MAASAI MARA UNIVERSITY

BOOK OF PROGRAMME AND ABSTRACTS

ANSO-MMU-SAJOREC INTERNATIONAL CONFERENCE
4TH-6TH SEPTEMBER 2019

THEME BIODIVERSITY FOR SUSTAINABLE DEVELOPMENT

VENUE MAASAI MARA UNIVERSITY

WWW.MMARAU.AC.KE
BIODIVERSITY IN DRYLANDS AND WETLANDS: CHALLENGES AND OPPORTUNITIES IN THE 21ST CENTURY

Theme: Biodiversity for Sustainable development

Thematic areas

Thematic areas of the conference are:

2. Research, Infrastructural Development, Policymaking and Socio-economics of Dryland and Wetland resources.
3. Weather and Climate Change and Adaptation on the Ecosystem of Dryland and Wetland Biodiversity
5. Advances of Molecular Biology and Genetics of Biodiversity in the Dryland and Wetlands.
6. Public Health and its impact on Drylands and Wetlands
ALLIANCE OF INTERNATIONAL SCIENCE ORGANIZATIONS (ANSO)

BACKGROUND

Alliance of International Science Organizations (ANSO) is a non-profit and non-government international scientific organization founded in November 2018 by 37 international science and education institutions from around the world. ANSO came into being under the principles of joint consultation, joint effort and shared benefits championed by the Belt and Road Initiative (BRI). ANSO is designed to meet the science-related environmental and socio-economic challenges of the BRI through well-focused activities in Science, Technology, Innovation and Capacity Building (STIC). ANSO will also promote collaborations across the scientific and technological communities of the world to ensure that the benefits are widely shared.

VISION

To become an action-oriented international organization with global impact in catalyzing and implementing programs and initiatives in Science, Technology, Innovation and Capacity Building (STIC) for the promotion of shared development and the advancement of the UN SDGs.

MISSION

Promote and implement innovative initiatives in STIC through international collaborations and partnerships to address the global challenges to the progress and wellbeing of human societies.

MAJOR ACTIVITIES

1) Carry out training, education and capacity building, the basis and foundation for the joint development of a community of the whole humankind with a shared future.
2) Catalyze and initiate major international science programs focused on areas of key importance for sustainable development.
3) Organize and support S&T programs and initiatives focused on human livelihoods and wellbeing, such as clean drinking water, sustainable agriculture, environmental protection, desertification control, poverty reduction, and public health.
4) Organize and carry out science-based studies and advice for regional and global sustainable development.
5) Promote improvement of wellbeing and economic development through close integration of technology, innovation and marketing. Efforts are to be made for IP protection and maintenance of standards.
6) Award prizes that encourage active participation and collaboration in ANSO initiatives.
PRIORITIES

Grand Challenges
Global environmental challenges (Climate Change and Adaptation, Natural Disasters, Water Security, Pollution, Urbanization, Desertification); Agriculture and Food Security; Biodiversity; Health and Biosafety; Energy Security; STI Policy and Strategy for Sustainable Development; Higher Education; Emerging Technology: Big Data, Artificial Intelligence, Robotics, etc.

Priority Actions
i. Provide science-based advice and communications for regional and global sustainable development.
ii. Plan and implement major international science programs with a special focus on areas of key importance for sustainable development.
iii. Promote the application of STIC to improve human livelihoods and wellbeing.
iv. Promote improvement in wellbeing and economic development through close integration of innovation, technology and technology transfer, and marketing, while safeguarding IP and standards.
v. Organize training, skill development and capacity building, creating the social capital for the development and shared future of humankind.
vi. Award prizes to reward excellence in STIC and to enhance participation in activities related to the ANSO agenda.
vii. Add value to ANSO activities through collaboration with other organizations at national, regional and international levels.

ANSO ACTION PLAN 2019-2020

During the first 3 years, ANSO will develop the management structure and establish a series of programs, projects and joint activities with member countries and international S&T organizations including:
1) ANSO Scholarship for Young Talents;
2) ANSO Collaborative Research;
3) ANSO Associations;
4) ANSO Collaborating Partners;
5) ANSO S&T Cooperation Prizes for Development;
6) ANSO Training Program;
7) ANSO Science-based Advice;
8) ANSO Fellowships
9) ANSO Conferences and Workshops;
10) Other Proposed Activities
MAASAI MARA UNIVERSITY

Background of Maasai Mara University

Maasai Mara University (MMU) is located at the gateway to the world famous Maasai Mara National Reserve within the greater Mara-Mau Ecosystem. The University is in Narok Town, approximately two kilometers from Town center along the Narok-Bomet Highway. Narok Town, approximately 143 kilometers west of Nairobi City, is in the Southern part of the Kenyan part of the Rift Valley. The University is the successor to Narok University College (NUC), which started in 2007 as a college campus of Moi University. The College took over the then existing Narok Teachers Training College. NUC was later established as a constituent college of Moi University by the Narok University College Legal Order No. 101 of 2008. On 11th February, 2013 NUC was awarded a Charter and renamed Maasai Mara University.

Our Vision

"To be a World Class University committed to academic excellence for development."

Our Mission

"To provide Quality University Education through innovative teaching, research and consultancy services for development."

Core Values

Excellence
Professionalism
Teamwork
Creativity and Innovativeness
Transparency and Accountability
Equity and Social Justice

ISO Certification

Maasai Mara University is ISO 9001:2015 Certified. The University continues to maintain its certification through a raft of internal Audits carried out by Internal Auditors and periodic Surveillance Audits by the Certification Body KEBS. The quality Audits provide a feedback on the performance of the Quality Management System, the feedback obtained is further used for continued improvement.
SINO-AFRICA JOINT RESEARCH CENTER (SAJOREC)

ABOUT SAJOREC

Sino-Africa Joint Research Center (SAJOREC) is a talent cultivation and scientific research institute aided by the Chinese government on the basis of the exchange of official letters between Chinese and Kenyan Governments. The headquarters of SAJOREC covers a land area of 40 acres on Jomo Kenyatta University of Agriculture and Technology (JKUAT) main campus in Juja, Kiambu County in Kenya, and with total building area of 4,300 m². The infrastructure in SAJOREC comprises of expert accommodation apartment, laboratory building, training and conference center, and a modern herbarium. The center also has a 37-acre botanical garden. SAJOREC has been equipped with modern research equipment purchased by Sino-Africa Joint Research Center, Chinese Academy of Sciences (SAJOREC-CAS). JKUAT is responsible for day-to-day management while SAJOREC-CAS plays a key technical and advisory role in the running of SAJOREC. The implementing agencies of SAJOREC on China and Kenya sides are Wuhan Botanical Garden, Chinese Academy of Sciences and Jomo Kenyatta University of Agriculture and Technology, respectively.

First of its kind in Africa, SAJOREC serves as a platform and bridge of scientific cooperation between the Chinese and the African scientists in a wide range of fields. It is a hub of Sino-Africa collaboration on wildlife conservation and utilization, microbiology, ecological environment management, remote sensing and disaster warning, modern agriculture demonstration, etc.

Since its establishment in 2013, SAJOREC has put forward more than 48 joint research programs on biodiversity-related research. The center has already supported the publishing of 6 academic monographs, 258 peer-reviewed journal articles. So far, SAJOREC has provided scholarships to over 149 students from Africa to pursue both master degrees and Ph.D., most of them are from Kenya. Over 500 scientists and senior technicians from 13 African countries have been trained through the organization of over 30 training courses and seminars. (Data updated by June, 2019)
WELCOMING REMARKS

Prof. Mary K. Walingo, PhD, MKNAS, EBS
Vice Chancellor: Maasai Mara University

About 66 million years ago, research tells us, 75% of plant and animal species were wiped out in a sudden mass extinction. In that violent natural catastrophe, we know for a fact that the dinosaurs were not so lucky! Research also tells us that the current species extinction rate is a staggering 1000 times more than the pre-human period. This massive increment in species extinctions rate is mostly blamed on human activities that destroy habitats for millions of species. Clearly, the world is at biodiversity crossroads. The very survival of the earth as a lifegiving, life-sustaining and life-perpetuating planet is at stake. The inherent paradox in this sad reality is that human species are actively killing the very planet that gives them life! It behoves us, as the supreme culprits of environmental destruction, to conserve what is left and restore, what is restorable, of what has been lost of the planet’s biodiversity. This conference, Biodiversity for Sustainable Development, is a small, but vital cog in the global wheel that is designed to drive human existence that respects the existence of other species. It is not accidental, then, that the Conference brings together both public and private sectors to jointly contemplate a roadmap to guide human development that respects biodiversity. Biodiversity for sustainable development demands multidisciplinary, trans-disciplinary and multi-sectoral approach as exemplified by the thematic areas of this Conference. This Conference could not have been held in a more appropriate place. Maasai Mara University is geographically located in the Mau-Mara ecosystem, which is home to some of the remaining enclaves of virgin biodiversity in the world, including the Maasai Mara National Reserve and the Mau Forest. The Maasai Mara National Reserve is a world conservation heritage site. The Mau Forest is the source of the major rivers that feed the Lake Victoria. Lake Victoria gives rise to the White Nile, the longest and the most reliable source of River Nile waters. The Nile Valley is one of the cradles of human civilization that sits in our backyard; surely, we must protect it for the very sustainability of the human race! As I welcome you to this Conference, I must hasten to add that the biodiversity tale is not all doom and gloom. Numerous biodiversity conservation efforts across the globe give us reason to be optimistic. We are in a war for
survival. This war requires the concerted effort of every human being. It is a war that we must win – for us and for posterity.

CHIEF GUEST
Prof. BAI Chunli

Prof. BAI Chunli, a chemist and an expert in nanoscience, is the president of the Chinese Academy of Sciences (CAS), and the Chairman of the Presidium of the Academic Divisions of CAS. He is also President of the World Academy of Sciences for the advancement of science in developing countries (TWAS), the Honorary President of the University of Science and Technology, and the Honorary President of the University if the Chinese Academy of Sciences (UCAS). Prof. Bai’s research areas include organic molecular crystal structure, EXAFS, molecular nanostructure, and scanning tunneling microscopy. He has been elected member or foreign member of world-known academies of sciences or engineering in approximately 20 countries and territories, including CAS, TWAS, National Academy of Sciences of US, the American Academy of Arts and Sciences, the Royal Society of UK, the American Academy of Arts and Sciences, the Royal Society of UK, the European Academy of Sciences, and Russian Academy of Sciences.
Prof. Bulitia Godrick Mathews

DEPUTY VICE-CHANCELLOR, (ACADEMIC & STUDENT AFFAIRS)
CO-SECRETARY GENERAL, ORGANIZING COMMITTEE

The ANSO –MMU –SAJOREC International Conference, 2019 It is my great pleasure to welcome you to the Alliance of International Science Organization (ANSO), Sino –Africa Joint Research Centre (SAJOREC) and Maasai Mara University International Conference on ‘Biodiversity in Drylands and Wetlands: Challenges and Opportunities in the 21st Century’. This Conference is a testament of our commitment to playing our role in creating a platform for scholars, industrialists, policy makers, thinkers, innovators and other like-minded entities to interact, deliberate and come up with novel ideas and solutions to emerging problems and challenges bedeviling the African continent in particular and the world at large, without leaving out those specific to Kenya. Biodiversity and healthy ecosystems are a foundation for sustainable development and, thus, play a key role in supporting the achievement of the Sustainable Development Goals (SDGs). Through this Conference, the University is specifically supporting SDG 15 which aims at protecting, restoring and promoting sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss. As a University, we aim at being at the center of knowledge economy, as is expected of us, to innovate and use the knowledge we generate to serve the public as well as contribute to sustainable growth and development. Therefore, it is my sincere belief that, at the end of this Conference, we shall see its outputs through publications in referred journals, policy briefs and decisions, patents, copyrights and trademarks which will benefit the society. It is also my hope that new collaborations will be forged and already existing ones invigorated. I wish to thank our partners: the Sponsors; Alliance of International Science Organization (ANSO), the Co-organizers; Sino-Africa Joint Research Centre (SAJOREC), collaborating institutions of higher learning, the Scientific Committee, the Organizing Committee, the Conference Secretariat, and all the Sub-Committees within it, and the entire MMARAU staff and students for hosting a successful Conference. I wish you all a wonderful stay at Maasai Mara University.

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I wish you all a wonderful stay at Maasai Mara University.
It is my pleasure to welcome you to Maasai Mara University for this Alliance of International Science Organization (ANSO) - Maasai Mara University (MMU)-Sino Africa Joint Research Center-CAS (SAJOREC) International conference. As the Division in charge of Administration, Finance, and Planning in the University, we re-affirm our commitment to foster, enhance and deliver our International Partners’ needs in research, teaching and innovation. Setting International Partnership and collaboration is our division’s main strategy. The MMU-ANSO-SAJOEC International Conference is one of its kind in Africa and MMU is privileged to be the first institution to host such a conference in Africa. This is as a result of good collaborations and associations between MMU, ANSO and SAJOREC-CAS which has seen this conference successful. Let me take this opportunity to thank our partners ANSO and SAJOREC-CAS for the commitment, dedication and efforts to make sure that this Conference is successful. I wish all the presenters and participants a very fruitful conference session and stay in Kenya for our participants from outside the Country.

Thank you.
Prof. Dr. Wycliffe Wanzala, PhD, AMATINER, MACSE, MISE, FASI.
Associate Professor, Biological/Biomedical Sciences/Ethnomedicines
CHAIRPERSON, CONFERENCE SECRETARIAT

On behalf of the planning and organizing committee, it is my pleasure and privilege to welcome all of you to the 2019 ANSO-MMU-SAJOREC International Conference on “Biodiversity in Drylands and Wetlands: Challenges and Opportunities in the 21st Century”. With its Theme: Biodiversity for Sustainable Development, the conference brings together many of the world’s foremost research thinkers, entrepreneurs, innovators, scholars, policy makers and provides an international platform for sustainable engagement on issues related with nature and the survival of humanity.

I would like to congratulate members of the three levels of conference committees: Conference Scientific Committee (CSC), Conference Organizing Committee (COC) and Conference Secretariat for their exemplary commitment, teamwork and cooperation. Once again, thank you very much! Members of the Conference Secretariat are committed to provide maximum hospitality services to all our guests. Please feel free to ask these members any questions for appropriate guidance. Ladies and gentlemen, we are here to serve you!

During the conference, there are professional development sessions and social events. We hope that you will be able to attend many of these events, which will provide you with plenty of opportunities for exchanging ideas, findings and the latest research results, while engaging in many academic, industry and social events, and meeting peers from different countries for fruitful networking. In particular, the conference provides you with exciting opportunity of exploring what Maasai Mara National Reserve (with its 7th world wonders), the Mau forest complex (the largest indigenous montane forest and critical water catchment area in East Africa) and the legendary Maasai cultural life have to offer. Enjoy your memorable time of visiting and discovering their natural uniqueness.

Thank you once again for your support and commitment. And to our guests, indeed have wonderful and memorable days at the conference.

God bless you abundantly!

KEY NOTE SPEECH
Introduction

Drylands and wetlands are critical ecosystems of Africa’s natural resources landscape. East Africa remains central to the conversation of wetlands and drylands since it is home to critical wetlands such as Lake Victoria and others. In addition, most part of East Africa have drylands. These drylands are home to the Masai people who intend have to undergo seasonal migration with their cattle’s and herds; Drylands has erratic climate patterns and vulnerable to Global system of climate change. In an era of climate change; the evolution of the 4Rs technologies and others, there was a need for the Maasai Mara University (MMU) to convene this conference to share knowledge on how to over the critical challenges in conserving Africa’s biodiversity in wetlands and drylands. This keynote will focus on the state of Africa’s Drylands and wetlands and biodiversity, the history of South Africa’s wetlands, Biodiversity in Drylands and Wetlands: Challenges and Opportunities in the 21st Century; and Conservation and Sustainable Use of Resources; The Link Between Funding as A Driver of Resource Conservation and Sustainability and then draw some conclusions.

State of Africa Drylands, Wetlands, and Biodiversity

In recent study on the *Biodiversity in Drylands: Challenges and Opportunities for Conservation and Sustainable Use* by the World Conservation Union (IUCN), Findings of the review can be summarized as follows:

1. Agrobiodiversity is relatively well preserved; dryland farmers maintain high levels of biodiversity of crops and livestock breeds in their farms and family herds;
2. The status of wild animal and plant species diversity is poorly documented, apart from IUCN Red Lists records on endangered species;
3. The immediate major threat to dryland biodiversity appears to be the degradation of ecosystems and habitats caused by new and powerful forces of environmental degradation: urbanization and other forms of human settlements, commercial ranching and monocultures, industrialization, mining operations, wide scale irrigation of agricultural land, poverty-induced overexploitation of natural resources, and underlying them all, disincentives and distortions in the enabling environment. Some of these challenges are similar even with wetlands.

History of Wetland Research in South Africa

South Africa has continued to work and research on neglected wetlands through National Wetlands Research Programme to address the neglect of wetlands. Since 2000, the number of wetland researchers have increased by 85%.
However, there remain some challenges to Wetlands research in South Africa and Africa as a whole. These challenges include Lack of sustained funding (long-term projects); diverse systems (climate, geology, biota, land tenure, use); lack of base-line information for planning and decision-making; difficulty in finding suitable/interested students and governments departments over-worked, under-resourced, and (some) lack political will.
To ensure we have sustainable wetlands and drylands, we must admit wetlands research have several advantages including access Water Research funding, coordinating, disseminating knowledge-rational strategy for assessing research needs-quality control of research.
For us as researchers and policy makers, we must acknowledge that to over the challenges and ensure sustainable use of resources, we need to identify and overcome gaps in knowledge and tools. These gaps and tools include Collection of fundamental data, Optimization of constructed (treatment) wetlands; National wetlands inventory -attributes database; and Quantification of wetland benefits (measurements, economic costing).
Knowledge production in the field of BIODIVERSITY CONSERVATION research in Africa have increased over the years. From just six (6) articles in Scopus in 1980 to 4,359 articles in 2019.
These implies that, we are fully aware of the state of biodiversity conservation in Africa.

