africa, (ii) updating the SCS-SA model for design flood estimation by deriving CNs for local conditions, (iii) use of ensemble joint probability approaches to improve and assess the uncertainty of design flood estimation, (iv) the use local data to improve design flood estimates, (v) assessing the impact of data screening, declining observation networks and poor data quality on the estimation of design floods, (vi) synthesizing and assessing the socio-economic impacts of floods in South Africa, and (vii) updating unit hydrograph approaches for design flood estimation in South Africa.

New research activities suited to PhD and Post-doctoral studies include the following:
(i)   uncertainty estimation in design rainfall and design flood estimation in South Africa,
(ii) accounting for the impacts of climate variability and change on both design rainfall and design floods estimation,
(iii) updating of the estimates of estimates of extreme rainfall (Probable Maximum Precipitation) for duration sub-daily to 7-day durations,
(iv) further development and assessment of regionalised methods for both daily and design rainfall disaggregation into sub-daily hyetographs,
(v)   developing methods for design flood estimation in data sparse regions, as typically found in many parts of Africa, and
(vi) refinement and consolidation of research findings rom the NFSP into tools for use in industry, including the development of a data portal to make the tools and data available to industry (suited for post-doctoral student with suitable software development experience).

Eligibility
The successful candidate(s) should be motivated, disciplined and be able to work as a member of an experienced research team, as well as to set and meet deadlines. Candidates are expected to have at least a BSc Engineering degree in an appropriate field, or an Honours degree in Hydrology, and preference will be given to PhD and post-doctoral students. Experience in design flood estimation, hydrological model development and application, and computer programming knowledge (e.g. Python, R, FORTRAN) are advantages. Good proficiency in English, both verbal and written, is also required.

Scholarship package
Prospective students are encouraged to apply with competitive funding offered, dependant on, *inter alia*, the remaining available budget. The university normally provides remission of fees, one year for fulltime MSc students and three years for fulltime PhD student. The candidate is expected to cover accommodation and living expenses, including travel to/from the University and any relocation, visa and medical insurance costs, if required.

How to Apply
E-mail your CV (with at least three traceable references), academic record and a sample of your writing in the form of a recent publication to Prof. Smithers (smithers@ukzn.ac.za). Application Deadline: TBC   **Start date**: 2023

MSc/PhD Opportunities at the University of KwaZulu-Natal
Centre for Water Resources Research

DEVELOPING A DATABASE AND UTILITY TOOL FOR UNDERUTILISED INDIGENOUS CROPS FOR INCREASED AGRICULTURAL DIVERSIFICATION IN SOUTH AFRICA

Scholarship description
According to the Food and Agricultural Organisation, three staples (rice, maize and wheat) provide more than half of the world's food. This situation needs to change by increasing crop diversification, which is a key agronomic strategy to help reduce the negative impacts of intensive monocrop agricultural systems. Improving agro-biodiversity can be achieved by expanding the production of underutilised crops. Therefore, the main objectives of this research project is to develop the following: 1) an extensive online database related to the potential yield, water use and crop water productivity of several underutilised crops currently grown in South Africa, and 2) a web-based utility to disseminate the information stored in the online database.

Eligibility
The successful candidate should be driven, disciplined and be able to work as a member of an experienced research team, as well as to set and meet deadlines. The candidate must have an Honours/Masters degree in hydrology, crop science or computer science. Preferably, the candidate should have 1) programming knowledge (e.g. Fortran, Python, R, Ruby, Unix), and 2) experience in GIS and crop modelling. Proficiency in English, both verbal and written, is also required. No candidates over the age of 35 will be considered.

Scholarship package
Prospective candidates are encouraged to apply with competitive funding offered, but dependant on, *inter alia*, the available budget and other project resources. The funding package will help cover accommodation and living expenses, as well as medical insurance costs and travel to/from the university. The university normally provides remission for fulltime MSc (one year only) and PhD students (three years only). All project-related expenses, including travel to workshops and conferences will be covered by the research project.

How to Apply
Email your CV (with at least three traceable references), academic record and a sample of your writing in the form of a recent publication/chapter from your Honours or 4th year project/MSc dissertation to Mr. Richard Kunz (kunzr@ukzn.ac.za).

Application deadline: Ideally, 31st March 2023 (or until filled)   **Start date**: As soon as possible in 2023

MSc/PhD Opportunities at the University of KwaZulu-Natal
Centre for Water Resources Research

WATER RESOURCES ACCOUNTING
(Funding is available via a Water Research Commission funded project.)

