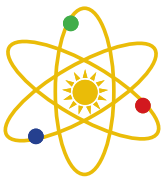
National Research Symposium 2016

Programme and Book of Abstracts

REPUBLIC OF NAMIBIA



NCRST
NATIONAL COMMISSION ON
RESEARCH, SCIENCE & TECHNOLOGY

21-23 September 2016
Safari Hotel
Windhoek, Namibia

Theme:

Engaging conversations, enhancing research quality

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FOREWORD

THE National Research Symposium 2016 represents an important milestone in our country's science, technology and innovation landscape and indeed in the history of our great Nation. The National Commission on Research, Science and Technology is tasked with the coordination of the implementation of the National Programme on Research, Science, Technology and Innovation for 2014/15 to 2016/17 that was approved by the Cabinet of the Republic of Namibia, and launched during the first quarter of 2015.

One of the 5 key strategic priorities in the National Programme on Research, Science, Technology and Innovation is "Disseminating Scientist and Technological Knowledge, looking towards a growing involvement of institutions researchers, enterprise and entire population". Under this strategic priority a key initiative has been formulated that speaks to the promotion of dissemination and publication of research results. It is through this initiative that the National Research Symposium is organized annually, where Namibian researchers are given an opportunity to present their research findings. The theme for the National Research Symposium 2016 "***Engaging conversations, enhancing research quality***" resonates very well with the mantra of the National Programme on Research, Science, Technology and Innovation for 2014/15 to 2016/17, which is the national research agenda contribution to the transformation of our economy into a knowledge based society.

As a country, we have set ourselves ambitious targets which we must achieve for science, technology and innovation to contribute to the achievement of National Development Plan objectives. The National Programme responds to research priority areas which address and contribute to solving the primary social and economic challenges of Namibia. History, experience and evidence-based facts have shown that economic growth is always accompanied by research output and technological advancement.

This symposium attracted a number of research papers from areas related to those identified in the National Programme. The areas of research and papers received cut across several sectors and include health; agriculture and fisheries; water; energy; geology and mining; indigenous knowledge; social sciences and humanities, logistics; environment and tourism; as well as the areas addressing enabling technologies which are manufacturing technologies, information and communication technology; biotechnology and space science.

I am pleased with the high quality and applicability of the current symposium research papers and I believe there is a lot of applications of research results out there. I am confident that the National Research Symposium will grow from strength to strength and that a conversation will increase not only among the research academic community but also between academia and industry, which will provide opportunity for commercialisation of research results.

Dr Eino Mvula

Chief Executive Officer

National Commission on Research, Science and Technology

Prof. Percy Chimwamurombe

Prof. Chimwamurombe is a Geneticist who was trained at University of Pretoria. He has graduated 8 PhD and 14 MSc students who now are serving the Namibian scientific fraternity in various capacities. He has attracted to Namibia research funding from international and regional agencies as well as being invited to present scientific papers world-wide. To date he has published over 80 peer-reviewed research articles.

In 2015, in Kavango region, he discovered the bacterium *Bradyrhizobium subterraneum* in collaboration with other researchers and are now investigating ways to innovatively manufacture a biofertiliser. He is negotiating with the University of Namibia lawyers to license biofertiliser formulation. Furthermore, Professor Chimwamurombe has harnessed a strong relationship with the local farmers to develop marama bean into a climate-smart crop alternative. He is now designing ways of making marama prototype products. Presently, he is leading research work in the production of marama bean seeds for international dissemination

Unlocking the potential of orphan legumes: Advances in the domestication of *Tylosema esculentum* (marama bean) in Namibia

By

Percy Chimwamurombe, Department of Biological Sciences, University of Namibia

Orphan and neglected legumes have been largely ignored by both researchers and industry due to their limited and un-explored economic potential in the global market. Negligence is despite that many people, particularly in developing countries, rely on these crops not only as food and feed crops but also for their daily healthcare needs. These legumes such as marama bean have exceptional characteristics, such as high tolerance to abiotic environmental stresses, especially drought, and production of stress response compounds with pharmaceutical value. Orphan legumes are therefore a likely source of important traits for introducing into major crops to aid in combating the stresses associated with global climate change. However, a greater investment of resources and manpower are necessary if the potential of orphan legumes is to be unlocked and applied in the future. In this paper, the strides that have been made with marama bean, a nutritional and drought tolerant legume which grows naturally in the Kalahari agro-ecological zone will be discussed. Over 500 accessions have been collected and characterized. Prototype improved by-products have been developed. Current efforts are in developing high seed yielding varieties using various approaches.

Dr Penny Hiwilepo-van Hal

Dr van Hal is a Food Scientist – specialized in the area of Food Quality Management and Product Design. She is currently working as a Senior lecturer in the department of Food Science and Technology at the University of Namibia, Neudamm Campus, and the Department which she is currently heading. Her education background include obtained Bachelor's degree of Science in Food Science and Technology at the University of Namibia in 2000, a Master degree in Food Safety in 2004 majoring in Food Technology at Wageningen University in the Netherlands and a PhD degree in Food Quality and Product Design at the same University (Wageningen University) in 2013.

She has 15 years' experience in a broad range of development and capacity building work, of which 6 years were shared between postgraduate studies and research at Wageningen University, The Netherlands. In addition to regular work and training, she has substantial international exposure in other countries such as France, The Netherlands, the United States of America and South Africa through studies, workshops and short training courses in the field of Food Science, Food Safety and Quality Managements. Furthermore she has extensive management experience having served as a member of the Faculty of Agriculture and Natural Resources management Board (University of Namibia), a reviewer of NCRST, a member of the UNIDO steering committee and as the Deputy chair of the 2016 NDP5 Food Security working group.

Health Benefits of "Omaongo" Fermented Marula *(Sclerocarya birrea)* Juice

By

Penny Hiwilepo-van Hal; Department of Food Science and Technology, University of Namibia-Neudamm Campus

This paper presents the effects of fermentation on the retention of vitamin C, total polyphenols and antioxidant activity in the naturally fermented marula juice. The fermentation conditions have been varied: temperature ranged between 20 and 40 ^{o}C and fermentation time from 1 to 8 days. Marula juice fermented at higher temperatures ranged between 30 to 40 ^{o}C for 6 to 4 days retained high antioxidant activities, and they were positively correlated to its ascorbic acid and phenolic content. The values obtained ranged between 0.0239 ± 0.0051 to 0.029 ± 0.0038 µmol/mg for Trolox Equivalence Antioxidant Capacity, 870 ± 80 to 960 ± 130 mg/100 ml for total phenolic content and 90 ± 6 to 159 ± 15 mg/100 ml for ascorbic acid. Overall, fermented marula juice can be used as a good source for natural antioxidants.

Day 1: Wednesday, 21 September 2016

Opening Session ***Master of Ceremony: Ms Elzita Beukes/Ms Iyaloo Kandjabanga***	
08h00-08h30	Registration
09h00-09h05	National Anthem and AU Anthem
09h05-09h15	Welcoming Remarks: Dr Eino Mvula, CEO, NCRST
09h15-09h45	Unlocking the potential of orphan legumes: Advances in the domestication of *Tylosema esculentum* (marama bean) in Namibia: Prof Percy Chimwamurombe
09h45-10h15	Keynote address: Honorable Dr Itah Kandji-Murangi; Minister of Higher Education, Training and Innovation
10h15-10h25	Vote of Thanks: Mr John Sifani, GM:Innovation and Technology Development, NCRST
10h25-10h30	National Athem and AU anthem
10h30-11h00	Photo session and Excursion to exhibitions: Mrs Angelique Philander: Manager: Science Promotion, Human and Institutional Capacity Development, NCRST
11h00-11h30	**Tea Break**
Plenary Session ***Facilitator: Dr Gideon Ferdinard*** ***University of Namibia***	
11h30-11h50	Health Benefits of Omaongo Fermented Marula Juice: Dr. Penny Hiwilepo-van Hal
11h50-12h50	Panel discussion Title: Food Security and Sustainability in Namibia Moderator: Ms Hilda Basson- Namundjebo Panelist 1: Mr Solomon Tsanigub; Food Safety and Standards, Agro-Markerting & Trade Agency Panelist 2: Prof. Kazhila Chinsembu; University of Namibia Panelist 3: University of Namibia Panelist 4: Ministry of Health and Social Services
12h50-13h00	**Questions and Discussions**
13h00-14h00	**Lunch**

Parallel Session		
	Thematic area: Agriculture *Facilitator: Dr Pauline Lindeque: Pro Vision Consultancy, Research and Technology*	Biotechnology; Energy & Environment *Facilitator: Dr Simon Akpo International University of Management*
14h00-14h20	*B. Thomas*, C. Togarepi* Assessment of Farm level and Market Postharvest losses along the Tomato Supply Chain of Small Scale Horticultural Farmers in Omusati Region, Namibia	*C. Mukakalisa, M. Kandawa-Schulz, M. Beaukes, K.M. Kalili and R. H. Hans** Evaluation of antioxidant and antimicrobial activity from selected Namibian indigenous edible tubers
14h20-14h40	*C. Mberema*, B. Thomas, C. Togarepi, T. Maharero* Analysis of Factors that Influence the Choice of Marketing Channels for Goats and Goat Products in Omusati Region	*H. Iileka*, A. Sendegeya, Z. Chiguvare* Monitoring of Domestic Solar Water Heating Systems in the National Housing Enterprise (NHE) Houses at Otjomuise, Windhoek, Namibia
14h40-15h00	*R.P. Shilangale*, P.M. Chimwamurombe* Comparison of excision, swabbing and meat fluid sampling techniques on the prevalence of *Salmonella* isolated from beef in Namibia	*M. E. Okorie** Comparison between LIDAR and Tower Observed Wind Data at Schlip – Namibia
15h00-15h20	**Questions and Discussions**	
15h20-15h35	**Tea Break**	
15h35-15h55	*M. Zgambo, P. Hiwilepo-van Hal*, S. Emvula, C. Togarepi* Nutritional and Sensory Analysis of Pearl millet-Marama Composite Flour Porridge	*N. A. Amatsi** An analysis of the management and utilisation of used motor oil and potential interventions in Walvis Bay, Namibia
15h55-16h15	*C. Togarepi*, B. Thomas, M. Hangula* Perception of Extension Officials on Technology Adoption by Farmers in Omusati and Oshana Regions of Namibia	*I. Hilia, C. Hange, F. Hakala, M. Matheus, C. Jansen, J. Hidinwa, O. Awofolu** Prevalence and Chemo-kinesis of Toxic Trace Metals in Environmental Samples
16H15-16H35	*H. Amunyela, P. Hiwilepo-van Hal*, C. Samundengu, C. Togarepi* Production and Comparison of Nutritional Composition of The Instant and Traditionally Prepared Cowpea *(Vigna unguiculata) Oshigali* powder	
16h35-16h55	**Questions and Discussions**	
	End of Day 1	