Biodiversity in Drylands and Wetlands: Challenges and Opportunities in the 21st Century

The major challenges for biodiversity in dry lands and wetlands are well documented by IUCN and other international and local organization. Although we are in the 21st century most of their challenges identified as far as the early 1990’s still persists. These include lack of adequate funding to support all programmes within these ecosystems. These problems have been compounded due to the dwindling support from international communities mainly in Europe
and America. In addition, the influx of the Chinese who are taken all our resources within their ecosystems without been concerned about the environmental effects is somehow worry- ing. In addition, other challenges include the neglect of dry and wetlands ecosystems the grand management of natural resources and their biodiversity. Many opportunities remain for effective management of drylands and wetlands Ecosystems and their biodiversity. In the last few years, several governments in Africa (most especially in East Africa) have passed policy and legislations on environment. The overall aim of these policies is to ensure sustainable use of these natural resources. This is a good ground for us to ask governments for implementation plans and sources of funding to implement these policies. Most African Universities undertake programmes in the field of environment and natural sciences. This means Africa has the needed critical mass to management their resources. In addition, communities over the years have gained better understanding on the benefits they get from conserving wetlands and its biodiversity. The Vaal University of Technology is one of Universities of technologies in South Africa. Over the past years, teaching, learning and research at our university is building capacity of students to use technology to find solutions to critical problems in drylands and wetlands in South Africa.

**Conservation and Sustainable use of Resources**

To ensure sustainable use of resources in drylands and wetlands ecosystems, stakeholders including those who live in these areas and depend on them should first understand the issues of ownership and benefit sharing from the use and preservation of these ecosystems. There should also be alternative live hoods programs, which will reduce communities’ dependence on these ecosystems. In addition, communities’ food security programmes should aim at reducing household dependence of this ecosystem by ensuring food availability and accessibility all year round.

On the higher levels, research outcomes (that is new knowledge generated) on drylands and wetlands should be properly and well disseminated to policy makers and all users to ensure trust and proper uptake and utilization of findings for effective policy which seeks to ensure conversation and proper utilization of drylands and wetlands.

At VUT, the Plant Molecular Genetics and Biotechnology focus area is using new equipment and technology to keep pace with the ever-changing research environment in biodiversity. The programme delves into new research ideas and through grants, attracts postgraduate studies to work and gain knowledge in the field for sustainable development.
The Link Between Funding as a Driver of Resource Conservation and Sustainability

Poverty, marginalization of people within wetlands and drylands and political power and control are some of drivers to unsustainable use of wetlands and drylands. Of all efforts mentioned in the above session as a means of ensuring sustainable use of dryland wetlands, funding remains critical to all. Mainly international donors and conservation bodies including the IUCN, WWF and UNDP fund current most wetland and drylands projects, programmes and research. These institutions have established strong partnerships with their donors over the years and therefore in most cases have a reliable source of funding for their activities.

However, since we all know the centrality of funding to the sustainability of conservation and sustainable use of biodiversity in wetlands, there is a need for all to explore other sustainable sources of funding for this critically endangered ecosystem.

Stakeholders gathered here should look at the possibility of starting discussions with regional bodies such as NEPAD and EAC amongst others. These partnerships should be built of trust and commitment to preserve these nature reserves from deterioration. In addition, funds/income generated from activities within ecosystems should have a percentage committed to the programmes that seeks to ensure sustainable use and conservation of their ecosystems.

In addition, capacity needs to build in new areas of research and community managements. Donors and national governments should establish systems of accountability (effective monitoring and evaluation frameworks) to ensure trust and proper reporting of all activities, which are funded.

Without adequate funding it is clear these ecosystems with be overused and their survival threatened. Sustainable funding with ensure continuous research and sustainable programmes and by extension generate new knowledge to empower all stakeholders and reduce community’s dependence.

At VUT, there exist funding opportunities for Postdocs and the possibility of establishing joint research programmes and centers for undertake critical research in the area of biodiversity research in wetlands and drylands. VUT will use it’s already established partnerships with well-established universities in South Africa to strengthen the collaboration with this university.

Conclusions

The theme and thematic areas of the conference are very relevant to the research and programme landscape of biodiversity conservation in wetlands and drylands. It is therefore important that Research production in the area should look at training more scientists and social scientist in the various sub fields. Whilst Maasai Mara University seeks to strengthen partnership with Vaal University of Technology, there will also be the need for the two (2) universities to establish strong partnership by having some Institutional arrangements and collaborations between universities and international research institutions such as the United Nations University – Institute for Natural Resources in Africa (INRA).

In addition, the discussion should not stop here. VUT and MMU should establish niche areas where the two can collaborate and form a stronger partnership.
New National STI Policies should look at addressing the issue of funding of biodiversity research and programmes in dry lands. MMU and VUT with other stakeholders should explore how the 4Rs’ debate can used to sustain Africa’s drylands and wetlands. Overall, our partnership should look at acquiring adequate funding to improve Infrastructure Development for research in the theme areas for this conference to ensure proper management and sustainable use of biodiversity in drylands and wetlands. On this note, I wish you all a fruit discussion within these three days.

Thank you.
THE SCIENTIFIC COMMITTEE

Prof. BAI Chunli
Chairperson
President of the Presidium of the Academic Divisions of CAS, and the President of the World Academy of Sciences for the Advancement of Science in Developing Countries Bai Chunli (TWAS)

Prof. Mary K. Walingo
Vice-Chancellor- Maasai Mara University
Secretary

Prof. Victoria Wambui Ngumi,
Vice-Chancellor. JKUAT
Member

Prof. Felix Dapare Dakora
President, The African Academy of Sciences
Member

Prof. Raphael Munavu
President, Kenya National Academy of Sciences
Member

THE ORGANIZING COMMITTEE

Mr. CAO Jinghua
Executive Director, ANSO
Chairperson
Prof. Qing-Feng Wang
Director, Sino-Africa Joint Research Center, CAS (SAJOREC)
Co-Chairperson

Prof. YAN Xue
Executive Director of SAJOREC-CAS
Secretary General

Prof. Bulitia Godrick Mathews, Ph. D
Deputy Vice-Chancellor (Academic and Student Affairs) Maasai Mara University
Co-Secretary General

Prof. Mohamed Hussein Abdille, Ph.D., FNAS
Deputy Vice-Chancellor. (Administration, Finance & Planning) Maasai Mara University
Co-Chairperson

Prof. Dr. Wycliffe Wanzala, PhD, AMANTINER, MACSE, MISE, FASI
Director, The Institute of Ethnobiology and Ethno Medicines
Organizing Secretary
CONFERENCE SUB-COMMITTEES

Abstract, papers and Publications Sub-Committee

Prof. Wycliffe Wanzala
Chairperson, Conference Planning Committee

Prof. Romulus Abila

Dr. Aloys Osano

LIU Huaibo

Conference Secretariat and Programme coordination Sub-Committee

Mr. Moses Okombo
Secretary, Conference Planning Committee

Ms. Elizabeth Wakoli

WU Hao

Jiang Yiqi

Al Likun

Publicity and Promotion Sub-Committee

Anil Kumar

Nila Akinyi

LIU Huaibo

Security, Health and Safety Sub-Committee

Mrs. Teresa Cheruto

Ms. Faith Resiato

YU Haifeng

Mr. Evans Ouya

YU Quan

Hospitality, Accommodation and Transport Sub-Committee

Dr. Kennedy Onyiko

Ms. Caren Goro

ZHANG Guoshi

Mr. Peter Kipleting

YU Haifeng
# THE CONFERENCE PROGRAMME

**DAY ONE: WEDNESDAY, SEPTEMBER 4TH, 2019**

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<th>MC: Dr. Nancy Ayodi/Dr. Onyiko</th>
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<td>Arrival and Registration of Participants</td>
<td>M/s. E. Wakoli/Mr. M. Okombo</td>
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<td>11:00-11:30</td>
<td>Research Laboratories &amp; Equipment Handing-over Ceremony</td>
<td>The Vice Chancellor, Prof. Mary Walingo</td>
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<td>11:30-11:50</td>
<td>Tree Planting Session</td>
<td>Prof. Wycliffe Wanzala/IEE Staff</td>
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<td>11:50-12:00</td>
<td>Crowning of Guests</td>
<td>The VC’s Office-M/s. Rose Lomo/ Director, Marketing and Staff</td>
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<td>12:01-12:10</td>
<td>Group Photo Session in the Garden</td>
<td>University ICT/Mr. K. Mzalendo</td>
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**IN THE CONFERENCE MAIN HALL**

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<td>Opening Prayers</td>
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<td>Entertainment of Guests</td>
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<td>13:15-13:25</td>
<td>Vice Chancellor, MMU</td>
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<td>Editorial Director, Royal Media Services</td>
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<td>13:35-13:45</td>
<td>Senator, Narok County</td>
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<td>13:45-13:55</td>
<td>H.E. Governor- Narok County</td>
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<td>13:55-14:05</td>
<td>Chief Administrative Secretary (CAS) - Ministry of Environment</td>
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<td>Cabinet Secretary- Ministry of Education</td>
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<td>14:25 -14:45</td>
<td>Chief Guest</td>
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<td>14:45-15:05</td>
<td>ANSO Executive Director</td>
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<td>15:05-15:20</td>
<td>Director, SAJOREC-JKUAT</td>
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<td>Time</td>
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<tr>
<td>08:00-08:30</td>
<td><strong>Registration:</strong> M/s. Elizabeth Wakoli and Mr. Moses Okombo</td>
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<td><strong>Chairperson:</strong> Prof. ZHANG Quanfa</td>
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<td><strong>Rapporteur:</strong> Dr. Beatrice Manyasi / Dr. Rev. John Matuya</td>
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<td><strong>THEMATIC AREA 1</strong></td>
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<td>Geobiodiversity and Sustainable Conservation,</td>
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<td>Utilization and Management in the Drylands</td>
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<td>8:30-8:45</td>
<td>Impacts of Woody Plant Encroachment on Plant</td>
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<td>Diversity and Vegetation Structure in Borana</td>
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<td>Rangelands: The Case of Hallona and Medhacho</td>
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<td>Peasant Associations, Ethiopia. <strong>Niguse Bekel, Mekuria Argawand Gemedo Dalle</strong></td>
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<tr>
<td>8:45-9:00</td>
<td>China-Africa Centre Research Programs in Senegal: Research for Preparedness and Responsiveness on Infectious Diseases <strong>Lubin JIANG</strong></td>
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**DEPARTURE OF GUESTS AND PARTICIPANTS TO THEIR RESPECTIVE HOTELS**
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<thead>
<tr>
<th>Time</th>
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<th>Speaker(s)</th>
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<tbody>
<tr>
<td>9:45-10:00</td>
<td>Appropriate Cropping Pattern for Improved Land Productivity on Terraced Andosols in Suswa, Narok County, Kenya. <em>Alice Ruto, Charles Gachene, Patrick Gicheru, David Mburu and Zeinabu Khalif</em></td>
<td>Characterization and evaluation of antifungal and phytochemical activities of <em>Sennadidymobotrya</em> leaves extracts <em>Muiru John, Osano A. Mosima, Linda Mesoppirr, Bakari Chaka.</em></td>
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<tr>
<td>10:00-10:15</td>
<td>Gender Relations in Access to and Control Over Payment For Ecosystem Income In Maasai Mara, Narok County, Kenya. <em>Mercyjoy Karoki Mugambi, and Benson Kipkoech Kirui</em></td>
<td>Characterization of Blood Clotting Agents from Active Compounds of <em>Tradescantiazebrina, Tagetes minuta</em> and <em>Codiaeumvariegatum</em> plants <em>Gakuo Grace, Osano Aloys and Bakari Chaka.</em></td>
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<tr>
<td>10:15-10:30</td>
<td><em>Acacia senegal:</em> A Potential Tree in Soil Improvement in the Drylands of Kenya</td>
<td>Mineralogical and Morphological Properties of Matisaa Gray Rock as a Possible Raw Material For Manufacture of Cement. <em>Mwendwa Geoffrey, Otieno Fredrick, and Motochi Isaac</em></td>
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<td>10:30-10:40</td>
<td>HEART HEALTH BREAK</td>
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<td>13:00 - 14:00</td>
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<td>14:10-14:15</td>
<td>Influence of Drought and Household Characteristics on Food Security among the Pastoral and Agro-Pastoral Households in Mbirikani and Kimana Wards, Kajiado County. <em>Mutinda Mark Ndunda</em></td>
<td>Plant Diversity and Traditional Utilization of Medicinal Plants in Tropical East Africa: An example in Kenya <em>Guang-Wan Hu, Elizabeth M. Kamande, Qing-Feng Wang</em></td>
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<tr>
<td>14:45-15:00</td>
<td>Climate Change, Food Security and Agricultural Technological Innovations in Kisumu County, Kenya <em>Gudda Patrick</em></td>
<td>The Role of Soil Carbon Levels in Determining Food Nutrients. A Case Study of South Rift Region in Kenya <em>Naulikha J., Walingo, M. Alloy. O.</em></td>
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<tr>
<td>15:15-15:30</td>
<td>Livestock Depredation in Maasai Mara Conservancies, Narok County, Kenya <em>Elizabeth Wakoli, Dorothy Syallow, and Moses Okombo</em></td>
<td>Land Use and Cover Change and its Implications on Gully Erosion in Suswa Catchment Area, Narok County, Kenya <em>Charity Konana, Charles Gachene, David Mburu, Stephen Mureithi, Patrick Gicheru, Zeinabu Khalif</em></td>
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<tr>
<td>15:30-15:45</td>
<td>Management Practice of Arid Environment on Resources and Ecology by Local Ethnic People in Northwestern Arid Region, China <em>Wenjiang LIU and Borong PAN</em></td>
<td>Effects of Traditional Harmful Practices on Social-Economic Development of Women in Drylands in Kenya <em>Justine Amadi Orucho and Kennedy Karani Onyiko</em></td>
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<td>15:45-16:15</td>
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| 16:15-16:30| Investigating the Utilization and Effectiveness of Water Pans as a Water Harvesting Adaptation Strategy in Narok County | Mercy Kirumba, Nathan Oyaro and Romulus Abila                        | Spatial-temporal Variation of Vegetation Coverage and its Responses to Precipitation and Temperature in Kenya from 2000 to 2013
|            |                                                                         |                                                                      | WEI Xianhu, GUO Zhięng, ZHANG Zongke, SHI Lingfèi, QIU Fengting, Kiprotich Paul |
| 16:30-16:45| Combined Ozonolysis Pretreatment and Anaerobic digestion of Municipal Waste Activated Sludge                        | Benton Otieno, Seth Apollo, Bobby Naidoo, Aoyí Ochieng               | Modified Shannon-wiener diversity index towards quantitative estimation of biodiversity and environmental wellness levels under a non-comparative scenario
<p>|            |                                                                         |                                                                      | Dennis O. Omayio and Emmanuel Mzungu                                     |
| 16:45-17:00| Chairperson: Dr. Stella Kirui Rapporteur: Mr. Evance Ouya              | THEMATIC AREA 7 Management and use of Renewable Energy and other New Advanced Technologies in the Drylands and Wetlands Production of biomass briquettes from Eichhorniacrassipes ((Mart.) Solms) and Eucalyptus globulus (Labill.) leaves. Onyango Janet Atieno, Wycliffe Wanzala, Yan Xue | Investigating the Quality of Locally Produced Ethanol Spirits Using GC-FID, FTIR and PH Meter Analytical Methods. A Case Study of Spirits from Meru and Narok Region. Atuna Titus Gitari, Osano Aloys Mosima |
| 17:00-17:15| Synthesis, Preparation and Characterization of Silver Sulfide, Silver Selenide and Silver Telluride Nanoparticles with their Polymer Nanocomposites. | Oyandi Sense, Thokozani Xaba, Wesley Omwoyo, Vusumzi E Phakade        | Climate change and Kenya’s rangelands: How will mammals they fare? Simon Musila |
| 17:30-18:00| Health Break/ Departure of the Day                                      |                                                                      |                                                                               |
|            |                                                                       |                                                                      | DAY THREE: FRIDAY, SEPTEMBER 6TH, 2019                                      |</p>
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<th>Time</th>
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<tr>
<td>8:30-</td>
<td>The effect of Fe/Mn ratio on a bimetallic oxide heterogeneous catalyst supported on silica for the degradation of methylene blue. <strong>Nande Mgedle, Elvera Viljoen, Augustine Ofomaja, Mike Scurrell</strong></td>
<td>Analysis of the Catalytic Behaviour of <em>Oyris Alba</em> Bark and <em>Indigofera Amabelacensis</em> Plant Extract in Ethanoic and Lactic Fermentation Process. <strong>Maxwel Gitonga and Aloys Osano</strong></td>
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<td>8:45-</td>
<td>A Compact Decentralized System for Wastewater Treatment for Re-use in Remotely Located Higher Learning Institutions and Settlements. <strong>Seth Apollo, Grace Lubaale, Manana Seretlo, John Kabuba</strong></td>
<td>Characterization and Antimicrobial Profiling of Bacterial Isolates from Surfaces in The Maasai Mara University Clinic, Kenya. <strong>Osigo Michael and Eshitera Eric</strong></td>
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<td>9:00-</td>
<td>Leveraging on the Language of the Catchment Area for the Use and Management of Renewable Energy in North Rift, Kenya. <strong>Ayodi N. K and Kirui S.C</strong></td>
<td>Impact of 3D Technology in Education <strong>Anil Kumar, Bulitia G.</strong></td>
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<td>9:45-</td>
<td>Research on Sustainable Development of Industrial Parks in Africa. A Case Study of Ethiopia. <strong>Kai LIU</strong></td>
<td>Physiological and molecular behaviour of microsymbionts nodulating <em>Polhillia, Wiborgia</em> and <em>Wiborgiella</em> species of the South African Cape Fynbos Region. <strong>T. Mpai, S.K. Jaiswal, F.D. Dakora</strong></td>
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<td>10:00</td>
<td>Maasai Mara University Impact in Knowledge Sharing on Renewable Energy for Sustainable Development to Narok County, Kenya. <strong>Bulitia Godrick Mathews, Rahab Koech, Rogers Obare Matikho, Aloys Mosima Osano</strong></td>
<td>Molecularly imprinted polymers selective to polychlorinated biphenyls and their integration in QCM Sensors. <strong>Elizabeth N. Ndunda</strong></td>
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<td>10:00-10:15</td>
<td>Prof. A. Thuo</td>
<td>Dr. Sammy Mutisya</td>
<td>Role of Comparative Genomics in the Conservation and Management of Dryland Fisheries of East Africa: the Case of Magadi tilapia (<em>Alcolapia grahmani</em>). Geraldine D. Kavembe and Romulus Abila</td>
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<td>THEMATIC AREA 4 Management and use of Renewable Energy and other New Advanced Technologies in the Drylands and Wetlands</td>
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<td>Capacity building on ecological research and biodiversity conservation in Tropical Asia. Jin CHEN</td>
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<td>Biodiversity of rhizobia in African soils: insights into their phylogeny and potential utilization as biofertilizers for sustainable agriculture. Mustapha Mohammed, Sanjay K. Jaiswal &amp; Felix D. Dakora</td>
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<td>11:00-11:15</td>
<td>Ms. Jaqueline Naulikha</td>
<td>Dr. Domnic Menge</td>
<td>Chairperson: Ms. Jaqueline Naulikha Rapporteur: Dr. Domnic Menge THEMATIC AREA 6 Public health and its impact on drylands and wetlands Education level and HIV/AIDS Knowledge, awareness, attitudes and practices among the online partner and spouse seekers in Kenya Naomi K. Miriti, Sichangi Kasili and Wycliffe Wanzala</td>
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<td>11:15-11:30</td>
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<td>Competency-Based Curriculum in Kenya and Learners’ Capacity Building to Combat Environmental Degradation. Florence K. Kisirko</td>
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<td>Fabrication of Aptamer Conjugated Gold Coated Iron Oxide Nanoparticles for Breast Cancer Diagnosis. Shonny Nkuna, Ayabei Kiplagat, Martin O. Onani and Mervin Meyer</td>
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<td>Analysis of Farne spp. and <em>Cyamboponcitratius</em> Extracts for their Beverage Potential Compared to Processed Black Coffee and Black Tea Leaves. Bakari C., Olal W., Osano A., Magu M., Omondi F. and Maghanga J.</td>
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<td>11:45-12:00</td>
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<td>Red Wine Gold Nanoparticles Efficacy on Prostate Cancer. Nonkosi Matinise, Abram M. Madiehe and Martin O. Onani</td>
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<td>12:00-12:15</td>
<td>Species diversity of birds in Mountains of Southwest China and the Horn of Africa</td>
<td><em>Fumin Lei</em></td>
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<td>The Synthesis of Antimicrobial Peptide (Amp) - Loaded Chitosan Nanoparticles for Treatment of Sexually Transmitted Infections (STI’s).</td>
<td><em>N. Phathekile, M.O. Onani, M. Meyer and G.E. Okuthe</em></td>
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<td>12:15-12:30</td>
<td>Collecting, Depositing, and Scientific Researching on Biological Collections of the Chinese Academy of Sciences</td>
<td><em>Jun CHEN, Peng HE and Gexia QIAO</em></td>
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<td>Adsorption of Chromium (VI) by Magnetized Quaternary Activated Carbon-Silica Composites.</td>
<td><em>Qhubu MC, V.E Pakade and P Nomngongo</em></td>
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<td>12:30-12:45</td>
<td>Study and utilization of artificial rice resources tetraploid rice.</td>
<td><em>Shengbin TU</em></td>
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<td>ElectrosponZein/PVA/Mn₃O₄NanocompositeFibers as an Adsorbent for Chrysoidine G from Aqueous Media</td>
<td><em>Nompumelelo S.M. Kubheka, Makwena Moloto and Nolutho Mkhumbeni</em></td>
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<td>12:45-13:00</td>
<td>Discourses on the Kenyan Competency Based Curriculum (CBC) - A Critique</td>
<td><em>Alexander Meitamei and Jane Ombati</em></td>
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<td>Analysis of Microbial Composition and Abundance in Drinking Water Sources in Narok Town, Kenya.</td>
<td><em>Doryce Nanjala Ndubi and Wycliffe Wanzala</em></td>
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<td>13:00-14:00</td>
<td>HEALTH BREAK</td>
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<td>14:00-14:15</td>
<td>Challenges of E-Government Communicating Disaster Information in Wetlands and Drylands: Case of Narok County, Kenya.</td>
<td><em>Raphael W, Namaru¹ Dr Shem I, S Khamadi²</em></td>
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<td>Photocatalytic degradation of acetaminophenusingpolyene modified TiO₂ under visible light.</td>
<td><em>Olayinka O. S. Awofiranye, Sekomeng J. Modise and Eliazer B. Naidoo</em></td>
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<td>14:15-14:30</td>
<td>Chairperson: Mr. Salaton Tome Rapporteur: Dr. Samson Mabwoga</td>
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<td>THEMATIC AREA 3 Weather and Climate Changes and Adaptations in Ecosystems of Drylands and Wetlands</td>
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<td>Optimization of biogas production from kitchen wastes using <em>Terminalia</em> spp. and <em>Acanthaceae</em> spp. bio-catalysts.</td>
<td><em>Bakari Chaka, Osano Aloys, Maghanga Justinand Magu Martin</em></td>
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<td>Photodegradation of Methylene Blue using Bismuth Oxy-halide (BiOBrₓI(1-x)) Nanomaterials.</td>
<td><em>Robert O. Gembo, Cecil K. King'ondu and Aoyi Ochieng</em></td>
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<td>14:30-14:45</td>
<td>Climate Change and Pastoral Livelihoods in Karamoja region, Uganda.</td>
<td><em>Alex, R. Mwangu</em></td>
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<td>Primary Healthcare Services and Sustainable Development in the 21st Century: Impacts and Challenges in Kenya.</td>
<td><em>Israel Nzuki</em></td>
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<td>14:45-</td>
<td>Impact of Population Increase on African Traditional Environmental</td>
<td>Jackson M.M., Walingo Bulitia G K.M and Osano A</td>
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<td>15:00</td>
<td>Conservation Practices: A Case of the Maasai People of Narok</td>
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<td>15:00-</td>
<td>Antimicrobial Activity of Titanium Dioxide Nanoparticles Immobilized</td>
<td>Sibongile C. Nkabinde, Makwena J. Moloto and Kgabo P. Matabola</td>
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<td>on Electrospun Polyacrylonitrile-Cellulose Acetate Polymer Blended</td>
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<td>Nanofibers.</td>
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<td>15:15-</td>
<td>Past and Future Changes in Climate Extremes over Kenya based on</td>
<td>Philip Obaigwa Sagero, Chris A. Shisanya and George L. Makokha</td>
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<td>15:30</td>
<td>Three Coordinated Regional Downscaling Experiment High-Resolution</td>
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<td>Regional Climate Models.</td>
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<td>15:30-</td>
<td>Removal of CU^{+2} Ions from Domestic Water using Extracted Cellulose</td>
<td>Mesoppirr, L. S., Oyarou, N., Omwoyo, W. N., Makwena, J. M</td>
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<td>from Typhaaugostifolia.</td>
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<td>An Assessment of Environmental Impacts of Quarrying: The Case of</td>
<td>Njue Daisy and Salaton Tome</td>
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<td>Narok Town</td>
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<td>Promoting Tree Planting for Climate Change Mitigation as a Platform</td>
<td>Evance Ouya, Paul Weble and Romulus Abila</td>
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<td>for Public Education and Community Outreach Programme for</td>
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<td>Environmental Conservation in Narok County.</td>
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<td>16:00-</td>
<td>Indigenous Adaptation Mechanisms to Climate Change in Drylands of</td>
<td>Munyi M.K, Kirui S.C and Kiptum L.J</td>
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<td>16:15</td>
<td>West Pokot County, Kenya.</td>
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<td>Effects of climate warming and heat wave on macrophytes and their</td>
<td>Li Zhongqiang</td>
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<td>reproductive strategies and their interactions</td>
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<td>The Impact of Climate Change and Anthropogenic Activities on</td>
<td>Naulikha, J and Mukoya, E.</td>
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<td>16:30</td>
<td>Fisheries of Lake Logo, South</td>
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<td>Rule of Law and Climate Change Governance in Kenya.</td>
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<td>Biological Cleaning of Sewage</td>
<td>Immaculate L.A. Ouma, Augustine E. Ofomaja and Eliazer B. Naidoo.</td>
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<td>Water Using Common Water Hyacinth (Eichhornia crassipes (Mart.)</td>
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<td>Solms).</td>
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<td>Hexavalent Chromium Adsorption onto Magnetite-Pine Cone composite: A</td>
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<td>Social Workers’ Roles In Palliative Care in Kenya.</td>
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<td>Investigating the Quality and Quantity of Briquettes Fuels Prepared</td>
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<td>Kecharong Moses and Osano Aloys</td>
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<td>17:00</td>
<td>Master of Ceremony (MC)</td>
<td>Dr. Augustine Kara</td>
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<td>Chairperson of the Conference Secretariat – Closing Remarks</td>
<td>Prof. Wycliffe Wanzala</td>
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<td>Director, Research, MMU– Closing Remarks</td>
<td>Prof. Nathan Oyaro</td>
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<td>DVC, AF&amp;P) – Closing Remarks</td>
<td>Prof. Mohammed Hussein Abdile</td>
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<td>DVC, A&amp;SA) – Closing Remarks</td>
<td>Prof. Bulitia Godrick Mathews</td>
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<td>ANSO Secretariat</td>
<td>Prof. AI Likun</td>
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<td>Director, SAJOREC-JKUAT– Closing Remarks</td>
<td>Prof. Robert Gituru</td>
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<td>Chief Guest of the Closing Ceremony</td>
<td>Dr. Eric Mwangi</td>
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<td>Issuance of Certificates by Chief Guest</td>
<td>Dr. Otieno Friedrich Onyango</td>
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Geo/Agrobiodiversity and Sustainable Conservation, Utilization and Management in the Drylands and Wetlands