Scholarship description
With the increasing scarcity of water, reliable information on water availability and use is a necessary input to water policies that aim to provide equitable and sustainable use and to the efficient management of the water resource. Agriculture is the largest water user worldwide, so it is important that accurate information on agricultural water use and return flows is available for water resource planning and management. Urban water users in a catchment can require a high gross abstraction at a high assurance of supply, but return a portion of the abstracted water, albeit potentially with a lower quality. Ecological infrastructure provided by healthy catchments is an alternative to built water infrastructure and these services need to be quantified and better understood. Water resource accounts aim to show water inflows, outflows, storage and depletion within a catchment. To produce these accounts, an integrated data and water resource modelling system needs to be able to compute the water balance and distinguish between different components, i.e. green and blue water, between beneficial consumption, non-beneficial consumption, between recoverable fraction and non-recoverable fraction and changes in storage. In this project a methodology for modelling water resource systems to produce water resource accounts will be implemented at a national scale, with the aim of eventually being able to produce annual water resource accounts for the whole country every year.

Potential areas for research by postgraduate students could include (among others): (i) improving estimates of urban water use and return flows by obtaining and evaluating quantitative data of water releases in water treatment plants and waste water treatment plants, (ii) improving nationwide estimates of inter-basin transfer schemes by obtaining and evaluating quantitative data, (iii) improving estimates of water stocks in the form of soil moisture and groundwater, (iv) improving nationwide estimates of the impact of dams, by obtaining and evaluating data on dam releases, and interacting with DWS, (v) improving estimates of irrigation water use, (vi) application of the water resource accounts for reporting on SDGs. The student would be expected to liaise with DWS staff in the planning section for the above, to be able to obtain the data and to investigate how DWS estimate the above flows for planning purposes.

Eligibility
The successful candidate should be driven, disciplined and be able to work as a member of a research team, as well as to set and meet deadlines. Preferably, the candidate is expected to have at least an Honours degree (or equivalent 4-year degree) for an MSc or a Masters for the PhD) in hydrology, agricultural engineering or civil engineering. Ideally, previous experience in data analysis and processing, GIS and hydrological modelling would be advantage. Proficiency in English, both verbal and written, is also required.

Scholarship package
Prospective PhD and MSc students are encouraged to apply. Competitive funding is offered, but dependent on, inter alia, the available budget and other project resources. The candidate is expected to cover accommodation and living expenses, including travel to/from the University out of this funding. However, all project-related expenses will be covered by the project.

How to Apply
Email your CV (with at least three traceable references), academic record and a sample of your writing in the form of a recent publication or chapter from your Honours/4th year project to Dr. Stefanie Schütte SchutteS@ukzn.ac.za).

MSc Opportunities at the University of KwaZulu-Natal
Centre for Water Resources Research

**THE USE OF REMOTE SENSING AND EARTH OBSERVATION FOR ESTIMATING COMPONENTS
OF THE WATER CYCLE, HYDROLOGICAL MODELLING OR WATER RESOURCES MANAGEMENT**

(Note: All funding is tentative and should be finalised by mid-December. Positions can thus only be confirmed once the funder has fully agreed to the proposal.)

Scholarship description:
Remote Sensing and Earth observation technologies for estimating rainfall, ET and soil moisture are fast becoming an alternate to conventional methods of measurement due to the larger spatial and temporal resolutions.   These datasets offer new opportunities for hydrological modelling, flood and drought prediction, water use estimation and decision making for water security in South Africa. However, there is a need for validation of these types of datasets. Opportunities exist for research into the broad areas of satellite based rainfall and new products, ET and energy balance models as well as remotely sensed soil moisture estimates for integration into hydrological models for decision making.

Eligibility:
The successful candidate(s) should be focussed, disciplined, able to work as a member of a team, and be able to set and meet deadlines. Proficiency in English, both verbal and written, is required. An MSc candidate is expected to have a BSc (Hons) degree in hydrology/environmental sciences or a BSc Eng degree in a related discipline or the Honours candidate is expected to have a BSc degree in hydrology. For funding, candidates need to be South African citizens eligible to apply for NRF/SANSA or self-funded students are welcome to apply.

How to Apply:
Contact Ms. Chetty (chettyk@ukzn.ac.za).

MSc/PhD Opportunities at the University of KwaZulu-Natal
Centre for Water Resources Research

LEVERAGING THE GOOGLE EARTH ENGINE TO ANALYSE VERY-HIGH SPATIAL RESOLUTION UNMANNED AERIAL VEHICLE DATA TO GUIDE AND INFORM PRECISION AGRICULTURE IN SMALLHOLDER FARMS.

(Note: Funding is tentative. Positions can only be confirmed once the funder has fully agreed to the proposal.)