* Corresponding Author

Day 2: Thursday, 22 September 2016

Plenary Session *Facilitator: Prof Roderick Zimba, University of Namibia*	
08h00-08h30	Registration
08h30-10h00	Workshop on Intellectual Property Rights: Local and International Partnership/collaboration: TBC
10h00-10h30	**Tea Break**
10h30-13h00	Workshop on Intellectual Property Rights: Local and International Partnership/collaboration: TBC
13h00-14h00	**Lunch**

Parallel Session		
	Thematic area: Fisheries & Water *Facilitator: Dr PaulChisale, Namibia University of Science and Technology*	Thematic area: Social Sciences and Humanities *Facilitator: Prof Kingo Mchombu, International University of Management*
14h00-14h20	*E. Omoregie*, G. Garises, G. Liswaniso, J. Iitembu* Effects of ocean acidification: The dissolution, strength, organic content and surface texture of Pacific oysters (*Crassostrea gigas*) shells under varying acidic levels	*J.J. Coetzee** Governance as a Conceptual Paradigm for Institutional Reform and Transformation
14h20-14h40	*D.C. Louw* , R.Barlow , J. Seppäla* Composition structure of the *Pseudo-nitzschia* Species within the phytoplankton community in the Northern Benguela Ecosystem	*C. Harris** The linguistic Dilemma in Namibia's Zambezi Region
14h40-15h00	*R. Rafael** The effect of replacing the commercial fish feed with maggot meal on growth perfomance of Tilapia fingerlings	*T.K Muduva** The Contribution of *Moringa Oleifera* tree to Hunger poverty reduction in Namibia
15h00-15h20	**Questions and Discussions**	
15h20-15h35	**Tea Break**	

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15h35-15h55	*J.T Hamutoko*, M Beyer, M Gaj, H. Wanke, P. Koeniger, M. Wallner,* Analysis of major ions and stable isotopes in shallow and deep aquifers of the Ohangwena Region, Namibia	*D. Tjirare, F. Bhunu Shava** Developing Security Metrics to Evaluate Employee Security Awareness Levels: A Case of a Ministry in Namibia
15h55-16h15	*M.N. Uugwanga, N.A Kgabi*, K. Knoeller* Isotopic Composition of Water Bodies in the Kuiseb and Cuvelai-Etosha Basin, Namibia	*E. Madejski*, L. Jackie, T. Hamukoto* Investigating into the impact of driver's negligence, reckless driving and the impact of traffic law enforcement and road accidents statistics in Namibia
16h15-16h35	**Questions and Discussions**	
	End of Day 2	

Day 3 : Friday, 23 September 2016

Parallel Session		
	Thematic area Logistics, Social science and Humanities and Manufacturing Technologies *Facilitator: Ms Loide Shifula, University of Namibia*	Thematic area Health, IKS *Facilitator: Dr Petrina Kapewangolo, University of Namibia*
08h00-08h20	*K. Odero** Assessment of Feasible Meta- analysis of Methods for Measuring Logistics Performance in Namibia	*H. M. Kwaambwa** Antibacterial Activity of Moringa Extracts Against Water –borne Bacteria diseases and New Insights into Structure of Flocs
08h20-08h40	*J. Reinhardt*, J. Sieck, H.N. Muyingi* A Study for Interaction in Augmented Reality for exhibitions and Museums	*J.T Ithindi, N.A Kgabi*, E. Atekwana* Concentrations, Salinity and Toxic Trace Elements of Different Water Sources within the Kuiseb and Cuvelai-Etosha Basin, Namibia
08h40-09h00	*L. Akundabweni*, C. Mberema, B. Thomas, C. Togarepi* An assesment of the Opportunities for Commercialization of the Underutilized Indigenous Food Crop Mutete *(Roselle-Hibiscus Sabdariffa L.)* in Namibia	*E.L.M David*, E. Daniels, V. Uushona-Mikka* Determination of diagnostic reference levels for chest examination for Windhoek, Namibia
09h00-09h20	**Questions and Discussions**	

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09h20-09h40	*S. Shimhanda** A Review of the Global Navigation Satellite System (GNSS) Network and Determination of Ionospheric Total Electron Content (TEC)	*M. Mukesi, F. Engelbrecht, S. Khan, S. R Moyo** Prevalence and Capsular Type Distribution of Group B Streptococcus (GBS) Among Pregnant Women in Windhoek, Namibia
09h40-10h00		*E. Imalwa** Management of cultural heritage sites in Namibia: A case study of the Twyfelfontein World Heritage Site, Namibia
10h00-10h15	**Questions and Discussions**	
10h15-10h30	Tea Break	
	Thematic area ICT and Geosciences *Facilitator: Mr Lameck Mbangula Amugongo, Namibia University of Science and Technology*	Thematic Area: Space Science *Facilitator: Dr Eli Kasai, University of Namibia*
10h30-10h50	*I. Nhamu*, H. Venter* A meta analysis of the state of the art Cloud Forensics Data Acquisition Techniques	*A. Gairiseb** International Cooperative Mechanism on Space Activities in Namibia
10h50-11h10	*S. A. Reju*, I. D. O. Ndadi, G. Gope* Applications of Wavelet Analysis to Geomagnetic Disturbance Monitoring and Modelling of the NamPower Network	*W.N Nekoto*, N. Oozeer* Namibia Virtual Observatory
11h10-11h30	**Questions and Discussions**	

Closing ceremony ***Master of Ceremony: Ms Elzita Beukes/MsIyaloo Kandjabanga***	
11h30-11h35	***National and AU Anthem***
11h35- 11h50	***NRS2016 Recap and summary: Mrs Angelique Philander, Manager: Science Promotion, Human and Institutional Capacity Development, NCRST***
11h50-12h00	***Presentation of certificates of participation: Dr Eino Mvula, CEO and Dr Diina Shuuluka, GM: Research, Science, Technology & Innovation Coordination and Support, NCRST***
11h35-12h20	***Vote of thanks: Mr Albanus Sindano, Programme Officer: Science Promotion, Human and Institutional Capacity Development, NCRST***
12h20-12h35	***National and AU Anthem***
12h40-13h40	***Lunch***
End of the Symposium	

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Agriculture

Analysis of Factors that Influence the Choice of Marketing Channels for Goats and Goat Products in Omusati Region

C. Mberema[1*], B. Thomas[2], C. Togarepi[2] and T. Maharero[2]

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Production of goats is an important component that supports the livelihoods of the majority of the households in the Northern Communal Areas of Namibia (NCA). It contributes to food security and alleviate seasonal food scarcity by continuously supplying milk, meat and cash. Goat production is however hampered by poor marketing strategies of goat products as information on existing goat marketing systems, flock dynamics, management interventions, and levels of investments are limited. In the NCAs, the challenges and opportunities that farmers face in goat production and marketing are poorly understood and documented. Therefore the aim of this study was to analyse the current goat marketing systems and potential of goat products in Ogongo Constituency in the Omusati Region. The study used a stratified sampling method in which the constituency was divided into five strata represented by villages and households who farm with goats purposively selected after which households were selected randomly in each strata to meet at least 30% of the goat farmers. A structured questionnaire was then administered to the selected goat farmers on socio-economic information, income levels, livestock ownership, markets used for goats among others. The data was analysed using multiple regression analysis to identify factors that influence choice of goat markets among farmers. The results indicated that the factors that influenced the market channel (formal and informal) used were the number of goats owned, the purpose for keeping goats, other sources of income, distance to the market, price, and occupation of the head of household. Thus choice of marketing channel (formal or informal) was influenced by the above factors and these factors need to be considered where efforts to improve marketing of goats are concerned. This study recommends that there is need to explore use of other market channels such as the formal markets as results indicated that currently, most farmers use informal channels.

Keywords:
Formal markets, informal markets, challenges, opportunities, income, livelihood, price

Comparison of excision, swabbing and meat fluid sampling techniques on the prevalence of *Salmonella* isolated from beef in Nam

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Salmonella bacteria cause major challenges in food production and public health because of their ability to cause foodborne disease known as salmonellosis. The microbiological safety of food can be ensured through routine surveillance programs with a view to detect the presence of pathogenic bacteria such as *Salmonella*. However, the rate of *Salmonella* detection in food may be affected by the sampling technique used leaving the product unsafe for human consumption. In order to assess the effectiveness of sampling techniques for *Salmonella* detection, a total of 9508 of beef samples were collected from the local slaughter houses over a period of two years starting from January 2008 to December 2009. Samples used were routine samples collected using three different sampling techniques; excision, swabbing and meat fluid. Samples were pre-enriched in Buffered Peptone Water followed by enrichment in the Rappaport Vissiliadis and Selenite Cystine broth. The isolation of *Salmonella* was done on Xylose Lysine Desoxycholate and Brilliant Green agar followed by biochemical confirmation and serotyping according to Kauffman-White scheme. The statistics analysis by Chi square showed that there was a significant difference ($p < 0.05$) on the prevalence of *Salmonella* between the swabbing sampling techniques (2.67 %) with excision (0.50 %) and meat fluid (0.43 %) sampling technique. However, there was no significant difference ($p > 0.05$) between the excision and meat fluid sampling techniques. The findings suggest that the three sampling techniques could produce different results when used for sampling beef for *Salmonella* detection. The swabbing sampling technique showed a higher detection rate of *Salmonella* and could be the best choice as compared to other techniques. The significant detection rate of the swabbing sampling technique as compared to other techniques could probably be due to the large surface area employed in this technique.