Impacts of Woody Plant Encroachment on Plant Diversity and Vegetation Structure in Borana Rangelands: The Case of Hallona and Medhacho Peasant Associations, Ethiopia

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Abstract
The Borana rangelands are important areas of cattle production in Ethiopia. However, these rangelands are threatened by the increasing changes in the natural vegetation from grass and forbs dominated into unpalatable bushy woody vegetation resulting in the loss of some of the highly desirable grass species. This study was conducted to assess the impacts of bush encroachment on the diversity, structure and cover of the native vegetation in bush encroached and non-encroached sites. Vegetation data were collected from both sites by laying quadrat plots along transects using a systematic sampling method. According to the results, higher number of species was recorded in the non-encroached sites than that in the encroached sites. The diversity indices for the non-encroached and the encroached sites were 3.16 and 2.67, respectively. The abundance and cover analysis indicated that there was high density and cover of herbaceous species in the non-encroached site. There was a significantly higher density of woody species cover in the encroached site. Generally, the bush encroachment in the Borana rangelands has hampered the diversity of the native vegetation, particularly the grasses and forbs and reduced the ground cover, exposing large parts of the rangelands for soil erosion and other degradation process.

Keywords: Rangeland; Bush Encroachment; Encroachment; Non-encroachment; Diversity
China-Africa Center Research Programs in Senegal: Research for Preparedness and Responsiveness on Infectious Diseases

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Abstract
The main goal of Sino-Senegal Epidemic Prevention, Control & Innovation Center is to anticipate and prepare for the “next” emerging pathogens, as well as validate front-line treatments in clinical trials. This main theme will be supported by basic, technical and applied research projects covering a multitude of infectious disease pathogens already of public health importance from various principal investigators at IPS, KIZ (Kunming Institute of Zoology) and WIV (Wuhan Institute of Virology) to be conducted with researchers at IPD. We aim to provide an “end-to-end” solution to countering public health threats: 1) to proactively discover novel, emerging pathogens circulating in West Africa, 2) to develop and test sensitive/specific diagnostic assays to improve detection capabilities especially in rural areas, 3) to develop and test effective vaccines and drugs against known and unknown novel pathogens, and 4) to advance the most promising antivirals through the clinical pipeline. A Chinese-developed anti-malarial drug (JL01) has been characterized by IPS researchers that JL01 kills artemisinin-resistant *Plasmodium falciparum* at multiple life stages with high efficacy and safety. We have already completed all pre-clinical studies at IPS and are currently in process of application for clinical trials in Africa. The center will better carry out scientific and technological cooperation under the platform of “the Belt and Road Initiative” International Union of Scientific organizations.

Keywords: Research programmes: Africa; China; Infectious Diseases
Gender Disparities in Wildlife Management and Conservation: A Case of Maasai Mara Conservancies in Narok County, Kenya

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Abstract
This study aimed at assessing the gender disparities in wildlife management and conservation in conservancies within Maasai Mara ecosystem, Narok County, Kenya. Gender equity and women’s empowerment are prerequisites to effective biodiversity conservation, climate action and meeting the Sustainable Development Goals. In view of its ecological, social and economic value, wildlife is an important renewable natural resource. Its significance is felt in areas such as rural development, land-use planning, food supply, tourism, scientific research and cultural heritage. A better understanding of the different roles, knowledge, needs and aspirations of women and men with regard to wildlife management and conservation can help achieve the twin goals of better conservation outcomes and increased gender equity. The study was carried out in four wildlife conservancies in Maasai Mara. Descriptive survey and sequential explanatory mixed method approach were adopted for the study. A sample size of 167 respondents comprising of wildlife managers, conservancy landowners and conservancy rangers participated in the study. Data collection was done using questionnaires, focused group discussion and interviews. The findings showed that women were underrepresented as staff, wildlife managers and beneficiaries in payment for ecosystem benefits in conservancies. The study recommends that environmental education, gender advocacy training and capacity building needs be initiated in community based conservation in Mara. Further, the study recommends that government and non-governmental institutions focusing on wildlife conservation in Maasai Mara should effectively communicate, implement, enforce and institutionalize the policies on gender equity in wildlife management and conservation.

Keywords: Gender; Wildlife Management; Wildlife Conservation
Post 2020 Biodiversity Conservation Framework

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Abstract
The 15th Conference of Parties to the Convention on Biological Diversity (COP15) will be held in Kunming in 2020. The COP15 is a very important conference at which the progress and problems for the implementation of the Strategic Plan for Biodiversity 2011-2020 (i.e., the Aichi Targets) will be summarized and assessed, and a global biodiversity conservation strategy framework will be proposed for the next decade (2021-2030). China should play an active role in developing this biodiversity conservation framework. Moreover, it is necessary to sum up the case studies and experiences in biodiversity conservation under the guidance of “Ecological Civilization” in China that can be used as references of reconciling conservation and development for other Parties, especially for developing countries. What can we now contribute to the development of the post 2020 framework? Guidance on relationship between key approaches and frameworks (ERL/3 conditions/bending the curve/2 degree equivalent; Understanding the availability and robustness of biodiversity spatial and temporal data to underpin metrics in the post 2020 framework; Better connecting data and metrics across the DPSIR framework -including strengthening sensitivity and understanding links to CC, SDGs etc. Understanding the potential for bring together the multiple dimensions of biodiversity; Understanding and elaborating on the elements of the 2050 vision and the pathways towards achieving them; Reflections on targets-SMART, priority issues etc. Milestones.goals/targets for 2030 (and possibly also 2040) based on Biodiversity outcomes (species, populations, ecosystems, genetic diversity, function) Benefits (health, nature-based solutions, sustainable agriculture, sustainable use)Direct drivers of biodiversity loss (land use change, overexploitation, etc.). Indirect drivers of biodiversity loss (unsustainable consumption and production, etc.). Enabling conditions, mainstreaming and other responses. Indicators for the above. Means of implementation (resource mobilization, capacity-building, etc., accountability, review and reporting.

Keywords: Biodiversity; Conservation; Framework
Reintroduction of Rare and Endangered Plants in China

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Abstract
Human disturbance and climate change have increased the risk of extinction for rare and endangered plants in China. One effective way to conserve these rare and endangered species is through reintroduction. We assessed the current status of plant conservation translocation efforts in China. We identified 222 conservation translocation cases involving 154 rare and endangered species. We categorized the life form of each species, and determined for each case the translocation type, propagule source, propagule type, and survival and reproductive parameters. A surprisingly large proportion (26%) of the conservation translocations in China were conservation introductions, largely implemented in response to large-scale habitat destruction caused by the Three-Gorge Dam and another hydropower project. Documentation and management of the translocations varied greatly. Less than half the cases had plant survival records. Statistical analyses showed that survival percentages were significantly correlated with plant life form and the type of planting materials. Thirty percent of the cases had records on whether or not individuals flowered or fruited. Results of information theoretic model selection indicated that plant life form, translocation type, propagule type, propagule source, and time since planting significantly influenced the likelihood of flowering and fruiting on the project level. We suggest that the scientific-based application of species conservation translocations should be promoted as part of a commitment to species recovery management. We recommend the establishment of a national office and database to coordinate conservation translocations in China. In addition, we introduce two reintroduction cases and comment the future of plant reintroduction strategies.

Keywords: Reintroduction; Rare; Endangered Plants; China
Appropriate Cropping Pattern for Improved Land Productivity on Terraced Andosols in Suswa, Narok County, Kenya

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Abstract
A field experiment was carried out in Suswa, Narok County in the crops’ growing season of 2013-2015 to determine a suitable cropping pattern to optimally utilize moisture in terraced fields. A randomized complete block design was used with maize and beans as test crops. The study examined, under different cropping patterns (CP) soil moisture, soil nutrients and crop yield in terraced and on non-terraced farmers’ fields as control (CP4). The results showed significant differences ($p\leq0.05$) in moisture and nutrients availability with bottom terrace position recording on average higher (15%) moisture content compared to 13% in upper position. The bottom recorded 16 and 21% higher soil carbon and 33 and 48% higher N than the mid and upper positions, respectively. The bottom had the highest soil P (24.88) followed by mid (18.36) and top slope (14.85) ppm. K however was not affected by slope position. The yields were significantly ($P<0.05$) higher according to terrace slope position with values ranging from 7.2 t ha\textsuperscript{-1} to 3.0 t ha\textsuperscript{-1} for maize and 1374 kg ha\textsuperscript{-1} to 306 kg ha\textsuperscript{-1} for beans in lower and upper slope respectively. Significant differences ($P<0.05$) were also observed in cropping patterns with CP2 on average recording the highest (803 kg ha\textsuperscript{-1}) bean yields and CP4 (control) the lowest (576 kg ha\textsuperscript{-1}) in season I. The study found CP2 (Maize/Bean in upper and lower slope position and sole bean in the middle) most favourable for the study area and concluded that terracing and appropriate cropping pattern improved land productivity.