Scholarship description

In many developing countries around the world, smallholder farms are not only major contributors to agricultural production and food security but are also one of the main drivers of socio-economic growth. Despite their relative importance, smallholder farms generally lack the resources of their larger-scale commercial counterparts. Subsequently, their agricultural productivity potential is often not realized, resulting in these farms not effectively contributing to addressing food security and socio-economic challenges. In order to remedy this situation, smallholder farmers in developing countries require innovative, evidence-based and low-cost solutions that can assist them in optimizing their productivity. Recently, precision agricultural practices facilitated by the use of unmanned aerial vehicles (UAVs) has been gaining traction in the agricultural sector and hold a great deal of potential for smallholder farm applications owing to the unique characteristics of these technologies. Furthermore, advances in geospatial cloud computing have opened new and exciting possibilities in the remote sensing arena. In light of these recent developments, the focus of this study is to explore and demonstrate the utility of using geospatial cloud computing and multispectral UAV imagery to enhance the productivity of smallholder farms by mapping cultivated areas, assessing the health of these crops, as well as quantifying their water use and productivity.

Eligibility

The successful candidate should be driven, disciplined and be able to work as a member of a research team, as well as to set and meet deadlines. Preferably, the candidate is expected to have at least an Honours degree (or equivalent 4-year degree) in hydrology, crop science or any related environmental science. Ideally, previous experience in GIS and data processing would be advantageous, as well as programming knowledge (R and Java). Proficiency in English, both verbal and written, is also required.

Scholarship package

Prospective MSc students are encouraged to apply. Competitive funding is offered, but dependent on, inter alia, the available budget and other project resources. The candidate is expected to cover accommodation and living expenses, including travel to/from the University out of this funding. However, all project-related expenses will be covered by the project.

How to Apply

Email your CV (with at least three traceable references), academic record and a sample of your writing in the form of a recent publication or chapter from your Honours/4th year project to Dr. Shaeden Gokool (GokoolS@ukzn.ac.za or shaedengokool@gmail.com).

MSc (3x) Opportunities at the University of KwaZulu-Natal
Centre for Water Resources Research

Adding surface water groundwater interaction dimension in run off generation studies and in catchment water management practices using isotope tracers

(Note: Funding is tentative and should be confirmed in April 2022.)

Scholarship description

The goal of the proposed research is to make the investigation of surface water and groundwater interaction at multiple spatial scales (from small plot to catchment scale) in the Umgeni and uThukela catchments. Tracers/isotope hydrology will be used as the principal tool to meet the objectives/aims of the proposed work. The research aims to decipher the mechanism of groundwater movement in hillslopes, in small-forested watersheds and at catchment scale. Four sites, namely, the Cathedral Peak, the Fountain-Hill Estate and the Umgeni and uThukela catchments, all with long-history of hydrological monitoring will be used as case study sites. The first two sites will inform the hydrology model algorithm development through conceptual/mechanistic understanding of processes. The regional level- surface water groundwater interaction study of the Umgeni and uThukela catchments will inform water resources management (e.g. catchment protection practices, groundwater recharge zonation and protection, pollution control, etc.) practices in the region. **Three MSc students** are sought to conduct the research at the various scales.

Eligibility
Preferably, the candidate is expected to have an Honours BSc degree (or equivalent 4-year degree) in hydrology or hydrogeology science. Proficiency in English, both verbal and written, is also required.

Scholarship package
Prospective MSc students are encouraged to apply. Competitive funding is offered, but dependent on, *inter alia*, the available budget and other project resources. The candidate is expected to cover accommodation and living expenses, including travel to/from the University out of this funding. However, all project-related expenses will be covered by the project.

How to Apply
Email your CV (with at least three traceable references), academic record and a sample of your writing in the form of a recent publication or chapter from your Honours/4th year project to Prof Seifu Kebede Gurmessa (kebedegurmessas@ukzn.ac.za).

MSc Opportunities at the University of KwaZulu-Natal
Centre for Water Resources Research

Biomonitoring of stream water quality in intermittent streams

(Note: This MSc position might have already been filled, consult the centre for further details.)

Scholarship description

Hydrological studies are scant on the fate of non-perennial rivers and streams that periodically cease to flow. This oversight contributes to the degradation of the main source of water and livelihood for millions of people. As dynamic ecosystems that transition between flowing, non-flowing and dry conditions, intermittent streams are poorly represented in biomonitoring programmes in Africa or elsewhere. The applicability of biomonitoring approaches for the determination of ecological health of such streams is poorly assessed. The goal of the proposed research is to make test the applicability of biomonitoring tools such as miniSASS in determining the water quality status of intermittent streams in arid environments. The project site is located in a tropical arid environment in an African country out of South Africa.

Eligibility
Preferably, the candidate is expected to have an Honours BSc degree (or equivalent 4-year degree) in hydrology , water quality, environmental sciences etc. Proficiency in English, both verbal and written, is also required.