Keywords:
Sampling technique, excision, swabbing, meat fluid, *Salmonella*

Nutritional and Sensory Analysis of Pearl millet-Marama Composite Flour Porridge

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Although it has limited value added products, pearl millet remains a nutritious staple for many Namibians. According to government policy, it is a high priority crop in its drive for food security, enhanced rural livelihoods, income, job/enterprise creation and industrial diversification. On the other hand, Marama bean, an underutilized wild legume is part of the diet for indigenous populations of the Kalahari. The seeds are rich in lipid and protein, and have the potential to improve nutrition and food security for people living in these rural areas. Thus, the aim study was to evaluate effects of compositing pearl millet flour with varying levels of marama flour on sensory quality and nutritional composition of pearl millet porridge. The results showed that addition of marama flour to pearl millet enhanced the nutritional quality of the pearl millet porridge. Roasting the beans gave the porridge a nutty flavour and aroma. The three porridges formulated using the different ratios of pearl millet to marama flour: 50:50, 25:75 and 75:25 were found to be similar in their nutritional quality although ash content was significantly different ($p<0.05$). Sensory tests showed that the panellists found the porridges to be significantly different in appearance, flavour and texture ($p<0.05$). Consumer sensory test found that porridge made from 75:25 pearl millet to marama flour ratio was preferred compared to the other two porridges. It can be concluded that overall consumer acceptability is influenced by their familiarity with the product. Most of the panellists were regular consumers of pearl millet while a few had exposure to marama bean. The study recommended that more research be done to improve the sensory qualities of the porridge to enable its acceptability and marketability. There is also need for further research on possible additives that could improve the product quality and shelf life.

Keywords:
Processing, taste, proximate analysis, nutrition, food security, organoleptic test

Perception of Extension Officials on Technology Adoption by Rural Farmers in Omusati and Oshana Regions of Namibia

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Agricultural production in northern Namibia has been affected by erratic rainfall, low soil fertility, limited access to credit, high pest and disease incidences as well as limited use of new agricultural innovations. The purpose of this study is to find out the perceptions of the agricultural extension officials on the technology adoption by the farmers in Omusati and Oshana regions. The research questions focused on soliciting information on perceptions of extension officials on agricultural innovations among rural farmers. A purposive sampling method was used to collect data from agricultural extension officials using a structured questionnaire. Most of the data was of qualitative nature. Despite efforts by the government to increase farmers' productivity, adoption rates of modern innovations are however, still very low among rural farmers. The data was analysed using frequencies and cross tabulations for descriptive statistics. The results indicated that most public extension officials feel that they are not specialised in all areas that they need to assist farmers in, area of jurisdiction is too large, and the allowable kilometres are too low. Furthermore, the results showed that farmers do not attend meetings and also fail to follow instructions, farmers are not interested in new technology, and extension officials are not adequately trained on new innovations and too much administrative work among others. The study concluded that the extension officials perceive technology adoption among rural farmers to be moderate due to both extension officials and farmers' related factors such as farmers not following instructions and farmers not attending meetings where information on technology is shared. The study thus recommends that there is need for training of extension officials on new technology use, hiring more extension officials, hiring office assistants to assist with office administrative work and create awareness among farmers, among other aspects that can enhance technology adoption by farmers.

Keywords:
Innovation, production, rural areas, government, support, training

Assessment of Farm level and Post-harvest losses along the Tomato Supply Chain of Small Scale Horticultural Farmers in Omusati Region, Namibia

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Small scale farmers in Omusati Region experience post-harvest losses of their tomatoes due to lack of market, lack of processing facilities and high perishability of their produce. The losses are very high (30%) and thus cause losses of potential income to the farmers. The study sought to assess the post-harvest losses along the tomato supply chain. The study used a supply chain analysis approach to determine the different stages at which post-harvest losses occur. A purposive sampling method was used to select 44 tomato producers in Omusati region for interviews. The data was analyzed using descriptive statistics. The study found that at the farm level, post-harvest losses were up to 30% of total output while at the market it is 10%. The losses at farm level were a result of diseases (rust and leaf miners) and pests (nematodes, red spider mites and aphids), sun burn, over-ripening of crop in the field due to lack of on farm storage facilities which lowered the quality of tomatoes. At the market, the losses were a result of low shelf life and perishability, lack of cooling facilities, long distances to the market, as well as exposure to heat. These factors were found to increase post-harvest losses and reduced the incomes of the farmers by at-least 40%. The study therefore recommends that there is need for marketing cooperatives and use of cooling trucks to transport the produce to the market to maintain the quality of products. Although farmers do apply pesticides, there is need to train farmers and their laborers on proper disease and pest control as well as on general crop management at farm level.

Keywords:
Value addition, on-farm losses, marketing, employment, income, perishable, cooperatives, cold storage

Comparison of Nutritional composition of Cowpea (*Vigna unguiculata*) powder (*oshigali*) prepared using traditional and improved methods

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In this study, cowpeas *(Vigna unguiculata)* were processed into an organoleptically acceptable instant *Oshigali* powder and the nutritional value of the processed powders was evaluated. Four different processing methods (extrusion with additives, extrusion without additives, traditionally prepared without additives and traditionally prepared with additives) were evaluated for the effect on nutritional value and organoleptic properties of Cowpeas *(Vigna unguiculata)* powder (Oshigali). The nutritional value of dehulled extruded cowpea *oshigali* powder, dehulled cowpea *oshigali* powder and the dehulled boiled/ traditionally prepared *oshigali* powder were analysed. The proximate analysis showed that dehulled cowpea *oshigali* powder was higher in protein (24.50%) and crude fiber content (6.10%) than the extruded and traditionally prepared *oshigali* cowpea powders respectively. The fat, ash, crude fibre and moisture content of the dehulled extruded cowpea oshigali powder were 0.1%, 3.00%, 5.50%, 11% for dehulled boiled cowpea *oshigali* powder and 1.40%, 2.78%, 6.00%, 12.50% respectively. The cowpea *oshigali* powder was evaluated on the sensory attributes of appearance, odor, taste and texture. These sensory properties data were subjected to Kruskall-Wallis one-way Analysis of Variance; a non-parametric statistics test method with Chi-square p-value using the SPSS software version 21. There was a significant difference in the overall preference between the extruded (with or without additives) and traditionally-boiled (with or without additives) *oshigali* powders ($p < 0.01$). The results of organoleptic analysis revealed that the consumers preferred the dehulled extruded (with additives) *oshigali* powder with a mean rating of 7.00. The mean ratings of traditionally prepared powder without additives was 4.50, extruded without additives was 6.55, traditionally prepared with additives was 5.00 while the extruded with additives was 8.00. It can be concluded that extruded cowpea *oshigali* powder was preferred compared to traditionally prepared *oshigali,* as far as sensory properties (appearance, odor, texture and taste) are concerned. The extruded cowpea *oshigali* was accepted by the panelists based on the tested organoleptic properties.

Keywords:
Processing, proximate analysis, poverty, food security, organoleptic test

Biotechnology

Evaluation of antioxidant and antimicrobial activity of crude extracts from selected Namibian indigenous edible tubers

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The consumption of vegetables with high natural antioxidant content has been associated with reduced incidences of diseases like cancer, arthritis, heart diseases, brain dysfunction and immune system decline. Indigenous vegetables play an important role in food security and nutritional balance in sub-Saharan Africa; whereas indigenous leafy vegetables (ILVs) have been extensively studied, edible tubers are relatively unexplored in terms of nutritional and medicinal values. This study is therefore aimed at evaluating the antimicrobial and antioxidant activity of extracts from selected indigenous tuberous vegetables. These vegetables include *Coccinea rehmannii*, *Eulophia hereroensis*, *Trachomeria macrocarpa* and *Walleria nutans*, and form part of the Khoisan's diet.Plant collection was done in Tsumkwe in the Otjozondjupa region over the period 20th – 23rd January 2015. The air-dried, grounded tubers were subjected to a sequential extraction at room temperature, using analytical grade solvents: hexane, dichloromethane (DCM), ethyl acetate, acetone, ethanol and distilled water. Antioxidant activity testing was done using the 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay with ascorbic acid as the positive control. The spot on lawn method was used to evaluate the antimicrobial activity of extracts against four microorganisms: *Staphylococcus aureus, Escherichia coli*, *Candida albicans* and *Klebsiella pneumonia*. Minimum inhibitory concentrations (MICs) were also determined. Extracts were then tested for biofilm inhibition, eradication or reduction of *Staphylococcus aureus*, a well-known biofilm producer.The antioxidant activity recorded for the acetone extract of *Trachomeria macrocarpa,* with an IC_{50} of 0.09214mg/ml, was equipotent to that of the positive control (IC_{50} of 0.091mg/ml). An IC_{50} of 0.1162mg/ml was recorded for the ethanol extract of *Eulophia hereroensis*. The best antimicrobial activity was observed for the ethyl acetate extract of *Eulophia hereroensis* with an MIC of 2 mg/ml followed by the DCM extract of *Trachomeria macrocarpa* with an MIC of 5 mg/ml. Biofilm reduction of *S. aureus* was noted for *Eulophia hereroensis* and *Walleria nutans* with values ranging from 84% to 99%.In conclusion, the antioxidant and antimicrobial activity of extracts from the selected tuberous vegetables are reported here for the first time. Furthermore, this study identified two vegetables namely *Eulophia hereroensis* and *Trachomeria macrocarpa* which merits further studies. The isolation, characterization and biological testing of their phenolic compounds is currently being done.

Energy

Comparison of Lidar and Tower Observed Wind Data at Schilip Namibia

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Schlip Experiment is part of the National Wind Resource Assessment Project (NWRAP). In this experiment, Mobile Telecommunication Company (MTC) tower was instrumented and used for actual wind data observation. Previous studies indicates that wind data measured using dedicated masts (Tubular or Latticed) are inevitably subjected to uncertainties due to tower shadow effect, inertia effect of the anemometer and uncertainties due to hub height extrapolation. More uncertainties may be expected in Schlip Experiment where Communication Tower not built according to International Electrotechnical Commission Standard (IEC 1264100-12-1) was utilized for wind measurement. To understand this perceived uncertainties in wind speed, wind shear trend and energy production and to take spot-check of wind resource at different hub heights, a Continuous Wave (CW), QinetiQ Ltd (UK) ZelphIR (Z300) Lidar (Light Detecting and Ranging) was installed in close proximity from the foot of the tower. This paper entails evaluation, verification and comparison of the concurrently observed data from the two data acquisition techniques. The outcome of the study may assist the stakeholders to understand some inherent uncertainties associated with the use of tower of this nature for wind data measurement since the Lidar measured wind data is considered undisturbed and site representative. Detailed analysis of wind shear trend, speed distribution and energy yield estimation may provide insight on the sites suitability for wind power project development.