Keywords: Terracing; Slope position; Cropping patterns; Crop yields
Watershed Ecology: Theory and Applications

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Abstract
Watershed is a geographical unit on the earth’s surface with defined physical boundaries formed under the interaction of the earth's internal forces and subsequently modified by its external forces and human activities. From the ecological point of view, watershed is an open and complex system composed of multiple ecosystems such as forest, grassland, river, lake, farmland, and urban, etc. More ever, it is the atmospheric-terrestrial water cycle that forces the formation and the evolution of watershed, and also provides the critically drivers for the ecosystem processes in watershed. During the past decade, we have extensively investigated the structure and function of the ecosystems including uplands, wetlands, riparian, river, and reservoir, and further studied the nutrient cycle processes through water cycle in China’s Han River basin. Consequently the research results have been applied for the sustainable management in the watershed in terms of water resources, biodiversity conservation, and hydraulic engineering, etc. Under the context of global environmental change, theory and applications of watershed ecology could provide great opportunity for sustainable development in the coupling human and nature system.

Keywords: Watershed; Ecology; Theoretical Applications

Gender Relations in Access to and Control over Payment for Ecosystem Income in Maasai Mara, Narok County, Kenya.

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Abstract
This study aimed at assessing the gender relations in access to and control over payment for ecosystem income in Maasai Mara wildlife conservancies. Equitable access and control over biodiversity varieties and ecosystems, leads to greater habitat protection. Benefits provided by indirect use of natural resources especially from wildlife tourism are often used to generate opportunities for local communities and improve the tolerance of people towards presence of wildlife and conservation related actions. The study was carried out in four Maasai Mara wildlife conservancies. Descriptive survey and sequential explanatory mixed method approach were adopted for the study. A sample size of 167 respondents comprising of wildlife managers, conservancy landowners and conservancy rangers participated in the study. Data collection was done using questionnaires, Focused Group discussion and interviews. Reliability of the instruments was tested using test-retest method and Cronbach’s Alpha co-efficient was used to determine the internal consistency of the in-
straments. The findings showed that women benefited less and had less control over payment for ecosystem income in conservancies as compared to men. The reason behind this was that very few women owned land which was a crucial asset in determining benefits from payment for ecosystem. The study recommends that wildlife management and conservation institutions give a fresh look on addressing the issue of gender equity in distribution of payment for ecosystem income among men and women in conservancies.

**Keywords:** Gender relations; Access to and Control over resources; Wildlife ecosystems

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**Acacia senegal: A Potential Tree in Soil Improvement in the Drylands of Kenya**

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**Abstract**

*Acacia Senegal* (Gum Arabic) is a dryland multipurpose tree legume that is highly valued for gum arabic production, agroforestry and desertification control. Three varieties are currently recognized in Kenya namely: *A. Senegal* var. *senegal*, var. *kerensis* and var. *leiorhachis*. While these varieties are desirable in terms of adaptability and potential for genetic improvement, there is limited information on their potential to accumulate nutrients and fix nitrogen in the natural ecosystem. This study investigated the potential of the three varieties in soil improvement under natural conditions for sustainable conservation and management of the species. Sampling was done in three sites (Kajiado, Magadi and Kibwezi) located in the arid and semi-arid lands of Kenya. Soil samples were collected under canopies for physicochemical analysis. The potential of the three varieties to fix nitrogen in their natural ecosystems was determined using $^{15}$N natural abundance method. There were significant differences in soil physicochemical properties among the three varieties ($P<0.05$ and $P<0.01$). Soil nutrients under the canopies were higher than in the open canopies mainly due to litter accumulation. The estimated nitrogen fixed (\%Ndfa) values for the three varieties ranged from 18.20 – 32.21\% with *A. senegal* var. *senegal* showing the highest values. The three *A. senegal* varieties have beneficial effects on soil fertility that would enhance herbage productivity both in quality and quantity in the drylands. Domestication of the species would play a major role in management of drylands and subsequently improve the dryland communities who are key collectors of gum and other forest products.

**Keywords:** Conservation; Sustainable utilization; Biodiversity
Adoption of Adaptive Management Approach to the Maasai Mara Ecosystem, Narok County, Kenya: Potentials and Pitfalls

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Abstract

Global environmental challenges are setting new framework for human interactions with nature and for achievement of the Sustainable Development Goals (SDGs). Impacts from these challenges and the capacity to address them are not evenly distributed across the globe, but rather form hotspots. One of such hotspot is located in semi-arid tropical Africa, which is forecasted to experience increases in aridity, extreme weather conditions and temperatures. This paper, based on literature review, focuses on the Narok County in Kenya, which is mainly covered by savannah. It includes the Maasai Mara ecosystem (MME) that is world renowned for the annual large migration of fauna. Agricultural and pastoral practices by local communities residing in Narok County rely on this fragile ecosystem. Unfortunately, precise projections concerning the magnitude and location of their impacts on this fragile ecosystem are constrained by high levels of uncertainty and uncoordinated scientific knowledge and research. These imprecision and uncertainties constrain development initiatives and environmental management by making it difficult to foresee changes and thereby implement specific need-based interventions in due time. This paper proposes the adoption of adaptive management approach to the management of Maasai Mara Ecosystem. Adaptive management is an approach to natural resource management in an ecosystem that emphasizes learning based on the philosophy that knowledge is incomplete and much of what we think we know is actually wrong. The conceptual foundations of adaptive management are that there will always be inherent uncertainty and unpredictability in the dynamics and behaviour of complex social-ecological systems but management decisions must still be made, and whenever possible, learning should be incorporated into management.

Keywords: Management; Ecosystem; Natural resource
Understanding Core Poaching Expanses of Targeted Bush Meat Herbivore Species in Sengwa Wildlife Research Area, Zimbabwe

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Abstract
Poaching activities in most of the wildlife protected areas in Zimbabwe have been widely reported. Sengwa Wildlife Research areas has been one of the areas which were largely affected by such incidences. The purpose of this research was to understand the spatial relationship between kudu, impala and zebra poaching incidences in order to develop a collective poaching risk map in Sengwa Wildlife Research Area. We used the Ripleys $K_{1,2}$ statistic to investigate the spatial relationship between the study species. Prediction of poaching risk for the three-study species was modelled using the MaxENT species distribution modelling technique. Results showed a significant spatial association between poaching events at all distances for all the species (kudu, impala and zebra). The results further indicated that distance from rivers was the most important variable explaining poaching risk for the study species. For example poaching incidences were found concentrated around Lutope, Manyoni and Sengwa rivers. The risk map showed that poaching hot spots were concentrated in areas around the major rivers and decreased as we moved away from the rivers in the study area (Lutope, Manyoni and Sengwa). Results from this study are key in formulation of cost effective and strategic anti-poaching plans and also to craft improved law enforcement policies.

Keywords: Anti-poaching; Species; Distribution; Modelling; Remote Sensing
Creation and Development of a Medicinal Botanical Garden: a Heritage Facility for Conservation and Management of Flora and Fauna

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Abstract
Creativity and innovative thoughts in planning and management of the University spearheaded the creation and development of a medicinal-based botanical garden in a semi-arid area using purified water from Maasai Mara University Wastewater Effluent Management System (MWEMS). The rationale of this philosophical idea was that the University is located in a semi-arid zone and the sustainable management of water resources is therefore critical in such a harsh environment. The University therefore innovatively recycled the water it uses to create a heritage facility, African Medicinal Botanical Garden (AMBG), where ex-situ and in-situ conservation and preservation of flora is the main objective. However, fauna is currently being considered in the form of creating a zoo with the ultimate goal of developing ecotourism industry alongside a recreational facility for nature trail, picnics, filming, video recording and shooting. More than 250 plant species available in the Garden are useful resources for a wide range of pharmaceuticals, nutraceuticals, functional foods, fortified foods, cosmetics, aromatic, pesticides etc. The full potential of these resources will be realized through concerted efforts of developmental research. By establishing Farmers’ Field School (FFS) in the Garden, ethno-practitioners’ knowledge, mind, and experiences will be industrialized to develop medicinal woodlots in their own arable farming systems that will help the government’s strategies and efforts in environmental conservation and to combat desertification and increase the country’s forest cover to 10 per cent by 2020 as well as increasing and making housing resources available and accessible, henceforth, reducing the cost of construction at local level.

Keywords: Useful plant and animal species; Conservation and preservation; Water resources; Medicinal woodlots; Arable farming system
Diversity of Butterfly Species around Narok Town, Narok County, Kenya

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Abstract

Butterflies are useful as pollinators and as model organisms to study the environmental health, and climate change. Although European butterflies have been widely studied, documentation of African species are still scanty. Such observations would be useful in constructing a database and reference for the butterflies in Narok. The objective of this study was to determine the composition of the butterfly communities around Narok Town. Point trapping of the insects was done using hand-nets and bait traps at three different sites, namely site 1, around the botanical garden, site 2, near gate C, both in the Maasai Mara University Campus (MMU) and site 3, the bushy forest at the Olerai bridge. The samples were identified at the National Museums of Kenya. Results showed that Junonia eonone was the most prevalent species at site 1, whereas in site 2 had six species were equally prevalent. These were J.oenone, Colotis evanina, C. aurigeneas, Danaus chrysippus, Belenensis creona, Papilio demodeus, B. zochalia and Pontia helice,. Site 3 had 18 various species in 13 genera in four different families. These results show less diversity among butterfly species in the habitats within the MMU than in the bushes and forest areas at the Olerai bridge. Thus, the conservation values for butterflies were increased by the presence of the bushy and forest areas which have less disturbance than the sites on MMU. The protection of these areas from degradation should be a priority for policy makers since they support a species-rich community of butterflies pollinating cultivated plants.

Keywords: Diversity, Butterfly Species; Conservation; Narok County; Kenya
Evaluation of Kenyan Wheat Cultivars for Resistance to Stem Rust

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Abstract
The fast spread and mutation of a virulent race of stem rust in wheat has resulted in loss of the crop up to 90%. If this trend is not checked then, Kenya as country will have to import all of its wheat needs to avert starvation of her people. This study set out to identify cultivar resistant to wheat rust among the Kenya commercial wheat cultivars. From this study it was found that the infection ranged from no infection type “0” to maximum infection type “4” with 33% of the genotypes showing resistance and 67% of the genotype was medium susceptible to susceptible to stem rust. The varieties, which showed resistant to stem rust could be used for improvement of Kenyan wheat cultivars.

Keywords: Triticum aestivum; Stem rust; Ug99; Disease resistance

Causes of Land Degradation in Arid and Semi-arid Lands and Community Participation in Land Rehabilitation and Conservation: Case Study of Suswa Hill Catchment, Narok County, Kenya

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Abstract
Land degradation is a major challenge that leads to severe decline in land productivity and loss of biodiversity. The causes of land degradation vary depending on the type of land use systems, socio-economic factors, type of soils and topography among others. The soils in the arid and semi-arid lands are highly prone to degradation though water and wind erosion. They have low organic matter and clay content that make them to have weak structure and easily erodible by forces of wind and water. This is aggravated by some land use
systems where natural vegetation cover is cleared, leaving the soil surface exposed. Rehabilitation of degraded land is expensive and it takes a long time to rebuild the top-soil conditions on eroded land and re-shaping of deformed landscape. This paper gives results of rehabilitation of a part of Suswa Hill catchment that has been degraded in the last fifteen years. Occasionally the soil eroded from the catchment is deposited at a section of the major road from Maai-Mahiu to Narok, making the road impassable for all vehicles. Reconnaissance survey was done that involved satellite imagery analysis and ground truthing where the sub-catchment for rehabilitation was delineated. The community was mobilized to participate in the rehabilitation. An earthdam was constructed to control the surface run-off. Other structures including cutoff drains, semi-circular bunds and retention ditches were constructed. Forest trees were planted and the community agreed to keep off grazing in the area until full rehabilitation.

**Keywords:** Erosion; Control; Suswa; Narok; Kenya

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**China's Experience in Agricultural Development: The implications for Poverty Reduction in Kenya**

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**Abstract**

China has realized the dream of food sufficiency nowadays; the grain production has increased by about 400% since 1960. China with 8% of world’s arable land produces 20% cereals, 28% meat of the world, and feed 20% population of the world. China’s Experience in agricultural development could be with reference value to poverty reduction in Africa. China Government attaches great importance to agricultural development, especially in rural and agricultural infrastructure investment, agricultural R&D and extension, and regional rural comprehensive development. Effective agricultural techniques as balance fertilization, new crop cultivars, water saving irrigation and conservation tillage, for increasing yields were developed and extensively used in China. Increasing the crop yield is the key to reduce hunger and guarantee food security in Kenya. Kenyan Government should promote crop yield increasing initiative for 3-tons per ha. in next few years. Key measures, such as extension of new crop varieties, increasing fertilizer input, extending irrigation area and rainfall harvesting infrastructure, extension of small and cheap machinery should be implemented to break the vicious poverty cycle by improving resources management for agricultures in Kenya.

**Keywords:** Rural development; Crop yield increasing initiative; Kenya.
Renewable Energy Cooperatives in Rural Kenya: Recipe for Natural Vegetation Cover Restoration, Conservation and Poverty Alleviation

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Abstract
Natural Vegetation plays an integral role to the living things, humanity included and therefore its destruction threatens their existence. Massive destruction of the same through charcoal burning and firewood use has continuously paused a systemic global problem. This has culminated into the disappearance of dependable plant and animal species while rendering others endangered. Efforts by proponents to mitigate the vice have not effectively borne fruits. Consequently, Governments’ legislations to restore the biodiversity has not addressed the concern. It could be ignoring the usage of renewable energy that might be of significance. The purpose of this paper is to establish the impact of renewable energy cooperatives in rural Kenya for natural vegetation cover restoration, conservation and poverty alleviations. The targeted groups are ten households forming cooperatives. The ownership is by share contribution. The focused raw materials are: cow dung, agricultural residues, grasses, bones and plant leaves, which are monetized into shares. The affordable, user friendly and efficient technologies for biomass carbonization, briquetting, grinding, biogas-hydrogen gas blends and bio fertilizer processing will be accessible to beneficiaries. Pilot studies done in Maasai Mara University revealed: the technologies may replace charcoal and firewood. The produced energy quality is above the charcoal and firewood, for example bone char had a calorific value of 18.60 KJ/g, compared with 12.00 - 15.52 KJ/g calorific value range of charcoal. while organic fertilizer provides a rich nutrient base for plants. The cost benefit analysis at Ksh. 10.00 per kilogram will be friendly to rural forks. The model is significant to business start ups, policy formulation and further research by future proponents.

Keywords: Vegetation; Renewable; Energy; Restoration; Conservation
Determination of the Diversity of Algae and *Cyanobacteria* in the Maasai Mara University Botanical Garden Ponds

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Abstract

The Maasai Mara University Botanical Garden was initiated in the year 2017 through the collaboration of Maasai Mara University in Kenya and Wuhan Botanical Garden in China. The role of the garden is to maintain a documented collection of medicinal plants and other species of ecological importance. Its design contains patches of land for introduction of the medicinal plants and several ponds which hold water from the sewage treatment plant and into which several aquatic species thrive. Since the garden is in its initial stages of establishment and the process of documenting species thriving in it is ongoing, a study was conducted to determine the diversity of algae and *Cyanobacteria* species found in the botanical garden ponds. Water was sampled periodically from various points starting from the sewage treatment plants to the main pond, diversity was determined through the drop count method and species identified using Standard keys of identification of Algae and *Cyanobacteria*. Floating mats and scum were also collected. Physicochemical parameters were also determined using standard methods. A comparison was made between a period of prolonged dryness and at the onset of rains. The major groups identified were; Cyanophyceae, Chlorophyceae, Euglenophyceae and Bacillariophyceae. Species such as *Oscillatoria* sp., *Scenedesmus* sp., *Euglena* sp., *Spyrogyra* sp., *Nitzschia*, *Navicula*, *Pinnularia* and *Microspora* sp. There was an increase in the number of species in the wet season as compared to the dry season. Further studies on species diversity and effects of seasonal changes and documentation of the same should be considered.

**Key words:** Botanical garden, Algae, *Cyanobacteria*, Physicochemical parameters
Influence of Drought and Household Characteristics on Food Security among the Pastoral and Agro-Pastoral Households in Mbirikani and Kimana Wards, Kajiado County

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Abstract

Droughts are common in Arid and Semi-Arid Lands (ASAL) and cause food insecurity. The purpose of this study was to assess the influence of drought and household characteristics on household food security among the pastoral and agro-pastoral households in Mbirikani and Kimana Wards, Kajiado County. Stratified random samples of 171 pastoral and agro-pastoral households were interviewed using a structured questionnaire. Droughts were analyzed using a 10 year (2003-2013) rainfall data. Descriptive (frequencies, percentages, cross-tabulations, means, median, mode, and standard deviations) and inferential (regression, t-test and ANOVA) were used in analysing the data. The annual rainfall mean varied between 10 and 45 mm. Droughts, indicated by annual mean rainfall below the long term mean of the area, were found to have occurred. Food security in the area assessed using three indicators of food availability, accessibility, and utilization within the households was found to be of medium level. Livelihood diversification had a positive and significant effect (β= .924, p=.001) on food security as well as the social networks (β= .904, p=.001). The study concluded that households that practiced livelihood diversification and had more social networks had better food security compared to those that had less or none. The information generated by this study could be used to enrich stakeholder’s knowledge with regard to the role played by household characteristics and drought on the food security of households and the usefulness of the two livelihood strategies in combating food insecurity in the area.

Keywords: Droughts; Food Security; Drylands; Maasai
Women Perceptions on Changing Patterns of Mountains as a Source of Water and Livelihoods

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Abstract
Economic growth and development shaped by global pressures spur livelihoods and market access in remote communities around Africa. However, such development measures can change landscapes, and alter the embedded natural resources and access to them. Around Mt. Kenya, rural women and their livelihoods are frequently most affected by changes in water resources, at least women are able to remember this. Women around such watersheds value the mountain forests and perceive their own capacity to influence the hydrological cycle and their understanding of mountain forests as having the rainbringing capacity. The view that slopes of the mountain are solely responsible for increased precipitation is especially strong among the Kikuyu Women. Working with data from field work research on livelihoods of women around Mount Kenya, this paper seeks to examine the demographic structure and livelihoods and appraise their mountain forest resource uses and dependencies, and discern their perceptions of source, use and practices of water as a sacred resource. Finally, the impact of the changing nature of narratives of 'Water Tower' on women's lives and practices is examined.