Scholarship package
Prospective MSc students are encouraged to apply. Competitive funding is offered, but dependent on, *inter alia*, the available budget and other project resources. The candidate is expected to cover accommodation and living expenses, including travel to/from the University out of this funding. However, all project-related expenses including 2 international travels will be covered by the project.

How to Apply
Email your CV (with at least three traceable references), academic record and a sample of your writing in the form of a recent publication or chapter from your Honours/4th year project to Prof Seifu Kebede Gurmessa (kebedegurmessas@ukzn.ac.za).

MSc Opportunities at the University of KwaZulu-Natal
Centre for Water Resources Research

Applications of isotope hydrology for management of water related operational challenges in abandoned and active coal mines in KwaZulu Natal Province, South Africa.

(Note: This MSc position will start in Sept 2022, subject to availability of sufficient project funds)

Scholarship description

Mines pollute water and water scarcity limits the expansion of mines. This project aims to employ isotope hydrology tool to assess key water related operational challenges (dewatering, pollution migration, mine flooding) related to coal mines. It further aims to assess the water quality impacts of the selected mine on adjacent areas and aquatic systems. The specific mines for this assessment will be selected from the constellation abandoned and active coal mines in the KwaZulu region. The region is characterised by the presence of several critical biodiversity reserves sitting side by side with active and abandoned mines.   The project will seek to create strong partnership and stakeholder engagement including with Mines, National Parks, Local Communities, Water Utilities etc.

Eligibility
Preferably, the candidate is expected to have an Honours BSc degree (or equivalent 4-year degree) in hydrology, geohydrology or hydrogeology etc. Proficiency in English, both verbal and written, is also required.

Scholarship package
Prospective MSc students are encouraged to apply. Competitive funding is offered, but dependent on, *inter alia*, the available budget and other project resources. The candidate is expected to cover accommodation and living expenses, including travel to/from the University out of this funding.

How to Apply
Email your CV (with at least three traceable references), academic record and a sample of your writing in the form of a recent publication or chapter from your Honours/4th year project to Prof Seifu Kebede Gurmessa (kebedegurmessas@ukzn.ac.za).

MSc Opportunity at the University of KwaZulu-Natal

Centre for Water Resources Research

MAPPING AND ASSESSING THE IMPACTS OF CROP-WEED COMPETITION IN NEGLECTED AND UNDERUTILIZED CROPS.

[Note: funding is potentially available from the Water Research Commission.]

Scholarship description

In regions such as sub-Saharan Africa where the prevalence of food insecurity and malnutrition remains high, the promotion and prioritization of neglected and underutilized crops (NUCs) takes on added significance as local growing conditions are often unfavourable for most staple crops. Hence, NUCs play an important role as a supplementary or alternate source of food and nutrition. Root and tuber crops are among the main sources of food consumed by the population and therefore, achieving good, high-quality production levels of these crops takes on added significance. While there are several factors that may contribute to low yields and inferior product quality in many farmer's fields, poor weed management is often the primary contributing factor. Weeds are able to compete with crops for primary resources such as water, sunlight, nutrients and space, and inhibit crop growth and development. Since weeds are deleterious to crop production and their control or management can be resource intensive, it is essential to better understand and quantify crop-weed interactions to improve crop productivity and promote the efficient use of critical resources.

The immense potential of unmanned aerial vehicles (UAV) technologies, also "commonly known as drones" to facilitate precision agricultural practices in both large-scale commercial and smallholder farm settings has been widely recognized. However, the quantification of crop-weed competition dynamics can prove to be challenging if solely relying on traditional desktop-based image analysis procedures. Recent advancements in big data geospatial cloud computing platforms such as GEE (Google Earth Engine) have provided a means to overcome these limitations. Subsequently, the focus of this study is to explore the strengths of geospatial cloud-computing and very-high resolution UAV imagery to accurately identify and map the spatial distribution of weeds as well as understand and quantify the impacts of weed water use on crop health, quality, yield and available water resources.

Eligibility

The successful candidate should be driven, disciplined and be able to work as a member of a research team, as well as to set and meet deadlines. The candidate is expected to have at least a BSc degree or preferably an Honours degree in hydrology, crop science or any related environmental science. Ideally, previous experience in GIS and data processing would be advantageous, as well as programming knowledge (R and Java). Proficiency in English, both verbal and written, is also required.

Scholarship package

Competitive funding is offered, but dependent on, inter alia, the available budget and other project resources. The candidate is expected to cover accommodation and living expenses, including travel

to/from the University out of this funding. However, all project-related expenses will be covered by the project.

How to Apply

Email your CV (with at least three traceable references), academic record and a sample of your writing in the form of a recent publication or chapter from your Honours/3rd year project to: Dr. Shaeden Gokool (GokoolS@ukzn.ac.za or shaedengokool@gmail.com) OR   Dr. Maqsooda Mahomed (mahomedm@ukzn.ac.za