Keywords:
Wind resource assessment, communication tower, Lidar, data analysis, data comparison

Monitoring and Statistical analysis of data of Domestic Solar Water Heating Systems in National Housing Enterprise (NHE) Houses at Otjomuise, Windhoek, Namibia

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The Solar Thermal Training and Demonstration Initiative (SOLTRAIN) project's a project implemented by the Namibia Energy Institute with objectives that include the strengthening of the relationship between the Ministry of Mines and Energy (MME), and National Housing Enterprise (NHE), in supporting NamPower's electricity demand side management efforts of replacing. In an effort to develop a flagship site for the SOLTRAIN project in Windhoek that can be used as a show case for promotion of solar hot water among policymakers and project financers, the project has facilitated the installation of 62 solar water heaters at low cost houses in Windhoek's Otjomuise in December 2015. Monitoring instruments were installed at 6 houses. The paper presents preliminary results from the monitoring of these Domestic Solar Water Heating (DSWH) Systems installed by the Soltrain Project II in newly constructed houses under the National housing Enterprise in Namibia. The purpose of the study is to give a long-term comparison in terms of benefits and challenges between DSWH systems and domestic electric water heating (DEWH). All solar water heaters installed at the site have auxiliary back-up electric elements. The preliminary results presented in this paper are based on two types of households as case study: four houses meeting their hot water demand using only solar water heating systems (2m^2 systems) and two houses meeting their hot water demand by only electric geysers (rated 2kW). The former represent the test and later the control households. The systems were installed with measuring, monitoring and data acquisition or logging equipment to collect data about solar radiation received, thermal performance of the collector, hot water usage and energy usage (both electrical and solar) including losses. The preliminary results indicate that 30% of the electric energy consumption in houses without solar water heating systems is used to meet their hot water demand.. The preliminary results for the month of January show that for households with solar water heaters most of the time the electric back-up element was off and the families with only solar water heaters never lacked hot water. The solar yield in Otjomuise is between 140 and 145 kWh/month. One family of three using a solar water heater (160L) had no need for any electrical back-up during this three-month period. In the six houses monitored the hot water consumption ranged from 17 to 34 litres for one person per day. The electricity demand for electric geysers (100L) ranges from 45 to 90 kWh per month.

Keywords:
Solar energy; monitoring; solar water heaters; electric geyser

Environment

Prevalence and Chemo-kinesis of Toxic Trace Metals in Environmental Samples

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The aim of this study was to assess incidences, level and mobility of some toxic trace metals of human health concern in environmental samples. The goal was to assess environmental pollution emanating from potential anthropogenic sources and their consequences on human, wildlife and environmental health. Environmental samples (soil, plant and lower animals) were randomly collected from stratified study/sampling areas, labelled, preserved and taken to the laboratory for pre-treatment and analysis. Acid digestion technique was employed for the isolation of metallic contents in samples and their identification and quantitation were carried out using Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES). Analytical protocol was validated through the quality assurance process which was found acceptable with quantitative metallic recoveries in the range of 85-90 %; hence considered applicable for the analyses of samples. The mean concentration of analysed metals in soil samples ranged from 53.2- 2532.8 mg/kg (Cu); 59.5- 2020.1 mg/kg (Zn); 1.80 – 21.26 mg/kg (Cd) and 19.6- 140.9 mg/kg (Pb). The mean level in grass samples ranged from 9.33 – 38.63 mg/kg (Cu); 64.20-105.18 mg/kg (Zn); 0.28–0.73 mg/kg (Cd) and 0.53 -16.26 mg/kg (Pb) while the mean level in lower animal sample (beetle) varied from 9.6 - 105.3 mg/kg (Cu); 134.1-297.2 mg/kg (Zn); 0.63 – 3.78 (Cd) and 8.0 – 29.1 mg/kg (Pb) across sample collection points (SCPs) 1-4 respectively. Metallic transfer factors (TFs) were in the order Zn >Cd > Cu > Pb with Metal Pollution Indices (MPIs) in the order SCP1 > SCP2 > SCP3 > SCP4. About 60-70 % of analysed metals were above the Maximum Allowable Limits (MALs) in soil and plant samples.The results obtained generally revealed the prevalence of analysed metals at all sampled sites with indications of metallic mobility across the food chain. In addition, higher metallic concentrations above MALs were recorded in several analysed samples. This outcome is significant in that it revealed probable exposure route of the metals to human which can potentially lead to bio-accumulation, bio-transformation and bio-magnification across the food chain. This signifies dire consequences for human health and the environment with socio-economic implications.

Keywords:
Trace metals, prevalence, water, soil, animal, samples, health

An analysis of the management and utilisation of used motor oil and potential interventions in Walvis Bay, Namibia

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The automotive industry is one of the biggest sources of used oil. Waste oil is among those anthropogenic pollutants which are frequently discarded into the environment. If not handled properly, they provide a potential for severe environmental damage, as well as health and safety risks. In many towns and cities, this popular hazardous material is not correctly managed. In Walvis Bay, management, utilisation and areas of potential intervention were investigated using in-depth interviews of a sample of mechanics from auto mechanic workshops and oil recycling companies. A total of 29 auto mechanic workshops which offer oil changing services were sampled from three suburbs of Walvis Bay, namely Kuisebmond (13), Narraville (4) and Walvis Bay Proper (13). Interviews were also held with two companies doing recycling of waste motor oil. The study revealed that most workshops are operating illegally without registration with the local authority, while the rest were registered with the local authority. Furthermore, slightly more workshops give away their used oil for free, whereas the rest sell their waste oil. Various types of containers are used to store waste oil before disposal. Of the surveyed workshops, 31% use metal drums, 24% use metal tanks, 21% use plastic drums, 7% use plastic tanks, and 7% use half plastic Jerry cans, while 10% have no storage facilities. The preferred methods for disposing waste oil also vary. Based on the results, 79% of the workshops have their used oil collected by oil recyclers, while 7% have theirs collected by farmers/individuals. Further, 3% of the workshops take their used oil to a metal scrap yard, while the remaining 10% of the workshops keep their oil at the site as long as the drum has never filled up. The relationship between business registration status, storage and disposal methods for waste oil was not similar, but varied in magnitude between the three suburbs, and among workshops. There is no relationship between business registration status and weather the workshop is selling or not selling used oil. The method of storage for waste oil and the preferred disposal method are both dependent as to whether the auto mechanic workshop is registered or not. Interviews with two oil recycling companies revealed that the collected/received used oil undergo a separation process in order to produce light furnace oil that is burned in boilers for generation of heat.
The study concluded that automotive used oil is managed and handled differently within each suburb and across all the three suburbs.

Keywords:
Waste oil, auto mechanic workshops, oil recyclers, lubricants, storage, disposal, recycling

Fisheries

Effects of ocean acidification: The dissolution, strength, organic content and surface texture of Pacific oysters (*Crassostrea gigas*) shells under varying acidic levels

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Marine coastal organisms are exposed to periodic fluctuations in seawater pH driven by biological carbon dioxide (CO_2) production which may in the future be further exacerbated by the ocean acidification associated with the global rise in CO_2. There is widespread concern that these changes have direct impact on coastal organisms and alter the habitats severely. However, little or no attention has been given to the effects of the anticipated decrease in coastal pH on farmed oysters within the Namibian coastal waters. In this investigation, shells of the Pacific oysters, *Crassostrea gigas* were exposed to varying acidic levels under laboratory conditions; pH level 6.5 represented extreme hypercarpnia condition, 7.0 and 7.5 representing future predicted coastal pH levels. Shell dissolution rate, strength, organic content and surface texture were assessed after a two-week exposure period. Significant loss ($p < 0.05$) in weight and diameter were observed in shells exposed to 6.5, 7.0 and 7.5 pH levels compared to shells in the control groups (pH 8.1–8.2). With regard to organic content of the shell, significant reduction ($p < 0.05$) was only observed in shells exposed to 6.5 and 7.0 pH levels. Microscopic examination of the shell surface after the exposure period revealed reduced nacreous layer while the organic layer of the shells was sheared in acidic conditions. Visual inspection of the nacre region of shells exposed to 6.5, 7.0 and 7.5 pH revealed straight edged tablets, with the nacre regions characterised by sparse, irregularly shaped tablets within a reduced organic matrix. The observed changes in shell morphometry, coupled with the alteration of the shell structure could have broad impacts on the ecology of Pacific oysters at elevated acidic conditions and consequences for the cultured oyster industry that relies on them.

Keywords:
Ocean acidification, climate change, hypercapnic, pH, shell integrity, *Crassostrea gigas*

Composition structure of the *Pseudo-nitzschia* species within the phytoplankton community in the Northern Benguela Ecosystem,

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Changes in the Earth's climate and global warming are likely to have an impact on the bloom cycles such that upwelling may become less frequent, resulting in warmer offshore water intruding closer to the coast of Namibia. Under these circumstances, it is hypothesized that small phytoplankton are likely to become more prevalent in the warm waters where inorganic nutrients are lower. Since phytoplankton is the base of the marine food web, such a shift to dominance by small phytoplankton will have an impact on plankton productivity and fishery yields in the northern Benguela upwelling system (nBUS). Therefore, the composition of phytoplankton communities in Namibian coastal waters was investigated by means of HPLC, fluorometry and microscopy in order to gain improved understanding of the importance of small microalgae in the northern Benguela ecosystem. In our three-year data-set, nano-phytoplankton (<20 µm) was compared with net-phytoplankton (20-200 µm) and larger phytoplankton (>200 µm) using chlorophyll-a as an indicator. The data showed that in the nBUS these three size classes dominated at different periods annually. It was apparent that the net-phytoplankton (20-200 µm) dominated up to April, and nano-phytoplankton (<20 µm) increased from May to December. However, larger net-phytoplankton cells (>200 µm) peaked in December, while the phytoplankton cells in the range 20-200 µm stayed low. One prominent diatom specie, the *Pseudo-nitzschia* species seemed, to dominate. The presence of this species was important in the nBUS, because it was toxic and can therefore have a negative effect on the environment, the mariculture industry, and economy.