Keywords: Economic Growth; Water Resources; Hydrological Cycle; Sacred Resource; Water Tower
Climate Change, Food Security and Agricultural Technological Innovations in Kisumu County, Kenya

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Abstract

Agriculture is the bedrock of Kenya’s economic development. The small-scale farms employs 4.6 million people, it accounts for 33 percent of GDP in Kenya and contributes more than 50 percent in foreign exchange earnings. However, climate change has resulted in weather vagaries, emergence of pests, and resistance to fungicides leading to adverse effects on food and nutritional security in Kenya. Worse still, more than 50 percent of the populations in Kisumu County live in abject poverty, use inappropriate crop production technologies, thus resulting in low agricultural yields. Due to poor post-harvest technologies, infestation by pests, spoilage, etc, many people now face food insecurity, malnutrition and starvation. Using case design, the researchers applied Rogers’ products innovation constructs to examine the degree of agricultural technological innovations among SMEs in Kisumu City, Kenya. Results showed that innovation constructs of relative advantage, compatibility, complexity, trialability and observability apply to the SMEs newly developed agricultural technologies. It is recommended that the agricultural innovation system in Kenya take cognizance of the emerging agricultural technologies in the SMEs sector and integrate them into the National circuit through linkages with key industry players in a bid to enhance production and commercialization of the innovative products. This would in turn go a long way in mitigating the adverse effects of climate change, improve crop production and enhance food and nutritional security.

Keywords: Climate change; Food security; Agritech; Innovations; Kenya

Enhancing and Promoting Sustainable Land Management Technologies and Innovations to conserve agrobiodiversity in Kenya’s Drylands

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Abstract

About 84% of Kenya’s land area is classified as arid and semi arid lands (ASALs). These lands are characterised by spatial and temporal rainfall variability, erratic weather with recurrent droughts and floods which weakens the ecological fragility of the lands hence reducing their capacity to provide key ecosystem services (ESs) to the pastoral and agropastoral communities and wildlife. Despite their importance in supporting community livelihoods, Kenya’s drylands have undergone through severe land degradation which have been attributed to increasing population growth, government policies and inappropriate development models. Land degradation is manifested through soil compaction, erosion, nutrient depletion, and salinisation, which have often resulted in loss of agrobiodiversity thereby affecting ecosystem health. This has posed lot of risks to sustainable production of food and provision of ecological goods and services. Adoption and scaling up of sustainable land management (SLM) technologies and innovations can enable pastoralists, farmers and other land owners to have maximum economic and social benefits from land while enhancing ecological functions of the land resources. The aim of this review paper is to document and assess sustainable land management technologies and Innovations that promote to reduction of land degradation and enhancing agrobiodiversity in ASALs parts of Kenya. These include agroforestry, pastolism and grazing land management, mechanical soil conservation, improved tillage regimes, appropriate agronomic practices like use of organic manures among others. This will increase knowledge and inform policy that will enhance adoption of SLM technologies, which will result to a win-win strategy in addition to providing best practices to be emulated worldwide.

Key words: Arid and Semi arid Lands; Sustainable land management; Technology; Innovations

Management Practice of Arid Environment on Resources and Ecology by Local Ethnic People in Northwestern Arid Region, China

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Abstract

The Uygur people among the 56 Chinese nationalities have inhabited in Xinjiang China for more than 1,000 years. The Uygurs have accumulated a wealth of traditional knowledge and practices on arid environmental management, especially in utilizing plants in arid environment, developed unique home-garden vegetation in oasis ecosystem of Xinjiang. This paper presents results first time from a case study on plant diversity and management practice of traditional Uygur home-garden in Turpan prefecture of Xinjiang Uygur Autonomous Region. Studies show that the intimate interactions between the Turpan Uygurs and

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the plants in arid environment, on the basis of which an integrated traditional knowledge was built for the use and management of garden plants. The Uygurs’ home-garden involves cultivating both native wild plants and exotic domesticated horticulture ones in a space connecting their houses, the total number of home-garden plants is as high as 143 species in the case study area that demonstrated in traditional agro-ecosystem management practice a strong capacity in the integrated use of a rich diversity of home-garden plant species, for ornamental, food, aromatic & medicinal plants, timber and fiber, fodder and eco-protective plants in adaptation to the arid environment changes in Xinjiang of northwest China.

**Keywords:** Ethnobotany; Plant resources; Arid region; Indigenous knowledge
Livestock Depredation in Maasai Mara Conservancies, Narok County, Kenya

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Abstract
Human wildlife conflict (HWC) is an antagonistic reality experienced in most of regions that surrounds wildlife conservation territories in the world. Conflicts are known to occur as a result of animal attack on humans or human properties which in turn results into a retaliatory attack by human as an act of protecting their loved ones and property. Livestock predation is the most common form of HWC in the Mara region. Loss of domestic animals to wildlife attack is a major cause for human retaliation against wild animals. Most of the residents are pastoralists and rely on livestock as main source of livelihoods, this necessitates protection of livestock a priority of residents living in such areas. A one-year study investigating extent of livestock depredation in Mara ecosystem with an aim to examine most vulnerable livestock to depredation as well as the most problem wild animal species involved in Mara Conservancies showed that the level of livestock depredations is high with 261 cases reported in 8 months, the most problematic Animal is hyena with 162 incidences. The largest number of livestock species killed was 488 sheep. Results show that majority of those who experienced HWC as a result of livestock predation also experienced human threat, injury or death. Results obtained by Chi-Square analysis showed that there was a significant association between livestock depredation incidences and wildlife attack on human being ($\chi^2 = 17.320$, df=1, p=0.019).

Keywords: Wildlife; Livestock; Conflict; Conservancy; Depredation
Role of Comparative Genomics in the Conservation and Management of Dryland Fisheries of East Africa: the Case of Magadi tilapia (*Alcolapia grahami*)

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Abstract
Drylands in East Africa are typically characterized by sporadic and irregular rainfall patterns leading to unstable water bodies and unpredictable water characteristics. Nevertheless, dryland water bodies are home to a number of highly productive and resilient opportunistic fish species that have evolved to adapt to strong environmental disturbances. As such, these populations may hold great potential as a genetic resource for improvement of cultivated species as well as for use in genetic rescue of other fisheries, including of freshwater fisheries. However, in the recent years, it has been suggested that, dryland fish populations just like all other present biota, could enter into a sixth mass extinction mainly as a result of chronic exposure to anthropogenic activities. This threat is even higher in fragmented and isolated populations of dryland species that due to their intimate relationship with their environment are likely to respond rapidly to changes occasioned by the effects of climate change, invasive species and other eminent stressors. Therefore, there is an urgent need to investigate the processes that influence the diversity and the adaptive potential genetic potential of dryland fish populations to guide conservation decisions for this important resource. To gain, an insight into these untapped genetic resources, there is a need to employ techniques that allow for generation of adequate data that can be used to generate essential population genetic parameters and examine questions related to adaptation within and between taxa with reasonable cost implications. This work explores the opportunities that comparative genomics, an approach that involves comparative analysis of high-throughput genome-level data, presents as a tool in the conservation and management of dryland fisheries.

Keywords: Dryland fisheries; Genetic resources; Comparative genomics; Conservation
Investigating the Utilization and Effectiveness of Water Pans as a Water Harvesting Adaptation Strategy in Narok County

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Abstract
Narok County is an Arid and Semi-arid land (ASAL) which is highly impacted by weather and climate change. It is classified as a critical water deficit area and harvesting of rainwater is essential for survival of the communities. One of the most common rain water harvesting structure is a water pan, a large rectangular or round depression constructed either manually or mechanically by excavation on a flat or gently sloping landscape. Water pans are used for watering livestock, for domestic water supply and small irrigation farms during rainfalls and a few months after. Wildlife has also used this water resource since the beginning of time. In fact, water pans are now a widely accepted measure of rainwater harvesting and storage in ASALs. A study was conducted in 2018 to determine the utilization and effectiveness of water pans as water harvesting structures, as an adaptation strategy in Narok County. The study was conducted using purposive sampling of 467 households within Narok county covering four agroecological zones namely; high potential, medium potential, semi-arid and arid. The study provides data on levels and types of livelihoods dependency on water pans, ownership, governance structures and systems relating to the water pans and the community’s awareness and perception towards water quality. This data can be used as a basis of developing an integrated community-based management programme to ensure sustainable utilization and management of these important ASALs’ water resources.

Keywords: Water pan; ASAL; Agro-ecological zones; Rainwater harvesting

THEMATIC AREA 2
Research, Infrastructural Development, Policy Making and Socio-Economics of Resources in the Drylands and Wetlands

Analysis of *Faroe* spp. and *Cyymbopogon citratus* extracts for their caffeine and catechin potential

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**Abstract**

Prior to civilization by western nations, several communities in Kenya used to prepare beverages such as tea and coffee. The Maasai communities have continuously substituted these beverages with *Faroe* spp. (Olesesiai) concoction while the Luo community previously enjoyed preparing *Cymbopogon citratus* (lemon grass) concoctions in absence of coffee or tea leaves. Water and ethyl acetate extracts of these plants were characterized for physical-chemical, spectroscopic, antioxidant and phytochemical similarities compared with commercial coffee and tea leaves. While the physical-chemical properties were closely related, the results indicated concise resemblance in functional groups and conjugation as scanned by FTIR and UV VIS spectroscopies. The *Faroe* spp. ethyl acetate and *Cymbopogon citratus* water extracts also showed presence of antioxidants and essential beverage phytochemicals such as flavonoids, alkaloids, phenolic groups and glycosides amongst others.

**Keywords:** *Faroe* spp.; *Cymbopogon citratus*; caffeine; catechin
Enlightenment of Chinese Grape Industry to East Africa

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Abstract
Grape is one of the most important fruits in the worldwide and has a huge economic value. As a temperate fruits, grape domesticated from Eurasian wild species which located in Mediterranean climate region. In China, grape was first introduced by Zhang Qian, a Han Dynasty (about B.C 100) Imperial Envoy to the “Western Regions (West Asia)”. For nearly 30 years, China's grape industry has developed rapidly and made great achievements. The cultivated area and yield of grapes are among the best in the world. These achievements are due to advances in science and technology by the wisdom and efforts of our grape scientific workers across the country. It has been 65 years since Institute of botany CAS (IBCAS) first began the grape scientific research, which has also been the earliest in China. Over the past 65 years, IBCAS has collected and preserved a large number of wild species and hundreds of cultivars, released 26 grape varieties, and spread widely their cultivated area reached tens of thousands of hectares. IBCAS is a model for Chinese independent breeding of fruit trees and actively promote the development of grape and wine-making industry in China. The grape industry in East Africa is facing enormous challenges because grapes need low temperature to germinate. So East African countries spend a lot of foreign exchange on importing grape and its products every year. The price of grapes on the market is so high that consumers can hardly afford it. Since 2014, IBCAS and JCUAT have cooperated in the introduction, demonstration and extension of grapes in Kenya. In addition, IBCAS worked on the training of Kenyan technicians in grape science and breeding. We hope that after several years of cooperative research, Kenya can establish its own grape research team, technical system, training system, breeding its varieties, and develop its grape industry in the future.

Keywords: China; Grape Industry; East Africa
Genomics and Evolution of Ebola Virus

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Abstract

Sierra Leone was the most severely affected country in Western Africa during the 2013–2016 outbreak of Ebola virus disease (EVD). It has been reported that the EBOV genome variation might have an effect on the efficacy of sequence-based virus detection and candidate therapeutics. However, only limited viral information has been available since July 2014, when the outbreak entered a rapid growth phase. We firstly described 175 full-length EBOV genome sequences from five severely stricken districts in Sierra Leone from 28 September to 11 November 2014. We found that the 2014 EBOV has become more phylogenetically and genetically diverse from July to November 2014, characterized by the emergence of multiple novel lineages. The substitution rate for the 2014 EBOV was estimated to be approximating to that observed between previous EBOV outbreaks. We following collected and curated a comprehensive data set that includes 514 EBOV genome sequences from patients with confirmed EVD, >87.5% of which have residence information and definitive clinical outcomes. Analyses of the spatial-temporal distribution unravelled the lineage-distinctive distribution patterns. Different viral lineages have different case fatality rates (CFRs) during the same stage of the outbreak, implying that several lineages featuring SNPs may correlate with increased/decreased CFRs. At the meantime, we elucidated the intra-host dynamics that mainly reflect viral–host interactions and uncovered a total of 710 intra-host single nucleotide variations (iSNVs) from deep-sequenced samples from EBOV-infected patients, through a well-tailor bioinformatics pipeline. We presented a comprehensive distribution of iSNVs during this outbreak and along the EBOV genome. Analyses of iSNV and its allele frequency revealed that VP40 was the most conserved gene during this outbreak, and thus it would be an ideal therapeutic target. In the co-occurring iSNV network, varied iSNV sites presented different selection features. Intriguingly, the T-to-C substitutions at the 3’-UTR of the nucleoprotein (NP; positions 3008 and 3011), observed in many patients, result in the up-regulation of the transcription of NP through an Ebola mini-genome reporting system.

Keywords: Genomics; Evolution; Ebola Virus
Comparison of the Volatile Content of Vanilla (*Vanilla planifolia* L.) from Main Producing Regions of Madagascar, and La Réunion Island

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**Abstract**

For a better knowledge of vanilla spice (*Vanilla planifolia* L.) in the aim of reviving this sector, the composition of the volatile compounds of vanilla aroma was addressed by means of Headspace technique, associated with Gas Chromatography coupled with Mass Spectroscopy (HS-GC-MS), performed on 17 samples from the four major producing areas in Madagascar (SAVA, north-east; Analanjirofo, center east; V7V, south-east; Sambirano, north-west), and 4 from La Réunion island. 61 compounds were detected in Total Volatile Content (TVC), of which 37 could be identified, by means of GC-MS. Two major constituents: vanillin and guaiacol were present in all samples. No significant distinction by region of origin could be found in the samples from Madagascar. This suggests that, for Madagascar, other factors such as cultivation techniques and curing process may also affect significantly TVC composition. The samples from La Réunion were differentiated from those from Madagascar by means of higher content of hydrocarbons, mainly sesquiterpenes; furthermore, for those samples, mode of cultivation (under natural or artificial shading) induced significant differences in composition (exceptionally high sesquiterpene content in artificial shading sample).

**Keywords:** Vanilla; Volatile Compounds; Headspace GC-MS; Madagascar; La Réunion
Land Use and Cover Change and its Implications on Gully Erosion in Suswa Catchment Area, Narok County, Kenya

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Abstract
This study investigated land use and land cover change for the last 26 years in Suswa Catchment, Narok County using satellite imageries. Gully erosion is accelerated by land use change and land cover change, and results from a long history. Understanding historical and present-day gully erosion is therefore essential when addressing the consequences of future land use scenarios. Land use history therefore helps to give information in disturbed catchments, enabling accurate assessment of reference conditions for restoration. Changes in land use and land cover (built up areas, agricultural land, grassland, bareland and shrubland) for 1985-2000, 2000-2011 and 1985-2011 were determined using Chi square test. Results showed no significant changes in built up areas, agricultural land, bareland, grassland and shrubland during the period. Overall change of built up area, shrubland, bareland, agriculture increased in 26 years, while grassland decreased. Grasslands were therefore converted to build up areas, shrubland, bareland and agricultural areas during this period. An increase in built up area, bareland and agricultural land and a decrease in grassland are therefore drivers of gully erosion. A decrease in grassland results in an increase in soil erosion. Projections (2020) indicate a significant increase in built up area, agricultural land and bareland and a decrease of grassland. If the present scenario continues, then gully erosion activity will continue. Therefore there is a need for land use planning in Suswa Catchment for effective rehabilitation of the gully and also reduce threats to livelihoods.

Keywords: Soil Erosion; Remote Sensing; Geographic Information Systems; Restoration; Rehabilitation
Sustainable Use and Development of Chinese Herb Medicines for Prevention of the Isochemic Heart or Brain Diseases

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Abstract

Acanthopanax senticosus (Rupr. et Maxim.) Harms (ASH) (Araliaceae) is a typical Chinese herb, its roots are an important Chinese folk medicine for the treatment of a variety of human diseases, such as isochemic heart diseases, hypertension, rheumatic and tumor, etc. However, due to the devastating use of its roots, this valuable plant has been endangered in the past two decade. To meet this challenge, a systematic chemical and biological investigation on the leaves of ASH was conducted by using tandem ESI-MS and HRMS, and mouse models, respectively. Without time-consuming isolation of individual component from ASH, 18 saponins and 4 flavonoids were successfully identified. Among them, 8 saponins and 3 flavonoids were firstly found from ASH leaves. Biological and Pharmaceutical activity screening and further studies on the components from ASH revealed that flavonoids from ASH leaves demonstrated good effects on mice with cerebral infarction. In addition, preparation and optimization of pharmaceutical formulation were also achieved with inclusion complexes between flavonoids and cyclo-dextrin. At last, we successfully developed a new antithrombotic medicine from ASH Leaves.

Keywords: Acanthopanax senticosus; Harms; flavonoids; saponins; antithrombotic medicine
Characterization of Blood Clotting Agents from Active Compounds of *Tradescantia zebrina, Tagetes minuta* and *Codiaeum variegatum* plants

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Abstract

Many commercial drugs used for blood clotting are expensive and have associated adverse side-effects. *Tagetes minuta, Codieum variegatum* and *Tradescantia zebrina* are some of the local plants that are used for blood clotting due to their high efficiency without associated adverse side-effects. This study aimed at characterizing different extracts of the above species for possible blood clotting agents. Aqua extracts of these herbs were obtained and analyzed for functional group, bio-metal concentration, conjugation, physical-chemical parameters, phyto-chemicals, anti-fungal and anti-bacteria activity. Test for blood clotting agents such as calcium, fibrinogen and vitamin K was also conducted separately. The extracts were also separated by thin layer and partition chromatography to determine the number of fractions present. All extracts showed intense conjugation on ultraviolet visible spectroscopy and had common functional group peaks at 2800-3500cm\(^{-1}\), (carboxylic OH), 1680cm\(^{-1}\) (carbonyl), and 1035cm\(^{-1}\) (C-O\(_{\text{stretch}}\)). Both column and thin layer chromatography indicated 3, 2 and 4 fractions in the *Tagetes minuta, Codieum variegatum* and *Tradescantia zebrina* extracts, respectively. The extracts were slightly acidic with an average pH of 5.990 ±0.002 and an average conductivity of 0.580 ±0.079mS. The average solubility in distilled water was 16.670 ±1.534g/100ml water at 25\(^{\circ}\)C. The average bio-metal concentrations were in the order of Fe (9.85±0.112ppm), Zn (7.790 ± 0.912ppm), Cu (6.560 ± 0.002ppm) and Co (5.460 ± 1.002ppm). Both vitamin K and fibrinogen tested positive in all extracts while calcium levels were in the order of 12.310±0.891g/L, 10.110 ± 0.012g/L and 9.870 ± 0.033g/L for *Tradescantia zebrina, Tagetes minuta* and *Codieum variegatum*, respectively. All samples showed mild antifungal and antibacterial activity. In conclusion, *Tradescantia zebrina, Tagetes minuta* and *Codieum variegatum* extracts were found to exhibit appreciable levels of blood clotting agents.