Keywords:
Phytoplankton, nano-phytoplankton, chlorophyll-a, pigments, nutrients, temperature, wind, northern

The effect of replacing commercial fish feed with maggot meal on growth performance of tilapia fingerlings

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Demand for fish is increasing not only because of the increasing world population but due to greater awareness of the importance of fish in the diet and for some areas fish is a primary source of protein. Two feeding trials were conducted for eight weeks each to compare the growth performance of fingerlings of Redbreast tilapia (*Tilapia rendalli*) and Mozambique tilapia (*Oreochromis mossambicus*) fed commercial fish diets and maggot meal as alternative protein source. The fingerlings of 1-2 g were stocked in aquariums at 1.5 fingerlings/ liter at 28°C, fed 10% of their body weight three times a day. Each group of 3 aquariums was assigned to a dietary treatments for the *T. rendalli* study were either the Tilapia feed standard pellets (TS) as a control or Tilapia starter pellets and then maggot meal (TM). For the *O. mossambicus* study the fingerlings were fed either Tilapia Starter pellets (TS), MARBAR diet (MD) or maggot meal (MM). The chemical composition of the feeds was analyzed for dry matter (DM), crude protein (CP), ash and ether extract (EE). The DM content of commercial diets and maggot meal diets did not differ ($P>0.05$) among the treatments. The CP content of the three diets was significantly different ($P<0.05$) between all the treatments except MARBAR diet. The EE content of maggot meal was significantly higher ($P<0.05$) than that of the commercial feeds. The ash content of the diets differed significantly ($P<0.05$) among each other. Results on the growth performance indicate that there was a significant difference ($P<0.05$) in the wet weight and mean body length of the fingerlings among maggot meal diet and the commercial diets. MARBAR and Maggot meal had a significant ($P<0.05$) lower mean wet weight and mean body length compared to the standard starter pellets (TS). From these experiments, it is concluded that maggot meal is possibly a viable alternative for Tilapia diets if included at low inclusion levels rather than the total substitution of commercial diet. It is recommended that further studies on maggot meal inclusion levels in tilapia pelletized feeds be investigated.

Keywords:

Maggot meal, commercial diets, feeding fingerlings, Oreochromis mossambicus and Tilapia rendalli

Geosciences

Applications of Wavelet Analysis to Geomagnetic Disturbance Monitoring and Modelling of the NamPower Network

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Geomagnetically Induced currents (GICs) that flow along electric power transmission systems and other electrically-conducting infrastructure are produced by a naturally induced geo-electric field during geomagnetic disturbances. Modelling and monitoring of GICs have become an increasing interdisciplinary research area covering space physics, mathematical modelling, power system modelling and analysis, among the many related areas of expertise. GICs are capable of causing damage to power system plants such as power transformers and also cause system instability in power grids. The research paper employs wavelet analysis to investigate the low and high pass filter representations of the GIC profiles in the Ruacana-Omburu 330kV and the AuasKokerboon 220kV power lines of the Namibia's national power utility (NamPower) network. In the paper, the choice of Daubechies family of wavelets for the NamPower GIC signal analysis, is informed by their more extensive usefulness in solving a broad range of problems, e.g. self-similarity properties of a signal, signal discontinuities, etc. They have more vanishing moments, are not symmetric and have more coefficients both in low and high pass filter bands. Being the most popular wavelet family used for quality feature analysis, for example, due to orthogonal and compact support abilities, they use overlapping windows, so the results reflect all changes between signal intensities and they average over more intensities. From the wavelet simulations and analyses, any effect of GICs on transformers, for example, appears to be the same at some specific times of the day (especially early hours of the day, before mid-day and before sunset), thus suggesting that a mitigation put in place in one substation may be recommended for the other. Moreover, some of the results showed that the high filter signals or wavelets revealing signal intensities that are not usually evident in spectral analysis, are the same for the two substations despite their superposed symmetric profiles.

Keywords:
Geomagnetically induced currents; wavelets, Daubechies wavelets, NamPower

Health

Prevalence and Capsular Type Distribution of Group B Streptococcus (GBS) Among Pregnant Women in Windhoek, Namibia

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Vertical transmission of Group B Streptococcus (GBS) from colonized mothers to their new born babies can result in early onset GBS infection which occurs in the first 7 days of life and is a leading cause of invasive bacterial infection in neonates. Mortality in early onset disease is estimated at 5% and is characterized by bacteraemia, pneumonia and meningitis. Capsular serotyping has been one of the mainstays in the descriptive epidemiology of GBS. Ten capsular serotypes 1a, 1b, 11-IX, have been described based on the antigenicity of their capsular polysaccharides. This capsule represents one of the major virulence factors of GBS. This study sought to determine the prevalence of GBS in pregnant women in Namibia and establish the capsular type distribution of GBS isolated from those pregnant women. Lower vaginal and rectal swabs were collected from women between 35 and 37 weeks gestation for isolation of GBS. Multiplex Polymerase Chain Reaction (PCR) was performed using One *Taq*R master mix for determination of capsular types. Electrophoresis was done using 2% agarose with ethidium bromide. A total of 860 pregnant women were screened for GBS. The prevalence of GBS among pregnant women was 13.6%. Out of a total of 117 GBS isolates, serotype distribution was as follows: II (59.4%), III (24.6%), V (10.1%), Ib (2.9%), Ia (1.5%) and IV (1.5). Capsular type Ia, Ib, II, III and V were 98.5% of the total. Capsular types Ia, Ib, II, III and V which have been implicated as being responsible for most of the early onset diseases by most researchers were the most prevalent in Namibia. Capsular type III which is widely regarded as the most invasive had the second highest percentage among pregnant women in this current study. In Namibia the capsular types which were colonizing pregnant women are those which have been implicated in early onset disease in new born babies. Although capsular type distribution of GBS in Namibia is the same as in neighbouring countries like Zimbabwe and South Africa, the prevalence of GBS among pregnant women between 35 and 37 weeks gestation was much lower.

Keywords:
Group B streptococcus (GBS), capsular, pregnant, women, Namibia

Determination of Diagnostic Reference Levels for chest examination for Windhoek, Namibia

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The widespread use of x-ray examination has improved lives worldwide and this evolution of imaging has also resulted in a significant increase in the population's exposure to ionizing radiation. This exposure can be minimised by the setting up Diagnostic Reference Levels (DRL's). The International Atomic Energy Agency (IAEA) requests each country to establish its own DRL's appropriate to their own radiological techniques although such DRLs should match of the IAEA in order to minimise patient radiation dosages. Management of patient dose and determination of DRLs are important part of quality control programs in x-ray diagnostic departments as it forms an efficient and powerful standard for minimising radiation dosage to patients**.** Since Namibia has not yet established DRL's, the aim of this study was to develop DRL's for posterior anterior (PA) chest examination in Windhoek, Namibia. Quality control tests were done on the x-ray machines using a Xi-Unfors radiation meter. Entrance skin doses (ESD's) were obtained from 120 patients that were referred for chest examination at the six selected facilities in Windhoek. The following parameters were measured: kilovoltage peak (kVp), milliampere seconds (mAs), the focus to bucky distance (FBD) and focus to surface distance (FSD). The ESDs were then calculated. The average ESD was found to be 0.47 mGy, ranging from 0.14 to 1.3 mGy. The study provided baseline information on ESD's for PA chest radiography. The ESD's in this study was above the ESD's recommended by the IAEA which is 0.4mGy. This was attributed to the use of high kVp and mAs and a short FBD at some facilities. The results of this study, with more data expected to be collected by the National Radiation Protection Authority (NRPA) will provide a useful baseline to establish Namibia's DRLs.

Keywords:
Diagnostic Reference Levels, International Atomic Energy Agency, entrance surface dose, radiation

Activity of *Moringa* Extracts Against Water-borne Bacteria diseases and New Insights into the Structure of Flocs

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Treating water that contains pathogenic organisms and sediment is a serious challenge in both developed and developing countries. The main disadvantages of conventional water treatment chemicals are high cost, health hazards and environmental side effects. Coagulation and flocculation are important processes in water treatment systems and their primary purpose is to remove turbidity, caused by suspended particles, from the water. The suspended particles vary considerably in source, composition charge, size, shape, and density. Correct application of coagulation and flocculation processes and selection of the coagulants depend upon understanding the interaction between these factors. Since untreated water contains both bacteria and solid impurities, the antibacterial activity of seeds and bark of two Moringa species were tested and the resulting structure of flocs formed using different flocculating materials. Methanol, n-hexane and aqueous extracts of seeds and bark of M*oringa oleifera* and *Moringa ovalifolia* were tested on the laboratory strains of common bacterial species, namely, *Escherichia coli, Enterococcus faecalis, and Bacillus cereus*. To gain new insights into the structure of flocs, the following methodology was adopted. Proteins extracted from the seeds of Moringa trees which are known to effective flocculents of particles dispersed in water were used. A model system consisting of polystyrene latex particles was used to mimic dispersed water impurities. The polystyrene particles were chosen not only because of being well-characterised but also adsorb to the surface the Moringa seed proteins and cause the former to flocculation with unusually dense aggregates. For comparison, measurements were also made on samples of aggregates of model polystyrene latex made by addition of salts sodium chloride, ferric chloride and aluminium sulfate. Neutron scattering techniques were used to study the flocculation of polystyrene latex particles. The highest inhibitory effect was observed at the dilution 50 mg/mL and 35 mg/mL for *M. oleifera and M. ovalifolia* seeds methanol extracts on *E. coli, E. faecalis*, and *B. cereu*s, respectively, followed by bark methanol extracts. The n-hexane extracts of both seeds and bark of *M. ovalifolia* and *M. oleifera* had almost the same inhibition activities on *B. cereus, E. coli and E. faecalis*. The water extracts showed the least inhibition activities on both the test organisms for both *M. ovalifolia and M. oleifera*. However, the results of the study showed that Moringa had a degree of antibacterial properties against the selected test bacteria that cause water borne diseases but the activity varied depending on the type of Moringa species, part of the plant and solvent used for extraction. The protein from seeds of Moringa trees gave high fractal dimension (d_f) values close to the limiting value of 3 for tightly packed flocs as the concentration of particles increased. Varied floc structures were observed depending on the type of salt used.