Keywords: Blood clotting agents; *Tradescantia zebrina; Tagetes minuta; Codieum variegatum*
Mineralogical and Morphological Properties of Matisaa Gray Rock as a Possible Raw Material for Manufacture of Cement

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Abstract
Matisaa is a semi-arid area in Mwingi West, Kitui County, Kenya where a unique rock that the locals refer to as Matisaa gray rock is found. Matisaa gray rock is thought to have been formed as a result of declination of live coral cover and degradation coral reef habitat. This rock portrays properties like cement. This work explores the possibility of using Matisaa gray rock as a substitute for limestone in the manufacture of cement. The relative proportions of the constituent minerals and morphology were determined using X-Ray Fluorescence (XRF) and Scanning Electron Microscope (SEM) respectively. Fundamental oxides commonly found in cement were also seen in Matisaa gray rock in the following proportions: CaO (39.03-46.42wt.%), SiO2 (15.68-16.79wt.%), Al2O3 (0.47-4.81wt.%), Fe2O3 (0.06-1.04wt.%), MgO (1.56-3.56wt.%), SO3 (0.00-6.06wt.%), K2O (0.59-2.64wt.%) and Na2O (0.00-0.21wt.%). The Loss on ignition (LOI) for the sample was determined to be in the range of 29.99-36.24wt.. Except for SiO2, the proportions of the remaining oxides and the LOI for the sample were found to be within the recommended thresholds. The morphology of, Matisaa gray rock was found to be compact with block and irregular-angular grains which are agglomerated. The results obtained were found to match closely with the allied properties limestone and thus by this virtue Matisaa gray rock was regarded a possible raw material for manufacture of cement.

Keywords: Portland cement; Morphology; XRF; SEM
Characterization and evaluation of antifungal and phytochemical activities of *Senna didymobotrya* leave extracts

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Abstract

Conventional antifungal agents are expensive with numerous side effects. *Senna didymobotrya* plants are known to possess medicinal potentials as extensively used by the people of central Kenya as a traditional medicine in the treatment of ringworm (“mashilingi”). The main aim of this study was to analyze the most expound bioactive compounds present in this plant’s leaves crude extracts and determine its antifungal potency. The extracts obtained showed appreciable conductivities with dry and fresh methanol extracts having 123.050±2.8863mS and 94.870±2.6696mS, respectively, distilled water extract having 73.430±34.8537mS as hexane extract had the conductivity of 25.700±7.1439mS. This tallied with their solubility in polar and non-polar solvents with the solubility of 0.400±0.010g/100ml water polar solvent and 0.240±0.010g/100ml n-hexane non-polar solvent, which depicted their effective solubility which would highly make them easily soluble as a convensional antifungal agent. Since the *S. didymobotrya* leaves extracts contained essential bio-metals in considerable concentrations with copper having the concentrations of 0.074±0.0036, chromium with 0.174±0.0007, iron with 0.048±0.0010, zinc 0.004±0.0177, and cobalt with 0.361±0.0042ppm. Most of the phytochemicals like flavonoids, steroids, phenolic compounds and terpenoids known to possess antifungal activities were confirmed present. The ethyl acetate extracts had the highest percentage of mycelial growth inhibitions in fresh and dry leaves extracts, which were found to be 78.17% and 75.00%, respectively. Fresh leaves methanol extract had 47.17% mycelial growth inhibition followed by dry and fresh leaves chloroform extract with 36.17% and 16.67% respectively. Therefore, this study will help in the innovation of a more effective antifungal agent.

Keywords: Antimicrobial agent; Antifungal agent; *Senna didymobotrya*; Leaf extracts; ‘mashilingi’
Phytochemical variability and antimicrobial activities of essential oils from *Lantana camara* of Madagascar

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**Abstract**

The chemical composition of the essential oils extracted from aerial parts (leaves and flowers) of *Lantana camara* growing wild in Madagascar was investigated by chromatography (GC) and 37 components were identified. It was possible to distinguish three groups through principal components analysis and agglomerative hierarchical clustering analysis of the nine chief molecules identified. The first group (gr1) is composed of essential oils samples extracted from flowers and leaves of the yellow - orange variety, which are characterized by higher content in (E)-β-caryophyllene (28.2%) and in sabinene (14.8%) and lower content in cis davanone (0.20%). The second group (gr2) consists of essential oils extracted from the pink – violet flowers which are characterized by (E)-β-caryophyllene, cis-davanone and α-humulene detected at 12.9%, 12.5% and 7.3% respectively. And the last group (gr3), formed by essential oils isolated from the pink – violet leaves are characterized by higher content in cis davanone (23.7%) and lower content in (E)-β-caryophyllene (10.70%). The essential oil for each group was tested against 9 bacteria using a broth dilution method, and exhibited significant antibacterial activity. The minimum inhibitory concentration values ranged from 0.16 to 2.5 mg/ml for gr1, from 0.63 to 5 mg/ml for gr2 and from 1.25 to 5 mg/ml for gr3. The genetic differentiation of this species was investigated with a polymerase-chain reaction-restriction-fragment-length-polymorphism and demonstrated no significant difference between varieties, whether from the same or different collecting sites.

**Keywords:** *Lantana camara*; essential oils; chemical composition; antimicrobial activity; polymerase-chain reaction-restriction-fragment-length-polymorphism
Removal of Hexavalent Chromium from aqueous media using cellullosic material from sugarcane bagasse incorporated with magnetic nanoparticles

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Abstract

Are our waters safe for consumption? Increasing pollution of water sources worldwide arising from human activities has rendered waters unsafe for consumption. Chromium (VI) ions in particular are emerging class of pollutants present in most industrial, electronics, agricultural, pharmaceutical and personal care products considered to be highly toxic and carcinogenic. Their complete removal from wastewaters has been ineffective due to poor methods of waste treatment employed, high costs associated with their removal as well as the challenges faced by the newly emerging chemicals within this class. Thus, the objective of this study was to extract chemically purified cellulose from sugarcane bagasse then prepare cellulose nanocrystals from the cellulose. The two adsorbents were further modified through situ incorporation of magnetic iron oxide nanoparticles onto their surfaces to form the nanocomposites by co-precipitation. The obtained cellulosic materials and the composites were characterized using FTIR (Fourier Transform Infrared) for structural properties, TGA (Thermogravimetric Analysis) for thermal properties and SEM (Scanning Electron microscopy) for surface morphology and TEM (Transmission Electron microscopy) for particle sizes. The prepared composites portrayed good crystallinity, high thermal stability, well cemented matrix with homogeneous matrix and small particle sizes of between 23-28nm. MNPs-CNCs (Magnetic Iron oxide-cellulose nanocrystals) composite presented better sorption efficiencies for Cr(VI) removal than MNP/CPC(Magnetic Iron oxide-cellulose) composite, however both adsorbents adsorbed well at pH2 within a duration of 60-90min at room temperature (25°C). Kinetics studies indicated that the adsorbents fitted Pseudo second order kinetic model and followed Langmuir and Freundlich isothermal models, respectively.

Keywords: Pollution; Bagasse; Hexavalent Chromium; Iron Oxide Nanoparticles.
Gender-Related Cultural Practices that Violate Human Rights and Perpetuate Women’s Poverty in Maasai Community, Kenya

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Abstract
This paper, through a review of literature methodology, aimed at to discussing, debating and raising discourse on gender-related cultural practices that violate human rights and perpetuate women’s poverty in Kenya, particularly in Maasai community. The interplay between culture, human rights and women’s poverty in Kenya and the link between gender-related cultural practices are discussed. The paper calls for a cost-benefit analysis to be conducted in order to depress the benefits of the gender-related practices against possible loss associated with the norm. The practices are linked to the unequal position of women in the society, and limit/prohibit their access to property ownership, formal employment, and education. This paper reviews cultural practices and traditions in Maasai – polygamy, payment of bride price, female genital mutilation (FGM), marriage by abduction, inheritance, and primogeniture. The role of governments and civil society in human rights education, public awareness campaigns and community mobilization – in attempting to address, minimize or eradicate gender-related cultural practices that perpetuate women’s poverty, is also examined. Women’s voices must be heard and useful cultural practices that traditionally protected women and girls should be considered in designing programmes to address gender inequality and to reduce women’s poverty in Maasai Community. The paper has identified the following health hazards: damage to the penile structures, fatalities associated with the norm, inflicting bodily harm and violation of the initiates’ human rights. As a way forward, the paper recommends establishing or enforcing policies to regulate the operations and the practice.

Keywords: Polygamy; Bride Price; Discrimination; Female Genital Mutilation; Forced Marriages
Attitudes, perception and Effects of Euthanasia on Families in Wetlands in Kenya

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Abstract
Euthanasia decision making is perhaps the most difficult practice situation faced by health care social workers. Complex ethical issues arise from decisions regarding use of advancing medical technologies and/or other artificial treatments that may prolong life and compromise its quality. NASW has set forth a policy to help guide social workers dealing with euthanasia decisions and the preservation of client self-determination in these situations. Moreover, the Public and healthcare professionals differ in their attitudes, perception and effects on euthanasia and physician-assisted suicide (PAS). In addition to medical training and experience, religiosity, locus of control and patient characteristics (eg, patient age, pain levels, number of euthanasia requests) are known influencing factors. This study is based on secondary data collected through review of studies, reports, policy documents and surveys from various data sets from national, regional and international organizations more especially in social work field. Multivariate analyses reveal differing predictor models for attitudes towards euthanasia and PAS, and confirm the importance of individual differences in determining these attitudes. Specific implications for PAS and its interface with the social work profession are described with respect to multiculturalism; identity; perceptions of disease, illness, and pain; attitudes towards therapy; family decision making; ethics; and professional roles. Ethical dilemmas most often faced in end-of-life care situations relate primarily to issues of communication between and among patients, families, and professionals. Practitioners indicate that more specific practice guidelines and increased education regarding bioethics and issues of end-of-life care are needed to be effective in end-of-life decision making.

Keywords: Euthanasia; physician-assisted suicide (PAS); end-of-life care; ethical dilemma; social work practice
Effects of Traditional Harmful Practices on Social-Economic Development of Women in Drylands in Kenya

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Abstract
This article reviews effects of harmful traditional and cultural practices which lead to violation of women’s rights in drylands in Kenya and measures to be taken to mitigate them. It is based on secondary data collected through review of studies, reports, policy documents and surveys from various data sets from national, regional and international organizations. The paper focuses on the drylands as an area with highest rates of harmful cultural practices against women in Kenya. These effects are explored in terms of impacts on health, education and social-economic development. Traditional and cultural practices investigated include female genital mutilation, child marriage, marriage by abduction and virginity testing. The paper outlines a framework for analyzing global, regional and local initiatives to curb harmful cultural practices. Conclusions drawn from the review indicate that such practices have devastating physical and psychological effects on women further they hinder women’s social-economic development moreover, these regions with high harmful cultural practices are also regions with highest poverty and underdevelopment. Drylands reinforce the inferior status of women in society and continue to violate their rights and this has serious implications on the achievement of gender equality in society. Although Kenya has put in place legislation and other measures to outlaw harmful traditional and cultural practices on women, these continue unabated due to persistence of cultural attitudes, lack of capacity, resources and commitment among the implementers. This article argues for sub-regional strategy to address the problem of harmful cultural practices and social-economic development.

Key words: Abduction; Female genital mutilation; Virginity testing
Major banks specific factors affecting the growth of well-networked commercial banks in Kenya

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Abstract
The role of the financial sector as a leading contributor to growth has been substantially accepted and recently the focus has turned to its contribution to poverty reduction through easy access. In spite of the fact that by regional standards, financial system of Kenya is relatively well networked and diversified, major banks specific factors challenges keep it from achieving its maximum capacity. The aim of this study was to assess major banks specific factors affecting the growth of well-networked banks in Kenya. This study adopted a descriptive survey research design. The target population of this study was all the 39 commercial banks in Kenya (CBK, 2018). The sample size for the study was 11 commercial banks. Stratified random sampling technique and simple random sampling technique were used to obtain a sample size. The secondary data was collected from the banks’ published annual reports for five (5) years (2014-2018). Regression analysis was used to test the relationship between banks specific factors and growth of commercial banks in Kenya. The results showed that there was positive and significant association between growth and all the banks specific factors (capital adequacy, assets quality and liquidity) studied. The study recommends that efficient and effective management of bank specific factors should be initiated and practiced by bank managers to ensure that banks do not face growth challenges. The study concludes that bank specific factors have influence on growth of commercial banks.

Key words: Growth; Capital adequacy; Assets quality; Liquidity; Commercial banks
Frames on Finite Dimensional Hilbert Spaces

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Abstract
A frame is a generalization of a basis of a vector space that is linearly dependent. Frame theory on Hilbert space plays an important role in signal processing, image processing, data compression and sampling theory. It allows us to expand Hilbert space vectors in terms of a set of other vectors that satisfy a certain energy equivalence condition. This condition guarantees that any vector can be reconstructed in a numerically stable way from its coefficient. We focus on frame in finite dimensional Hilbert space. Given the frame coefficient $\langle x, e_i \rangle n, i = 1$ associated with signal $x$, this frame coefficient can be utilized, for instance, for transmission of signal or recovery of missing data. Although the analysis operator $x \rightarrow \langle x, e_i \rangle n, i = 1$ maps a signal into higher dimension. Frame theory also provides efficient method of reconstructing the signal. A signal is viewed as a vector in a vector space and the way it gets transmitted as a frame coefficient which represent the signal in terms of spanning set. Where frame gets interesting is that we can find a certain frame that retain orthonormal bases property-we can find coefficient for expanding vectors using dot product. Frames can be constructed with a wider variety of characteristics and can thus be tailored to match the need of a particular system. In this paper we develop the abstract theory of finite frames and group frame and demonstrate some of the applications in signal processing. We also demonstrate how we can still construct and reconstruct signal in a numerically stable way. We shall use re-scaling theorem and reconstruction formula.

Keywords: Frames; Signal processing; Hilbert Space
Synthesis and Characterization of Aluminium Oxide Nanoparticles from Waste Aluminium and Potential Applications in Fabricating Aluminium Ion Cell

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Abstract
Environmental pollution due to solid wastes and high costs and toxicity levels of energy storage batteries is a critical concern to society. Aluminium waste accumulated in landfills is one of such solid wastes in abundance. These wastes cause various harmful effects to a range of flora and fauna. Various methods have been employed to alleviate the waste such as recycling, but they are attributable to secondary pollution effects prompting alternative methods of waste cleanup. This study seeks to provide an alternative recycling procedure that will cause less harm and be beneficial to society in terms of health and economics through energy storage materials. Synthesis of aluminium oxide nanoparticles was done using two methods which resulted to white and grey aluminium oxide. The particles were then reduced in size to nanoparticle range by top-bottom approach method. The products were then characterized for functional groups by Fourier transform infra-red (FTIR) spectroscopy, presence of aluminum oxide by ultraviolet visible (UV-VIS) spectroscopy and X-ray diffraction (XRD). The synthesized ions were then fabricated to make electrolyte cells and the corresponding voltages tested using different electrolytes. The functional group analysis showed presence of Al-O bends and stretches. Ultraviolet visible analysis corresponded to that of aluminium oxide nanoparticles. X-ray diffractograms analysis showed the presence of both alpha(α) and gamma(γ) aluminium oxide nanoparticles. The results indicated high voltage values in the fabricated cells when magnesium sulfate and dilute sulfuric acid was used. Nanotechnology should be employed in fabrication of energy storage materials from recycled aluminum wastes.

Keywords: Waste aluminium; nanoparticles; electrolyte cell; FTIR; UV-VIS, XRD
Analysis of Similarities between five Indigenous Bio-catalyst Extracts used by several Communities in Kenya.

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Abstract
Commercial fermentation additives are quite expensive leading to increased production costs. Several communities in Kenya have continuously enjoyed fast saccharification of biomass during cooking and fermentation of porridge and ethanol using bio-catalysts. Infusion of these bio-catalysts into modern-day science is crucial in optimization of yields and reduction of production costs in food, alcohol, pharmaceuticals and energy industries. This study aimed at characterizing five extracts (Terminalia b., Acanthaceae spp., Osyris lance-
olata, Santaraseae spp. and Kigelia africana) for possible similarities in physical-chemical parameters, elemental composition, ionic stability and morphology. Water extracts were preferred as natively done by these communities. Wet chemistry was used for physical-chemistry parameters and elemental composition while spectroscopy was used to analyze presence of bio-metals, functional groups and conjugation and ligands present. Lab. simu-
lation studies were conducted to evaluate ionic stabilities. The results indicated the samples were slightly acidic (average 6.410±0.644) with closely related volatile solids and volatile fatty acids values. There were similarities in the functional group peaks and conjugation patterns. The ionic stabilities of the bio-metals present were highly related. There was slight variance in the concentration of nitrates and sulfates present. There was concise re-
semblance in ultra-violet visible light spectra of the phosphate ligands. In conclusion, the extracts were found to have extremely high similarities in; cobalt (ii), zinc (ii), iron (iii) ions, trans double bond peaks and phosphates. These compounds extracted from these herbs commercialized for industrial fermentation processes.

Key words: Bio-Catalysts; Water Extracts; Elemental Composition; Ionic Stability; Structure
Characteristics of aquatic plants and its role on water restoration

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Abstract
Aquatic plants are a group of plants whose life cycle cannot completely leave the water. Aquatic algae landed in about 450 million years, and “returned” from land to water habitats around 120 million years ago. This process has occurred at least 100 times independently in freshwater angiosperms, forming a diverse group of aquatic plants. Aquatic plants have many functions such as edible, ornamental and aquatic ecological restoration. The use of aquatic plants for water restoration is an important means of water restoration. However, the use of propagules has not paid much attention compared to the direct use of aquatic plants. This study evaluated the role of propagules on water restoration. The results show that the aquatic plant diversity is improved by 80% by using the propagule, while the water transparency is increased by 160% and the nutrient content is reduced. 30% (TP) and 50% (TN). On the contrary, the use of aquatic plant transplants only increased aquatic plant diversity by 20%, water body transparency by 50%, and nutrient content by 10% (TP) and 15% (TN), respectively. The above results show that the use of propagules for water restoration is much better than direct use of aquatic plants.

Key words: Aquatic plants; Water; Restoration
Plant Diversity and Traditional Utilization of Medicinal Plants in Tropical East Africa an example in Kenya

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Abstract
In Tropical East Africa, the equator and the Great Rift Valley go through on east-west direction and north-south direction respectively and make a cross. At here, complex landscape harbors rich biodiversity. There are three Hotspots of Biodiversity located in East Africa including the Eastern Afromontane, the Coastal Forests of E Africa and the Horn of Africa. Main vegetation in Tropical East Africa includes Savanna, Seasonal tropical rainforest, Montane Forest, Evergreen forest, Deciduous forest, Alpine bush and Alpine grassland (Moorland). The project of “Study and compiling of Flora of Kenya” set by Sino-Africa Joint Research Center, CAS plans to investigate and record all the vascular plants of about 7000 to 8000 species in Kenya, an important county in biodiversity in the Tropical East Africa. Traditional plant use is of great importance in many society and prevalent African communities. Wild plants provide cheap and available medicine. They serve as source of some ingredients in the modern pharmaceuticals. Medicinal value of these plants is due to presence of small active compound which leads to physiological actions in both human and animals. Tropic east Africa is really rich of plant biodiversity. Local people in tropic east Africa has abundant traditional knowledge in utilization of medicinal plant. Traditional knowledge is dwindling rapidly due to change to western lifestyle. Active compounds, effectiveness, proper method of preparation and side effect of these medicines have not yet been studied extensively. Therefore, more research is needed before they can be used with absolute safety and effectiveness.

Keywords: Ethnobotany; Hotspot of Biodiversity; Kenya; Medicinal plants; Plant Traditional utilization
Investigating the Effectiveness of a Microbial Fuel Cell in Treating Breweries Waste Water

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Abstract

More than 90% of the world’s energy is supplied by fossil fuels which are non-sustainable, pose negative environmental impacts and are very expensive. The non-renewable sources of energy are depleting at a faster rate in the current scenario. Fuel cells are one of the most important areas in renewable energy research. The main objective of this study was to design and fabricate a Microbial Fuel Cell (MFC) and use it to treat breweries waste water. Two chambers (anodic and cathodic) are separated by a salt bridge of Muller-Hinton’s agar. The anode tank was filled with the breweries waste water that consists of listeria monocytogenes bacteria. The brewery wastewater was characterized for physical chemical and anaerobic parameters. The sludge was then used as the inoculum in the anodic chamber and potential difference measured. The pH and salinity of the sludge reduced over the retention period of ten hours. The voltages obtained ranged from 0.025V to 1.00 V. The voltage produced increased to a maximum of 1.000 V at the sixth day before it started decreasing gradually. From the eleventh day of the experiment, the voltage attained a constant value of 0.45 V. The research showed that MFCs are a promising source of renewable energy that can be used to treat brewery waste water while providing electricity.

Keywords: Microbial Fuel Cell; Electricity; Brewery Waste water
Wastewater Management Technologies and their Effects on Wastewater Quality in Selected High End Tourist Facilities in Maasai Mara Game Reserve, Kenya

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Abstract
The world famous Masai Mara Game Reserve (MMGR) is experiencing an unprecedented expansion in tourist facilities to accommodate increasing tourist traffic. A major direct environmental impact of this expansion is wastewater released to the fragile environment from these facilities. This study aims at examining the effects of management methods on quality of wastewater in 4 high end tourist facilities located in Sekenani within Masai Mara Game Reserve (MMGR) by assessing seasonal quality of effluent discharged. Multiple samples from the influent, effluent and the water source downstream the facility were collected three times during both wet and dry seasons and were subjected to analysis for the following physico - chemical and biological parameters pH, Temperature, COD, BOD, Total Phosphates, Nitrates, Electrical Conductivity, DO, Turbidity, TDS and Coliforms. Data were analysed using SPSS software and tested using ANOVA at 0.05 alpha level. Quality of wastewater was generally poor and there existed seasonal variation in some parameters. Methods of wastewater treatment, together with age appear to affect quality of wastewater. We recommend incorporation of modern innovative environmentally sustainable wastewater management technologies e.g. constructed wetlands. Further studies should include monitoring changes in macroinvertebrate species diversity and abundance along the recipient streams to provide a more holistic and integrated assessment of the quality of the receiving lotic environments.

Keywords: Sekenani; Maasai Mara Game Reserve; Wastewater; Wastewater management; Physico – Chemical Parameters; Tourist Lodges
The Role of Soil Carbon Levels in Determining Food Nutrients: A Case Study of South Rift Region in Kenya


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Abstract
Food insecurity is a national problem in Kenya, but quite rampant among pastoralist communities. There are many compelling reasons contributing to this kind of scenario. They include crude and unpredictable climate conditions, poor handling of produce whenever there is good harvest, slow response to improved and innovative alternatives to “traditionally considered staple foods. The focus on general food insecurity seem to blind many policy makers and experts to the urgency to have a targeted regime of nutritional production and supply of food. Malnutrition among the Masai community is common on pregnant women and children under five years old, and is found to be protein related, albeit their uptake of rich diet proteins. The question therefore, why is there a persistent nutrient deficiency among the Masai community? It is hypothesized that low crop yield volumes or lack of appropriate nutrients in daily consumed food stuff. In this context the study seeks to offer both foundational and functional discourse of dimmed nutrient rich food supply and production among the communities resident in the South Rift region in Kenya. It is presumed that gas exchange in the bare soils and atmosphere due to global warming could lead to loss of essential soil nutrient and other components that contribute to low yields in pasture. Lack of enough vegetation cover of the soil allows seepage of effluents, chemicals and other non-desirable chemical compositions, thus affecting the natural renewability and threshold of soils. This study therefore seeks: to explore, develop and optimize a sustainable food nutrient management strategy in Maasai community using modern technologies.

Key words: Food insecurity; Soils texture; Deficiency trends
Socio-Cultural Determinants Influencing Adolescent Sexual and Reproductive Health in Bomet East Sub-County, Kenya

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Abstract

Sexual and reproductive health among adolescent is a fundamental human right and a human development issue that every government including Kenya must fulfill. However, studies have documented poor sexual and reproductive health outcomes among adolescents ages 10 to 19 in many developing countries and to the worst, rural settings. Although estimates from the 2014 Kenya Demographic and Health Survey indicate that the country registered improvements in maternal and child health outcomes, adolescent outcomes remained poor due to socio-cultural challenges associated with sexual and reproductive health information sharing. This study examined the Socio-cultural determinants influencing adolescent sexual and reproductive health in Bomet East Sub-County in Kenya and adopted a survey research design. Interview schedule and questionnaire constituted key instruments in collection of data. Data analysis utilized Statistical Package for Social Sciences in the organization and analysis of quantitative data collected and the findings presented using frequency and percentage tables. The qualitative data from the open ended questions and further probing were also integrated in presentation of findings. The researcher established that the major socio-cultural determinants influencing adolescent sexual and reproductive health included deeply ingrained culture, poor parenting, negative peer influence and religious factors. The researchers therefore recommended that the country and the national governments should conduct intensive sensitization programmes to both parents and adolescents on sexual and reproductive health issues and in consultation with other stakeholders, develop a mutually agreed curriculum for adolescents training in various religious forums and in secondary schools.

Key words: Adolescent; Determinants; Reproductive sexual health.
Optimization of Anti-microbial and Pesticidal efficacies of bio-slurry using *Terminalia* and *Acanthaceae* spp. Extracts

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Abstract
Over time, many plant pests have developed resistance to commercial pesticides. Therefore, more pesticides are thus used to reduce the effects of these pests leading to agricultural expenses and environmental pollution. Biogas slurry is known to have a natural pesticidal effect. This study aimed at analyzing the effects of using two indigenous biogas additives (*Terminalia b. and Acanthaceae spp.*) in hastening the antimicrobial and pesticidal activity of bio-slurry. Kitchen waste was used as the biogas substrate for a retention period of 30 days. The extracts were characterized for physical-chemical parameters, functional groups, pesticidal components (organochlorides, organophosphates and carbamates). Both gram positive (*Staphylococcus aureus*) and gram negative (*Escherichia coli*) bacteria along with *Candida albicans* fungus were used for antibacterial and antifungal tests respectively. In vitro efficacy tests were carried out on aphids (*Brassica albohlabra*) and fall armyworms (*Spodoptera frugiperda*) and the toxicity studies (acute dermal toxicity and acute dermal irritation) carried out on lab animals. The results showed the pesticidal samples were slightly acidic and quite volatile. There were presence of carbamates and organophosphorus peaks in the spectra of the additive samples. The results indicated abundance of organophosphates with traces of chlorides, organochlorides and carbamates in the test samples. The test samples showed antimicrobial properties with intermediate inhibition. The samples were effective in the control of aphids. The test samples did not induce toxicity in fall armyworms but their movement and feeding activity greatly reduced within 6 hours. No signs of dermal irritation and dermal toxicity were observed. Both *Acanthaceae* spp. and *Terminalia* additives were found to increase pesticide activity of bio-slurry.

**Key words:** pesticides, anti-microbes, bio-slurry, *Terminalia, Acanthaceae* spp.
Spatial-temporal Variation of Vegetation Coverage and its Responses to Precipitation and Temperature in Kenya from 2000 to 2013

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Abstract
80\% of Kenya's land area is located in arid and semi-arid areas, where the dryland ecosystems are highly vulnerable to environmental changes. Monitoring of long term changes of vegetation, and climate variables are fundamental for better understanding of change trajectories in dryland ecosystem, which is better for Kenya's ecological environment monitoring and management. In this paper, we study vegetation, temperature, and precipitation dynamics, as well as their correlations and time-lag effects in Kenya using MODIS NDVI data over the period 2000-2013. The results showed that the vegetation depicts a nonsignificant increase during the study period. Meanwhile, the annual precipitation showed a significant increase trend, especially in the short rainy season, but the annual average temperature showed a nonsignificant increase trend. In most areas of Kenya, a nonsignificant positive correlation was observed between vegetation and precipitation, and a negative correlation between vegetation and temperature. Moreover, the response of vegetation to precipitation and temperature exhibited a time-lag effect. In general, the vegetation cover in most areas of Kenya is relatively stable except for the decreasing trend of vegetation cover in the southeast, and the vegetation cover changes was more sensitive to temperature compared with precipitation. The research results can provide important reference materials for ecological environment protection and management in Kenya.

Key words: Kenya; MODIS; Vegetation Coverage; Climate Change; Correlation Analysis
Modified Shannon-wiener diversity index towards quantitative estimation of biodiversity and environmental wellness levels under a non-comparative scenario

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Abstract
Shannon-Weiner diversity index has been used extensively in environmental studies to estimate the abundance and species richness of an ecosystem. The use of the index works very well or has made sense in interpretation under comparative situations; where one is comparing two or more environments at ago. However, in non-comparative situations the index interpretation becomes very limited in terms of the information it gives on the quality of the environment’s richness and abundance of species. The recently increase of interest in quantifying diversity in different communities has increased the desire to develop some inclusive methods, since the weiner index is good in calculating diversity of less and moderate rich ecosystem. However, it’s difficult to compare communities that differ largely in richness using the Weiner approach. Moreover, the magnitude of the Shannon diversity index denoted as \(H\) is usually affected not only by the distribution of the data but also by the number of categories of species in an ecosystem. Also, this index is associated with conceptual problems which make some measurements in some areas impossible. Further, it combines unrelated aspects such as composition and abundance of species making analysis of the output difficult. Therefore, to add value to the index and its ability to give a meaningful quantitative analysis on environmental biodiversity and wellness levels under non-comparative situations, this study sought to address the weaknesses experienced when using the model. Further, the study sought to modify the index to enable its estimation of the environment’s wellness when not comparing it to another one in a scale of 0% to 100%. Therefore, this study utilized the integrated logarithmic indexing of three variables generated by the Shannon-Weiner diversity index (diversity index, evenness and mean logarithmic index) to generate a holistic index that estimated the overall quality levels of an environment under study. Using the ‘Omatec logarithmic indices’ and their corresponding percentages table’ the holistic index was given a magnitude of wellness in a scale between 0% to 100%. This enabled the distinction of various environments wellness and biodiversity levels effectively. A scenario which was not possible before, due to Shannon-Weiner model weaknesses highlighted above. Using selected case study environments to test the modified model in estimation of their biodiversity and wellness levels discriminatively; an ecosystem with 5 categories of species each with total number of species (N) of 50 and 10 had biodiversity and wellness levels of 45.13% and 33.03% respectively after the modification. This is despite the two environments having the same diversity index and evenness levels of 1.6094 and 1. Further, an ecosystem with 5 categories of species and total number of species (N) of 27 had a biodiversity and wellness levels of 38.38%, with Shannon diversity index and evenness value of 1.4901 and 0.9258 respectively. A control environment
with the three variables (diversity index, evenness and mean logarithmic index) measuring 0 had a wellness percentage of 0% in ‘Omatec logarithmic indices’ and their corresponding percentages table’. The results indicated that the modification of Shannon-Weiner diversity index model discriminated the biodiversity levels of environments with same number of species categories despite having same richness and evenness indices. Further, the corresponding percentages table enabled estimation of biodiversity and wellness levels of an ecosystem under non-comparative situations. In conclusion the modification of the model seems promising in contributing on quantitative evaluation of environmental wellness towards their management.

Key words: Environmental; Shannon-Wiener; Quantitative; Wellness; Biodiversity

Electrochemical Synthesis of Hydrogen Gas from Anaerobiacally Decomposing Biomass

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Abstract
The desire for a clean, accessible, affordable and sustainable fuel remains unfulfilled with the available fuel sources being exhausted as energy needs increases rapidly. There has been a tremendous growing concern over the impacts of the available energy resources on global warming, human health and ecosystems around the world and its sustainability, thus prompting researchers to find renewable alternatives for meeting our growing energy demand. Waste biomass has been on the increasing trends but, methods of tackling its mop out from the environment has not been successfully optimized. And biomass-derived fuels can be used to produce hydrogen sustainably. Waste Biomass offers the earliest and most economical route for the production of renewable hydrogen. Hydrogen is a secondary form of energy that has to be manufactured like electricity, it is an energy carrier. In this study, hydrogen and biogas were electrochemically synthesized from decomposing biomass waste, using a fabricated electrolytic biomass solar cell in view of optimizing mesophilic biogas plant production efficiencies. To achieve this, a 4000 mL volume and 10 W energy electrolytic biomass solar was fabricated, and used to electrochemically synthesize hydrogen and biogas from decomposing waste biomass. Hydrogen and biogas volumes produced were recorded and analyzed at different: times of the day, number of days, temperature variations and pH values. The biomass electrolyte solution was analyzed before and after electrolysis by determining: the structure of total solids using FTIR, total dissolved solids (TDS), total suspended solids (TSS), and microbial test. The biomass solar cell recorded an average hydrogen volumes of 400mL and 200 mL volumes of biogas. The electrolyte pH varied from 8.0 of raw electrolyte to 7.0 of electrolyzed biomass solution. Temperature ranged between 20°C-29°C and the sample was electrolyzed for 12 days producing a total of 3500 mL H₂ gas and 1290 mL biogas. FTIR spectrum showed that, organic peaks were
present before and absent after electrolysis. TDS, and TSS for electrolyzed and fresh electrolytes were as follows; TDS 1800 mg/l, and 1200mg/l; TSS, 1400 mg/l and 1000 mg/l respectively. The microbial test showed negative presence of microbial colonies for the electrolyzed sample and positive presence of microbial colonies for the non-electrolyzed sample. This study has shown great potential of an electrochemical method of conversion of waste biomass to hydrogen and biogas green energies, with impressive amounts while generating pathogen free renewable fertilizer.

**Key Words:** Waste biomass; Electrolytic biomass solar cell; Electro chemical Synthesis; Hydrogen and biogas

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**Investigating the Quality of Locally Produced Ethanol Spirits Using GC-FID, FTIR and PH Meter Analytical Methods. A Case Study of Spirits from Meru and Narok Region**

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**Abstract**

Our country Kenya has witnessed rampant deaths associated with consumption of illicit brews and the cause of these deaths is largely unknown. Most people in rural areas like consuming these cheap spirits as they are cheap and available as compared to bear and fortified spirits in shops. The quality and efficacy of locally produced liquors has be a threat to lives. The study attempted to investigate the quality of locally produced ethanol spirits. The samples collected from Narok and Meru regions were analysed in Maasai Mara University Chemistry Lab and some taken to DAWA limited QC Lab. For GC-FID analysis, standard were prepared to 5%. The samples were analysed using FTIR model IR2621 and HC-GC-FID model 2010 PLUS HS and PH Hannah model. The PH analysis results shown that, all samples were strongly acidic with PH values ranging from 3.0 to 4.0. This signifies presence of concentrated organic acid compounds. The FTIR spectra showed intensified broad peaks in the region of 2500-3500 cm\(^{-1}\) indicating strong presence of carboxylic acids. The strong peaks found around 1465 cm\(^{-1}\) also identifies presence of carboxylate ions. Presence of aldehydes and ketones were noted from the broad band in 1800-1590 cm\(^{-1}\) region. According to the GC results, ethanol, acetone, and isopropyl alcohols were found in the samples analysed. From these results, the study clearly showed that illicit brews are not safe for human consumption as they seem to contain toxic organic compound; acetone, isopropyl alcohols and carboxylic acids.
Analysis of the Catalytic Behaviour of *Osyris alba* Bark and *Indigofera amabelacensis* Plant Extract in Ethanoic and Lactic Fermentation Process

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**Abstract**

Green bio-catalysts are being used in modern industrial applications to produce a wide range of products due to the production of environmentally friendly products. They help in obtaining much purer products and large quantity amounts of the products. *Osyris alba* tree (bark smoke) is used to catalyze lactic acid fermentation process. *Indigofera amabelacensis* plant crude extract is used to catalyze ethanoic acid fermentation. 4 Batch Anaerobic digesters of sizes 1 liter each containing Catalyzed Maize and Sorghum flours with their Controls were set up in temperature regimes of 20-25°C. The setups were run for a 34-day retention time. Separation of fermentation products was done using fractional distillation where the boiling point of ethanol was distilled at temperatures below 90°C. The rate of catalyzed fermentation was proven to increase in the orders of 12 and 1.5 folds for Lactic and Ethanoic fermentation respectively. The main products of fermentation i.e. ethanol and lactic acid tested positive to Iodoform test and matched the library Functional Groups with FTIR. While the concentration of Lactic acid in the Catalyzed samples averaged 6.5% in contrast to 1.2% in the Control ones, GC-FID analysis for quantification Ethanol products showed a high disparity of 6 folds in the main peak at 6.132-minute Retention time between the catalyzed and control sample.