Keywords:
Activity, aluminum sulfate, activity, ferric chloride, floc dimension, Moringa, neutron scattering, polystyrene

Concentrations, Salinity and Toxic Trace Elements of Different Water Sources within the Kuiseb and Cuvelai-Etosha Basin, Namibia

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Radon is a colorless, odorless, water-soluble and radioactive gas that can affect the human respiratory system. Radon is known for damaging living cells and causing cancer after long-term exposure (Montana Department of Environmental Quality, 2011). The absence of baseline information on radon measurements and concerns about possible consequences of long term exposure to high concentrations of Rn222 and its progenies necessitates evaluation of radon concentrations in boreholes and households. This study thus investigated the levels of Radon gas (Rn222), salinity and elemental composition of different water sources (tap-water (18), boreholes (20), and surface water (15)) within the Kuiseb and Cuvelai-Etosha basin, in order to address the lack of scientific correlational studies on radon levels and toxic trace elements in boreholes and drinking water. Radon concentrations were measured using an AlphaGRAUD PQ2000 PRO system, and the elemental composition was determined using a NexION 350D Inductively Coupled Plasma Mass Spectrometer.The radon concentrations measured at all sampling points did not exceed the reference limit of 100 Bq/m^3 set by Water Resources Management act, 2011, and WHO, 1998. However, the findings of this study showed relatively high (2.71 Bq/m^3) radon concentrations in the Kuiseb Basin (possibly caused by natural uranium ore deposits in the Erongo Region) compared to the 0.43 Bq/m^3 average in the Cuvelai-Etosha Basin. The study also measured high salinity ($63^0/_{00}$) concentrations (linked to high Total Dissolved Solids of 25.46g/L) in the Cuvelai waters compared to the $37\ ^0/_{00}$ salinity (with low TDS of 3.8g/L) in the Kuiseb. The high salinity points to the geological and meteorological make-up of the Cuvelai i.e. Kalahari sedimentary rocks, runoff sediments, high temperature and evaporation rates, as well as alternating floods and drought (rainfall variations). The elements observed include Ba, K, Sb, As, Cd, Cr, Cu, Mo, Ni, V, Zn and Bi in the Kuiseb, and Ca, Cl, Mg, Na, Al, Be, Br, Ce, Cs, Fe, Pb, Mn, Se, Ti in the Cuvelai-Etosha Basin. Further, the Cuvelai-Etosha proved to have more anthropogenic activities (including burning of vegetation) influencing the elemental composition, and causing deterioration of the water quality. A t-test rejecting the null hypothesis at a P-value < 0.05 (i.e. P = 0.0006) lead to acceptance of the alternate hypothesis: "Cuvelai-Etosha basin has higher salinity and trace metal concentrations and lower Radon levels than the Kuiseb".

Keywords:
Radon, Trace metals, ICP-MS, AlphaGRAUD, Cuvelai-Etosha Basin, Kuiseb Basin

INFORMATION AND COMMUNICATION TECHNOLOGY

A meta-analysis of the state of the art Cloud Forensics Data Acquisition Techniques.

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There has been an increase in the use of cloud computing services. This can be attributed to the cloud's leverages such as flexibility, cost efficiency, availability and reliability through redundancy. However, the increased usage of cloud computing services brings to the fore a number of challenges as comprehensively listed in the National Institute of Standards and Technology (NIST), Cloud Computing Forensics Science challenges. These challenges are mostly attributed to the tools used, which are currently intended for traditional systems. This research presents current cloud computing forensic (referred to as "cloud forensics"), data acquisition techniques and their challenges when dealing with digital evidence. The purpose of the research was to evaluate current cloud forensic tools based on the ISO27001 standard on Information technology Security. Through intensive literature scans on currently available techniques using classification of the data acquisition tools based on published frameworks and architectures we identified the gaps that are incumbent in cloud forensics data acquisition systems. In the research we used the EBSCO research database run as a host discovery service by the NUST library. The Search engine has access to other research databases such as ACM, IEEE Xplore, Science Direct, and ProQuest. The keywords, "Cloud Forensics" and "Data Acquisition" were used and the results were further refined manually to get the required relevant literature. A total of 25 papers were reviewed. The state of the art techniques identified were then evaluated against the properties of IT security as defined by the ISO27001 standard so as to gauge their usefulness in cloud forensic readiness. We found out that there are very few tools that specifically deal with cloud forensic data acquisition and from the evaluation we found out that although tools currently being used conform to the IT security standards, they are not suited to forensics readiness. We then provide general guidelines such as, emphasis on early acquisition of data for cloud based data collection to avoid duplication and sychronisation of data problems. Finally, we provide recommendations for future work on cloud forensic acquisition techniques.

Keywords:
Cloud forensics, data acquisition techniques, digital evidence, challenges, and forensic readiness

Management of cultural heritage sites in Namibia: A case study of the Twyfelfontein World Heritage Site

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Twyfelfontein is located in the Kunene Region in north-western Namibia. The site has the largest concentration of rock engravings in southern Africa. Twyfelfontein was inscribed as a world heritage site in 2007 for its exceptional rock engravings. During the last two decades a steady deterioration of the site resulted because of poor site management by the National Monuments Council (NMC). After the NMC gained control of the site from the local community in 2004, it was necessary to rehabilitate the site for inscription as a wold heritage property. World heritage status can have repercussions on cultural heritage properties and the way they are managed. This paper tries to throw light on this issue by analysing the management of Twyfelfontein. The management of the site is a crucial issue as it has various cultural significances that need to be protected. In addition the site has an economic basis in tourism and an academic function in safeguarding the cultural heritage database. The methodology for the analysis of focuses on the evaluation of five management processes performed at the site. For each management process, three indicators are developed according to the best standards in the field. The analysis is also based on literature review, interviews with heritage practitioners, local community, visitors and local tour guides. The evaluation shows that none of the management processes is sufficiently conducted at Twyfelfontein. Conservation and visitor management processes appear to be the biggest challenges. Restrictions of visitor facilities are not respected, site monitoring and visitor research are largely overlooked. Other reasons for the poor performance of the management processes are weak site management, lack of adequately trained personnel, and lack of stakeholder involvement. The success of the site will depend to a great extent on strategic planning, management structures that promote research and stakeholder involvement.

Keywords:
Twyfelfontein, World Heritage, rock engraving, Namibia, National Monuments Council, heritage management

Logistics

Meta-analysis of Method for Measuring Logistics Performance in Namibia

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Logistics performance measurement is a critical tool for informing macro-economic policy and investment decisions. Although there is a growing global interest in measuring and tracking logistics performance, there is no single commonly agreed measurement method. This presents a dilemma for anyone intending to measure Namibia's logistics performance because no systematic empirical studies of trends and developments in Namibia's logistics sector currently exists. Yet, performance and growth of the logistics sector, especially the cost of logistics, has arguably a significant bearing on the performance of Namibia's economy and the competitiveness of its exports. Therefore, as a first step towards future analysis of the logistics sector, a meta-analysis of logistics performance measurement methods was conducted with the view to identify a methodology, or mix of methods, best suited for measuring Namibia's logistics performance.Meta-analysis used to identify and analyse different methods currently used around the world to measure logistics performance. The objective of this analysis and analyses was to identify a method (or combination of methods) that satisfies the following three criteria: (1) allows for measurement of the level of logistics costs in absolute terms and relative to other costs, (2) enables identification of the main drivers of logistics costs, and (3) supports analyses of how logistics costs and deficiencies in performance affect other sectors of Namibia's economy. Such method(s) would be suitable for understanding Namibia's logistics costs and performance in order to better evaluate and target policy efforts. Statistics-based studies tend to utilise statistical data, models and methods in deriving the level of logistics costs. While case studies also utilise statistics, the main difference between the two methods is that in the former the model is well established and verified whereas statistics-based studies tend to build models. Surveys utilise questionnaires to collect data from respondents. There is one significant difference in approach between statistics-based studies and surveys from the supply-chain perspective. Statistics-based studies tend to approach the problem from the supply side of the chain while surveys tend to be conducted among demand-side actors. Finally, case studies represent investigations based on the case-study methodology. Case studies tend to be used when sufficient statistics are not available and it is not possible to conduct a survey. Other studies in the literature include those employing mixed methods, and also those that do not clearly disclose the methods used. If correct applied, use of statistical-based and survey methods measuring Namibia's logistics cost and performance can contribute towards improving efficiency of supply chains and the functioning of related infrastructures, services, procedures and regulation. A sound and comprehensive set of national-level performance indicators is critical for high-level policy dialogue, preparation and implementation of the Master Plan for Development of an International Logistics Hub.

Keywords:
Logistics, costs performance measurement, methods

A review of the Global Navigation Satellite System network and determination of ionospheric Total Electron Content

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The ionosphere degrades the accuracy of single-frequency Global Navigation Satellite System (GNSS) receivers by refracting satellite signals in direct proportion to an ionospheric parameter designated as total electron content (TEC). Ionospheric refraction causes the measured signal path length to be 5-15 metres longer than the real path. In this paper the GNSS constellation is reviewed and GNSS-TEC is determined with the Global Positioning System (GPS)-TEC software to observe diurnal, seasonal and annual TEC variations of Windhoek in 2013 and 2015. GNSS-TEC of Windhoek, Hermanus and Dakar in 2013 were compared to observe variations in accordance with geographic locations. The International Reference Ionosphere (IRI) model's IRI-TEC and GNSS-TEC were compared to assess the model's performance over Windhoek. Results show that 67.9 TEC units (TECU), experienced in November 2015 was the maximum GNSS-TEC of Windhoek and 2.9 TECU in June 2015 was the minimum. The IRI-2012 model accurately predicted GNSS-TEC during predawn hours (0000-0500 Universal Time (UT)), but after sunrise its accuracy deteriorated. The model overestimated GNSS-TEC in winter, but it underestimated GNSS-TEC in autumn, summer and spring. Diurnal maximal TEC occurred at midday (1000-1300 UT) while minimal TEC occurred during predawn hours (0000-0500 UT). Dakar (14.720903^0N) had higher TEC (78.2 TECU) because it is closer to the Equator (0^0) in comparison to Windhoek ($22.5741\ ^0$S) and Hermanus (34.42463056^0S). TEC values are key to Global TEC imaging, a technique which allows the studies of various Space Science phenomena. Currently, the number and distribution of active GNSS receivers in Namibia are inadequate to give a good representation of the variability of the ionosphere over Namibia. Increasing the number of stations to give a more representative distribution, will improve this situation.

Keywords:
Ionosphere, ionospheric delay, scintillation, pseudorange, GNSS, free-electrons, ephemeris

Social Science and Humanities

Governance as a Conceptual Paradigm for Institutional Reform and Transformation

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Due to the inherent weaknesses of colonialism (such as complete disregard for human rights and dignity), traditional cultures (associated with autocratic leadership) and liberation movements (radicalism and violence), neither colonial nor traditional regimes nor liberation struggles prepare leaders for good governance. The paper is a descriptive narrative that aims to integrate the Ackoff-Gharajedaghi Five-Dimensional Design of institutional development with the normative principles of good governance as a paradigm for changing systemically corrupt institutions to promote integrity-driven performance. The research methodology is the 'soft systems approach' (SSA) (Checkland, 1981) to systems thinking. Some of the findings are that obstructions to development are inherently part of governance failures. Corruption is, amongst other things, deviant human behaviour, a breakdown of the integrity of systems, which in turn leads to serious development failures that cannot be rectified by piecemeal reforms, but only by a complete transformation of the whole institution. From the research executed, it is possible to say that governance is an open systems and inclusive approach. The aspiration to obtain influence and power in decision-making is one of the most critical drivers of development. Good governance as a construct goes beyond decision-making to promote integrity and has the potential to guide policies, strategies and values. Good governance is a conceptual paradigm for institutional reform and transformation of systemically corrupt institutions towards ones with integrity-driven performance.

Keywords:
Corruption, co-producers, obstructions, development

Developing Security Metrics to Evaluate Employee Security Awareness Levels: A Case of a Ministry in Namibia

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Employees that lack security awareness may cause a threat to an organisation without intending to do so. Security awareness is the knowledge and attitudes employees have concerning the protection of the information and physical resources of their organisation. The open nature of present computing setting has opened up security loopholes where there are always people such as eavesdroppers and hackers, who can access unsecured resources, steal identities, impersonate or take advantage of resources available to the rightful owners. Employees should be informed about information security risks, security policies, standards, procedures and guidelines, best practices and externally imposed laws, rules and regulations to improve their security awareness.A mixed research was conducted using a case study strategy to evaluate the security awareness levels of employees in one ministry and propose a solution to reduce the risk associated with security threats. Security awareness metrics were developed as an assessment tool of the case site security awareness levels. The security metrics will assist the Information Technology department to detect security breaches early, and then develop a security awareness program and policies to promote security best practices. On the other hand the metrics are meant to encourage top management to get involved. Qualitative data was collected using an unstructured interview with the ministry's security awareness programs experts and it was very effective since the participants were very open and willing to discuss their experiences. The qualitative data was analysed to determine what security awareness measures are considered to be effective. The results and literature informed the design of a survey tools to assess employee awareness levels. A quantitative survey using a questionnaire was used to gather information from the ministry employees in four different departments. Employees were requested to respond to questions on different security categories namely incident reporting, data confidentiality, email security, malware, phishing attack, password security, security policy, physical security, desktop security and internet security. Collected data were quantitatively analysed to gauge the security risk of the organisation. Analysed survey results were used to develop security metrics for assessing the confidentiality, availability and integrity risk levels using security objectives as measurements. Goal Question Metric (GQM) method was used to generate the metrics to evaluate the security awareness level. GQM approach is grounded on the assumption that for an organisation to purposefully evaluate itself, it must first specify goals for itself and its projects, then trace those goals to the data that intended to define those goals operationally, and finally offer a framework for interpreting the data with respect to the stated goals. Employees' responses were validated using literature, helpdesk statistics on incident reporting and antivirus statistics. A risk score table with the following risk levels low (25 – 39), elevated (40 – 60), moderate (61 – 81), significant (82 – 96) and high (97 – 120) was used for this project to determine the employees' awareness level. The results show that employees' awareness level was mostly low or elevated. Security standards and best practices are recommended based on the findings of risk rating per security category.

Keyword:
Security awareness, security metrics, employee security

The Contribution of the *Moringa Oleifera* Tree to Hunger Poverty Reduction in Namibia

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Namibia is one of the countries with the highest income inequality with a Gini coefficient of 70.7 (CIA) and 74.3 (UN) respectively, hence poverty is a serious problem. Namibia is also one of the driest countries in sub-Saharan Africa, and this in itself poses a challenge for agricultural production. The agricultural sector, despite its marginal contribution to the country's Gross Domestic Product (GDP) at 7.7%(CIA), supports 70% of the of the population, (directly and indirectly) both from commercial and subsistence agricultural production. It has also been established that malnutrition is prevalent in Namibia, mainly due to a lack of proper nutrition. To increase the agricultural output, calls for different strategies to ensure food security and this involves innovation as well as tapping into indigenous systems and knowledge. The Namibian government since independence in 1990, through various policies and programmes has put in place efforts to address poverty. In addition, the recently launched Harambee Prosperity Plan (HPP) has a particular focus on addressing poverty. This paper is aimed at increasing awareness about the uses and benefits of the *Moringa Oleifera* tree. Moringa is known as one of the most useful plant as all its parts can be utilize in various ways. Moringa is full of vitamins and minerals which is good for both human and livestock consumption. Moringa is also a very useful source of medicine. The Moringa tree particularly the leaves are packed with incredible nutrition which can strengthen the human body and prevent many diseases. Researchers have found that adding the Moringa leaves to cattle feed can increase their daily weight (by up to 32%) and milk production (by up to 43 to 65%). Various parts of Moringa such as the leaves, barks and young shoots can also be fed to sheep, goats, pigs and poultry. Among many other Moringa benefits, it can be used as fertilizer, because of its leafy material, which is full of essential nutrients (e.g. protein) for plant growth and is useful in inter-cropping systems. Moringa can also be used to purify water by putting the Moringa seed powder in dirty river water. The powder joins with the solids in the water and sinks at the bottom removing 90-99% of the bacteria contained in the water. The moringa tree grows well in dry climates and areas with poor soil quality. The Moringa tree is therefore suited for Namibia considering the existing efforts towards poverty reduction, the current drought, water scarcity and the country's climatic conditions. This paper recommends integration of this tree and it products into existing efforts to address hunger poverty and malnutrition. The paper further recommends large scale propagation of Moringa trees to ensure accessibility by the Namibian population.

Keywords:
Moringa, minerals, medicine, nutrition, *Oleifera*, malnutrition, fertilizer, vitamins, livestock, poverty

An Assessment of the Opportunities for the Commercialization of the Underutilized Indigenous Food Crop Mutete (*Roselle-Hibiscus Sabdariffa L.*) in Namibia

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Kavango regions suffer the greatest poverty relative to other regions with 55% of its population still living in poverty. However, the Kavango regions and the nearby areas have an opportunity that could open up a value chain addition window particularly through mutete production. Mutete or Roselle (*Hibiscus sabdariffa* L.) is one of the indigenous plants that falls under the neglected and underutilized crops in Namibia. It adapts easily to a variety of agro-ecological, drier climatic and soil conditions which makes it easier to grow by almost every household in Kavango. Attributes include its drought tolerance, edible appeal, ease of post-planting care and post-harvesting and less perishable especially when dried. It is currently contributing very little to the Namibian national green economy aspiration as it is mainly cultivated for subsistence purposes. However, mutete possess a potential for development as a small farm and niche market crop. The main objective of this study was to assess the constraints and opportunities for developing mutete as a commercial crop in the Kavango regions. The study employed a review of literature and key informant interviews in the mutete industry. The assessment showed that in Namibia, mutete grows naturally under rain fed conditions in the fields and farmers only tend to it as a secondary crop. The leaves are used as a relish vegetable cooked alone or in combination with other vegetables, meat or fish. In addition, small scale processing attempts for jam, juice and tea have been initiated by Rural Development Centre in Ongwediva from the calyces. Mutete is important as a niche-market crop, source of employment creation, holds a great promise in the area for improving household incomes and food security. Thus there exists potential for value addition and processing of mutete products into commercial products.

Keywords:
Value addition, processing, market, employment, food security, income

A Study of Interaction in Augmented Reality for Exhibitions and Museums

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New forms of digital information services such as Augmented Reality (AR) require new forms of Human Computer Interaction (HCI). Classical forms of interaction, e.g. mouse and keyboard, are well established but may mostly not work for augmented or virtual reality. To achieve an ideally natural and unobtrusive computational support new forms of interaction are needed. It is necessary to provide smart and reliable interactions characterised by simple gesture, natural movements and easy actions. Particularly for exhibitions and museums, simple interactions should allow the user an immediate and intuitive option for interaction. The goal of this research is to develop models of interaction how users of different experience levels can perform interactive AR applications intuitively and without extensive learning phases. The central questions are: (i) What forms of Natural User Interfaces (NUI) can be used in the AR space? (ii) Are there any novel interaction forms and control devices that could be used with HMDs? (iii) How could they improve the user experience? (iiii) How complex can be an interactive access to AR in a cultural environment?.In a first experiment, an interactive application for a Head Mounted Display (HMD) was developed, in which the user can choose between two video sequences from a menu. For the selection the user needed to turn the head to focus one of the menu items. Each sequence was represented by a simple symbol, which had been enlarged if it was in focus. To confirm the appropriate selection, two different approaches were tested with different user focus groups. For the first approach, the users had to use a touchpad, which was located on the HMD. A simple pressure on the touchpad confirmed the selection. The second approach recognised head movements for the menu selection. When selecting the appropriate icon, the icon was increased and the selection was carried out after a certain period. A filled circle on the icon visualised the period. After the time had elapsed, the selection was automatically accepted. The observations and surveys showed that all users preferred our second approach to the first one. The use of HMD was totally new to almost all users. Users could not find the touchpad without additional help. The observation also revealed that the movement of the head for selection was quickly understood and regarded as intuitive. By visualising the elapsed time, the users also recognised immediately that a selection was performed. Due to the short duration of visitors staying at the museum or exhibition and the use of new interaction forms, the principles of user-centred designs may apply. Principles based on natural gestures are well understood. For this purpose, additional and complicated devices for the interaction may be avoided. The experiment shows that additional interfaces, which are modelled on non-natural interactions, not be perceived as understandable. The used gesture was quickly learned and performed independently. The gesture corresponds to the natural rotation of the head to change the field of view.

Keywords:
Augmented reality; human computer interaction; natural user interfaces

The linguistic Dilemma in Namibia's Zambezi Region

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The geographically isolated Zambezi Region, formerly known as the Caprivi Region/Strip is the land of contrasts with a history unique to Namibia. In this part of the country, people are geographically, socially, culturally and linguistically different from the rest of Namibia. The Region is home to about eight (8) languages and language groups, viz Subia, Yeyi, Fwe, Totela, Mbukushu, Barakwena, Mbalangwe and the region's lingua franca, Silozi. The languages of the Zambezi Region despite their Bantu provenance and classification are somehow different to those of a similar nature in mainland Namibia and much closer to those of nearby Zambia and Botswana. The Silozi language is the most dominant in the Region and exclusively used in most domains of local governance at the expense of other indigenous languages of the Region. Technically, it can also be argued that Silozi is not a Namibian language rather that of neighbouring Zambia where it is spoken as a first language by close to a million people. How Silozi became part of Namibia's eight (8) nationally recognised languages is largely political and will be discussed in this paper. It is from this premise that the paper intends to investigate how and why Silozi became the dominant language to be used in the Region and how this impacts the development of other indigenous languages. Despite the fact that Silozi is often criticised as a foreign language to the people of the Zambezi, how come it remains the only viable language of communication amongst the region's inhabitants? To sum up, the questions below are put forward:

- Is Silozi a threat to the development of and could it possibly lead to the demise of other so-called "legitimately" indigenous languages of the Region?
- Is the Government through its language policy responsible for the marginalisation of other languages of the Zambezi region?
- Silozi remains the preferred language of choice for inter-tribal communication in the Region.
- It is the most developed language among the indigenous languages in the region and according to some authors in Namibia; it has its own orthography and rules when compared to other languages of the area.

Keywords:
Lingua franca, development, communication, indigenous and marginalisation

An investigation into the impact of reckless driving, traffic law enforcement and road accidents statistics in Namibia.

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Driving safety on Namibia's road has now become a major cause for concern. Empirical evidence indicates a serious disregard for traffic laws. Every year in Namibia many people are injured, killed and there is a high cost in terms of vehicle, property and damage. According to the NRSC Namibia Road Safety Council executive secretary Eugene Tendekule, Namibia records some 17,000 -19,000 vehicle crashes per annum. This paper aims to analyse the transportation system of Namibia, focusing on the road safety management, thereby providing concrete solutions on how to reduce high accidents rates. Driving a car should be regarded as a privilege which comes with a serious approach to road safety, but it appears to be increasingly viewed as a right, indeed a right that comes with little real responsibility. Even though, Namibia has an excellent road infrastructure, on par with that of the United Kingdom (World Economic Forum, 2015), much education still needs to be carried out in the transport sector in order to change driver attitudes. Our research findings indicate that 51% of drivers fail to adhere to basic traffic rules. Poor traffic visibility results in all too many road users driving through red traffic lights, without seatbelts, while on their mobile phones, not indicating while intending to turn or stopping beyond the pedestrian crossing line. The study has also highlighted private vehicle drivers as the worst drivers, despite common belief being that it is taxi drivers who are most negligent.For this research, Windhoek was used as a case study, with extensive traffic monitoring and recording of driver attitudes. To successfully examine drivers' behaviour, a survey was carried out. Face to face interviews and questionnaires consisting of open and close ended questions were used to collect data about drivers' reactions towards traffic warning signs, traffic instructions, robot signals, emergency vehicles, and mobile usage. Secondary data was collected from different stakeholders including the National Road Safety Council (NRSC), Road Authority (RA), Motor Vehicle Accident-Fund (MVA) and Ministry of Works and Transport (MOWT). The study can provide government, particularly the Ministry of Works and Transport an opportunity to review the regulations and operations of road transport in Namibia. To help bring order back to Namibia's roads, through proper regulation and traffic law enforcement strategies.

Keywords:
Traffic rules, regulation, driving, driver's attitudes, traffic enforcement

Space Science

International Cooperative Mechanism on Space Activities in Namibia

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Space exploration has a crucial role to play in the socio-economic growth in Namibia. Therefore, international cooperation in space activities is a common principle in the majority of the United Nation's legally binding and non-binding instruments related to or regulating the exploration and use of outer space for peaceful purpose. It is common because that space activities have been and are still taking place in Namibia. There are efforts to develop space science through various initiatives. However, such initiatives are established on the premise of space cooperation. To what extent has Namibia made use of space cooperation principle? And what cooperative mechanism has the country adopted? Thus, this paper discusses the governmental, intergovernmental or interagency modes of cooperation adopted in Namibia. In addition, the bilateral/multilateral or memorandum of understanding for these space collaborations are explained. The extent by which Namibia adheres to with UN space instruments is examined. Lessons learned and the way forward is discussed.The preliminary study indicates that Namibia has indeed ventured into international cooperation through governmental and interagency modes by entering into bilateral agreements or memorandum of understandings. The main areas of cooperation are scientific research, education and personnel training (technical assistance). Most of the conditions of cooperation in the bilateral agreements conform to the UN legal instruments (both binding and non-binding) on the exploration and use of outer space by taking into account the needs of Namibia as a developing country, being equitable and mutually acceptable, and the contractual terms that are fair and reasonable.

Keywords:
International cooperation, bilateral agreements, cooperative mechanism, outer space

Namibian Virtual Observatory

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The Square Kilometre Array (SKA) Africa, seeks to be amongst the largest providers of Astronomical Data in the world in the near future. Its goal is to construct and establish radio Observatories in the SKA African partner Countries. Namibia, as part of this SKA Africa consortium, has a promising Astronomical future together with the High Energy Stereoscopic System (HESS) Observatory. The HESS is among one of the leading institutions studying very high energy (VHE) gamma-ray astrophysics. The need for the accessibility of these data is much needed by various users from a multiplicity of disciplines, for uplifting the Namibian scientific community. We propose a Namibian Virtual Observatory (NAVO) platform, with the main goal to provide Namibian Astronomers online access to these data. The platform is designed to provide easy access for scientific and educational purposes. We present a prototype portal and interface with an interdisciplinary approach. The portal is designed to accommodate any existing virtual observatory standards and has room to expand for new VOs. The platform further provides users to query, upload, and analyse astronomical data. The design takes into account the expandability and transportability for other African countries.

Keywords:
Virtual observatories, AstroInformatics, astronomy, data mining

Water

Analysis of major ions and stable isotopes in shallow and deep aquifers of the Ohangwena Region, Namibia

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The multi-layered aquifer system in the Ohangwena Region consists of three main aquifers: perched aquifer (KOH-0), Ohangwena I (KOH-1) and Ohangwena 2 (KOH-2). KOH-0 is a discontinuous very shallow aquifer with fresh water and normally tapped by shallow hand-dug wells known locally as "eendungu and omifima". KOH-1 aquifer represents the main freshwater source in the areas surrounding Okongo area, and it is contained in the semi-consolidated sandstone of the Andoni Formation at depths between about 60 m and 160 metres below ground level (m b.g.l.). KOH-2 is the newly discovered aquifer at depths of 130 m to 380 m b.g.l.; it is hosted in red sandstone and clay of the Olukonda Formation. It's therefore of importance that these groundwater resources that are the main water supply in the Okongo area are managed properly, however, this can only be done with better understanding of the groundwater system. In this study, hydro-chemical and isotopic composition of the aquifers was used to analyse the relationship between the KOH-0 and KOH-1. Water samples were collected from both aquifers and were analysed for major ions and stable isotopes. The hydrochemical results show that bicarbonate is the dominant anion whereas the cations are quite variable from village to village and also between hand-dug wells and boreholes in one village. Nitrate concentration is higher in hand-dug wells than in boreholes; while some fluoride does not show any trend with regards to depth to water table, it varies according to the location of wells. The isotopic composition generally shows evaporation in the hand-dug wells. Omboloka shows very similar results for both chemistry and isotopes from both aquifers which could imply the mixing of water in the two aquifers. In conclusion, boreholes have better water quality than hand-dug wells mainly because hand-dug wells have shallow water levels and thus prone contamination.

Keywords:
Ohangwena Region, aquifers; stable isotopes; major ions; water quality

Isotopic Composition of Water Bodies in the Kuiseb and Cuvelai-Etosha Basin, Namibia

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Isotope studies previously commissioned in the Kuiseb and Cuvelai-Etosha Basin focused more on understanding groundwater recharge, fingerprinting the water, and using deuterium as tracer, without making a comparison of the isotopic composition of different water bodies in areas that have different meteorological features. Thus, the aim of this study was to investigate the isotopic composition/variations in different water bodies in the two basins over time. In this study, water samples collected from open and undefined water sources such as the Etaka and Ruacana waterfall in the Cuvelai-Etosha Basin as well as the boreholes, Atlantic Ocean and fog from the Kuiseb Basin were analysed for stable isotopes (Deuterium (δ2H) and oxygen 18 (δ18O)) and trace elements. Stable isotope ratios were measured using the Picarro L2120–i Analyser (Cavity Ring-Down Spectrometry method) and the trace elemental composition was assessed using the Inductively Coupled Plasma Mass Spectroscopy (ICP-MS). Open water bodies of the Cuvelai-Etosha Basin plotted below the Global Meteoric Water Line (GMWL) towards the evaporation trend, showing the high evaporation experienced within the basin. The Kuiseb boreholes were depleted of heavy isotopes and plotted along GMWL and Local Meteoric Water Line $\delta^2H = (7.2195\ \delta^{18}O) + 4.1065$ (Turewics, 2013), indicating direct recharge from precipitation and minimal, if any, evaporation effects. Trace elemental analyses indicated possible contamination of water bodies with high concentrations of Al and Fe, confirming the effect of sediment input in the flood-prone basin (Cuvelai-Etosha), and continual erosion/hard crust in the Kuiseb. Positive correlations with r^2 greater than 0.5 (significant at 0.01 level (2-tailed)), confirming increase in δ18O and δ2H with increase in trace elements including Strontium and Lithium in the Kuiseb Basin, and Molybdenum (Mo) and Manganese (Mn) in the Cuvelai-Etosha Basin were also observed.The results of this study will add to the existing isotope database, and ultimately contribute towards understanding the isotopic variations and establishing long-term isotopic data required for comparison and validation of prediction models.

Keywords:
Water stable isotopes, elemental composition, GMWL, ICP-MS, Namibia

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