**Keywords:** Catalyst; *Osyris alba* bark; *Indigofera amabelacensis* plant; GC-FID; FTIR; Fermentation; Ethanol; Lactic acid.
Climate change and Kenya’s rangelands: How will mammals they fare?

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Abstract
I searched online for information published on climate change effects on mammals and prepared the conservation status of Kenya’s rangeland mammals. Kenya has 390 mammal species mainly protected in legally protected areas (8% of Kenya’s land area (582,646km² (c.46, 611km²), private and community ranches (11% of Kenya’s land, c.46, 611km²). Although Kenya has high ecosystem diversity, rangelands/drylands cover about 88% (512,586.8 km²) of Kenya. About 70% of the protected areas and ranches are located in rangelands. Rangelands in Kenya, support most of the large and medium sized mammals, which also attract tourists and contribute hugely to Kenya’s GDP. However, climate change mediated threats will negatively affect the survival of these mammals both inside and outside Kenya’s protected areas. For example, the average population sizes of the most common mammal species (18) in Kenya, declined by 68%, while sheep and goats increased by 76% in the last 40 years (1977-2016). Climate change mediated threats, such as frequent and severe droughts in Kenya, has been identified as one of the main causes of the above mammals populations declines. In East Africa, the long and short rainy seasons have reduced, while the frequency of droughts have increased in recent years. Threats associated with climate change which will affect the survival of Kenyan mammals will include water scarcity, decrease in forage availability, increased wild mammals and livestock competition, intensified human wildlife conflicts, pressure to sub-divided ranches, settlement in wildlife corridors and wildlife poaching. To address these climate change threats there is need to: Control the spread of invasive plant invasive species in rangelands, rehabilitate degraded ranches and increase forage availability to livestock and wildlife, protection of wildlife corridors, increase share of benefits of proceeds of conservation with communities, and address rural poverty by ensuring basic needs such as water, education, food and medication are affordable to local people.
Characterization and Antimicrobial Profiling of Bacterial Isolates from Surfaces in the Maasai Mara University Clinic, Kenya

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Abstract
Previous studies have shown that surfaces in hospital settings are often poorly cleaned. The available methods of assessing the adequacy of cleaning are varied and include visual appraisal, several studies have demonstrated that less than 50% of room surfaces are clean. The objective of this study therefore was to isolate, characterize bacteria and determine their antimicrobial susceptibility from twenty (20) surfaces in the Maasai Mara University clinic. The bacteria were isolated from the surfaces by swabbing and inoculation onto Mannitol salt agar, MacConkey agar, Eosin methylene blue agar and Cysteine Lactose Electrolyte-deficient media. Characterization of the bacterial types was done microscopically, biochemically and by the use of antibiotic discs. A total of six bacterial species were isolated from surfaces in Maasai Mara University clinic and these were P. aeruginosa, S. pyogenes, P. vulgaris, S aureus, S. epidermidis and E. coli. All the bacterial isolates in the current study were resistant to Penicillin, Ampicillin, Lincomycin, Aloe barbadensis and Azadirachta indica (100%). Additionally, all (100%) the bacterial isolates were susceptible to Minocycline. From findings of the current study, it was concluded that there are antimicrobial bacterial contaminants of surfaces in the Maasai Mara University clinic. Further characterization of the bacterial isolates is recommended.

Keywords: Bacterial isolates, University clinic, Antimicrobial
Weather and Climate Changes and Adaptations in Ecosystems of Drylands and Wetlands

Optimization of biogas production from kitchen wastes using *Terminalia b.* and *Acanthaceae spp.* bio-catalysts

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Abstract

Biogas production from non-animal dung sources is annoyingly slow and produce low methane levels. Optimization of biogas production at cryo-mesophilic temperature regimes to fulfil both high yields and more methane levels is thus pertinent. On the other hand, kitchen waste accumulation is an urban menace associated with breeding pathogens. Traditional communities in Kenya used *Terminalia* and *Acanthaceae* spp. crude extracts to hasten fermentation of porridge and ethanol. This research aimed at exploiting these two plant extracts in catalyzing biogas production from kitchen waste during a 28-day retention period. The additives were characterized for functional groups, conjugation, physical-chemical parameters and bio-metals present. The biogas substrate was characterized for anaerobic digestion parameters at the onset and after every 7 days. Biogas yields and methane levels...
were also monitored. *Terminalia* extracts proved to contain more conjugated compounds with characteristic $\text{=C-H}_{\text{bend}}$ and trans $\text{=C-H}_{\text{bend}}$ peaks at around $960\text{cm}^{-1}$. The digestate pH and volatile solids content fluctuated over the retention period. Biogas production output was in the order of *Terminalia b.* (15861.4ml/gVS), *Acanthaceae* spp. (13219.6ml/gVS) and control (7444.8ml/gVS) at an average temperature of 19.500 $\pm$ 0.500°C. The methane levels were in the order of *Terminalia b.* (43.475 $\pm$0.922%), control sample (41.750$\pm$1.401%) and *Acanthaceae* spp. (39.275$\pm$0.269%). It was however observed that *Acanthaceae* spp. had very trace levels of hydrogen sulphide while the control sample had a lot of carbon monoxide gas. Both *Terminalia* and *Acanthaceae* spp. were found to significantly optimize biogas production from kitchen waste. Use of these additives can thus be used to cheaply optimize biogas energy production.

**Key words:** Biogas optimization; Plant extracts; *Terminalia*, *Acanthaceae* spp.

**Climate Change and Pastoral Livelihoods in Karamoja Region, Uganda**

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**Abstract**

Climate change is threatening pastoralists’ livelihoods in drylands. Ecosystems in drylands are highly vulnerable and continue to deteriorate posing threats of violent conflict, water scarcity, food security, human health on the resource-dependent pastoralists. Climate change is projected to increase risks with the increase in the magnitude of global warming. When the rate of global warming was considered to be lower than the current rates, the risk of harmful impacts on human systems, ecosystems and their services in Karamoja were significant. Scientists predict that many animals and plants will not be able to adapt with the increasing global warming. Karamoja is a highly vulnerable region to climate change. The region is grouped among the hard to reach areas by the government implying that it lagging behind compared to other parts of the country in service provision, literacy, while poverty rates are high. Access to information on climate change is low and documentation on how the Karamajong livelihood have been affected by climate change and how they are adapting is scanty and fragmentary. This is phenomenological study carries out in three districts i.e. Moroto, Nakapiripit and Abim of Karamoja region in Uganda. Data was collected through interviews and Focus Group Discussions. Results: The Karamajong are struggling because the patterns of weather have changed, indigenous knowledge the source of decision making is no longer accurate, there is species extinction and increasing food insecurity. Livelihood diversification and early warning mechanisms should be prioritized to curtail the predictable risks.
Keywords: Global warming; drylands; livelihoods; adaptation; ecosystem.

Impact of Population Increase on African Traditional Environmental Conservation Practices: A Case of the Maasai People of Narok County, Kenya

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Abstract

Population increase and economic development are contributing too many serious environmental problems in Kenya. These include pressure on land, land/soil degradation, forests, habitat destruction and loss of biodiversity, changing consumption pattern, rising demand for energy, air pollution, global warming and climate change and water scarcity and water pollution. Direct impacts of agricultural development on the environment arise from farming activities, which contribute to soil erosion, land salination and loss of nutrients. The objective was to establish the impact of population increase on African traditional environmental conservation practices among the Maasai people of Narok County, Kenya. The study adopted a descriptive design. The target population of this study was 215 community leaders from Maasai community in Narok County. Using stratified sampling technique, the study used a sample size of 132 respondents being 30% of the number of community leaders from Maasai community in Narok County. Primary data was collected using open ended and closed questionnaire. Quantitative data was analyzed by descriptive statistics (percentage and standard deviation). Data presentation was in percentages, bar graphs and pie charts. The findings shows that the conservation of water courses, streams, water pans and wells as well as the associated vegetation was protected through rules that ensured their sustainability. More important were the shrines, caves and the forests covering the springs which were never interfered with because of the belief that ancestors or evil spirits dwelt in such places. The study concludes that the Maasai community members have used various indigenous environmental norms such as prohibitions, protection of sacred places, totems and age and gender restraints in managing different elements of the biophysical environment with varying successes. Future studies should be conducted to establish other factors affecting African Traditional Environmental Conservation Practices apart from population increase.

Keywords: Population increase; African traditions; Environmental conservation practices; Indigenous environmental norms
Past and Future Changes in Climate Extremes over Kenya based on Three Coordinated Regional Downscaling Experiment High-Resolution Regional Climate Models

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Abstract
The climate of Kenya is characterized by a strong spatial and inter-annual variability. This study provides an evaluation of three Coordinated Regional Downscaling Experiment (CORDEX) high resolution regional climate models (RCMs) simulations of precipitation and temperature over Kenya of past and future projections of rainfall and temperature extremes based on Representative Concentration Pathways (RCPs) 4.5 and 8.5 emission scenarios. The skill of the three RCMs over the historical period is evaluated by the use of Climatic Research Unit (CRU) datasets. The results show that the average minimum temperature at the end of the 21st Century will increase by 1.26 and 4.32 °C under RCP4.5 and RCP8.5 scenarios respectively while that of maximum temperature will increase by 1.76 and 5.12 °C under RCP4.5 and RCP8.5 respectively over Kenya. The minimum temperature is expected to increase more than that of maximum temperature thus an increase/decrease in warmer/colder nights. On the other hand, March -May seasonal rainfall is projected to significantly decline while that of October to December season is predicted to increase. On Rainfall extremes, Consecutive Dry Days are expected to increase under both scenarios of RCP4.5 and RCP8.5, while that of annual precipitation total showing a statistically significant decrease at 5% significant level and consecutive wet days also show a declining trend in both scenarios, it is expected. The expected changes in temperature and rainfall are due to climate change and it is likely to impact negatively on the ecosystem hence affecting the people’s livelihood.

Keywords: Climate change; Temperature; Rainfall; CORDEX; Kenya
Indigenous Adaptation Mechanisms to Climate Change in Drylands of West Pokot County, Kenya

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Abstract

The issues of climate change and global warming appearing in news headlines have been on the rise and ways of adaptation have been of great challenge. Pokot like any other indigenous communities have been facing this challenge since time immemorial and how to survive in such harsh environments had been perplexing to get an eminent answer to the question. This project established indigenous adaptation methods dealing with climate change in dry lands of West Pokot County. Indigenous mechanisms have been marginalized and unrecognized by the contemporary generation. The study used random sampling technique to sample respondents and administered questionnaires and interview schedules to collect data, which were used for analysis and interpretation and thereafter conclusion and recommendations made. This study found out that Pokots used local weather forecast experts checking movements of stars, sun, moon, animal intestines and birds among others to foresee rains and drought. From the forecast, they advised the community about farming, grazing and inhabitation. It concludes that indigenous mechanisms play a great role in managing droughts and heavy rainfalls and recommends that indigenous mechanisms should be recognized and local experts be consulted often on matters pertaining to climate change.

Keywords: Weather forecast; Response; Land use; traditional methods; Local Community
Biological Cleaning of Sewage Water Using Common Water Hyacinth 
(*Eichhornia Crassipes* (Mart.) Solms)

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**Abstract**

The University is located in a semi-arid zone with scarcity of water resources throughout the year. The University buys its water very expensively from private companies in Narok County, Kenya. Therefore, it follows with logical necessity that the sustainable management of water resources is a critical issue in this area. The University therefore innovatively engineered the biological cleaning of its sewage water using the world famous Common Water Hyacinth (*Eichhornia crassipes* (Mart.) Solms) so that it provides for a useful and sustainable mechanism of recycling its hard acquired water. The *E. crassipes*, a member of the Pontederiaceae Family, is native to South American Amazon basin but widely naturalized in tropical and subtropical regions where it has become one of the world’s worst problematic invasive weeds, thus presenting unique environmental challenges *vis a vis* opportunities. At the University, *E. crassipes* has proved as a water-cleaning agent and thus provided a design of living technology for wastewater treatment. The cleaned water was tested and certified by National Environmental Management Authority (NEMA) for agricultural use only and henceforth, its current use to maintain unique flora and fauna in the African Medicinal Botanical Garden (AMBG) of the University. The *E. crassipes* residues are innovatively turned into biomass briquettes and anticipated to be formulated into animal feeds and organic manure. This process of wastewater treatment presents exciting and unique research opportunities and is anticipated to create water sports for tourism, establish fish ponds, generate hydroelectricity, produce fertilizer and cooking methane gas from its waste solid slurry.

**Keywords:** Sewage water; Common Water Hyacinth; Water purification; Semi-arid; Invasive weed
The Impact of Climate Change and Anthropogenic Activities on Fisheries of Lake Logo, South Wello, Ethiopia

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Abstract
A study was conducted in south Wello zone in Ethiopia to see the impacts of climate change on the fish production of Lake Logo. Purposive sampling and focus group discussions were used to generate data on the major anthropogenic activities, and perception of the beneficiaries of the lake about climate change. Besides, meteorological variables were obtained from the National Meteorological Agency and its correlation with fish yield of the lake was calculated. Major anthropogenic activities were identified as deforestation, poor soil and water conservation activities, intensified agricultural activities, urbanization, existence of alien invasive plant species, overfishing, illegal fishing, increased number of fishers, irrigation, and flooding. Fish catch of the lake over the years happened to be in a declining trend. Respondents perceived erratic rain, hotter temperature, flooding, drought and erosion. The meteorological data revealed that the mean annual maximum temperature showed an increasing trend, while the mean annual minimum temperature showed a decreasing trend over the years. Rainfall was found to have an erratic nature. Annual maximum temperature and fish yield had a positive relationship. Mean annual minimum temperature and fish yield had negligible relationship. Mean annual maximum rainfall had a positive relationship with fish catch. However, the mean annual minimum rainfall had no relationship with fish yield. It is highly recommended to apply a holistic and balanced environmental management systems so as to save the loss of aquatic biodiversity in the lake.

Keywords: Climate Change; Anthropogenic; Lake Logo; Fisheries
Soil Microbial Feedbacks to Climate Warming and Water Table Drawdown in Zoige Peatlands

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Abstract

Changing climate results in water table drawdown in peatland that induces shifts in vegetation structure. Microbial communities are important to ecosystem function and sensitive to temperature and hydrological dynamics. However, we lack predictable knowledge about how soil microorganisms respond to warming, water table drawdown and exogenous carbon input in peatlands. We investigated the bacterial, archaea and fungal communities along the different peat depths and assessed these communities response to temperature, water table and varied complexity organic matter substrate addition. Soil prokaryotes in moderately degraded peatland is most sensitive to climate change than that in heavy or light degraded peatland, and that intensive climate change (combined warming and 20% rainfall reduction) can make soil prokaryotes more homogenizational compared with single treatment of warming or 20% rainfall reduction and the control. Further through the water table drawdown experiment, we found that water table drawdown reduced alpha diversity indices of prokaryotic communities. Intriguingly, the reduction of diversity varied in different depths. At the same time, the vertical distribution of prokaryotic microbiota along the depth gradient was altered by water table drawdown, mainly by enriching the oligotrophs (e.g., Acidobacteria) over the copiotrophs (e.g., Bacteriodetes). Finally, combination of substrate addition, the depth-dependent pattern of fungal community shifted greatly ($R = 0.361, P < 0.01$), while there was no variation of the bacterial community ($P > 0.05$). Substrates had more prominent influence on fungal abundance than bacterial abundance. Surprisingly, fungal abundance in subsurface layer was increased 2 to 13 times after substrate addition. We suggest that the response of fungi to climate change might be more sensitive than bacteria, which must be considered when explicating the role of microbes in peatland carbon dynamics.

Keywords: Soil Microbiology; Climate Warming; Water Table Drawdown; Zoige Peatlands
Effects of Climate Warming and Heat Wave on Macrophytes Reproductive Strategies and their Interactions

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Abstract

Intensification of weather extremes is currently emerging as one of the most important facets of climate change. Extreme climatic events, such as heat waves, are predicted to increase in frequency and intensity during the next hundred years, which may accelerate shifts in hydrological regimes and submerged macrophyte composition in freshwater ecosystems. Since macrophytes are profound components of aquatic systems, predicting their response to extreme climatic events is crucial for implementation of climate change adaptation strategies. In order to assess the effects of predicted extreme climatic events on submerged macrophytes, we present data from a long-term experimental study addressing the responses of two different growth forms submerged macrophytes to different climate scenarios including a 4°C increment above ambient and ±4 °C oscillation around 4 °C increment. We show that at the moderate nutrient conditions provided in our study, neither an increase in mean temperature nor heat waves lead to a shift from a plant-dominated to an algal-dominated system. Instead, we show that species-specific responses to climate change among submerged macrophytes may critically influence species composition and thereby ecosystem functioning. Our results also imply that more fluctuating temperatures affect the number of flowers produced per plant leading to less sexual reproduction. Our findings therefore suggest that predicted alterations in climate regimes may influence both plant interactions and reproductive strategies, which have the potential to inflict changes in biodiversity, community structure and ecosystem functioning.

Keywords: Climate Warming; Heat Wave; Macrophytes; Reproductive Strategies; Interactions
THEMATIC AREA 4

Capacity building and its contribution to the growth and development of biodiversity in the Drylands and Wetlands

Competency-Based Curriculum: A Contribution to Conservation and Management of Biodiversity in Kenya

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Abstract
The world’s human population is estimated to reach 9.7 billion by the year 2050 and over 11 billion by the year 2100. This exponential human population growth means over exploitation of earth’s limited resources posing a great threat to biodiversity. Effects of climate change are further expected to complicate the situation and hence the need for education policy makers to rethink how education systems could be aligned to provide solution to the current and future threat to biodiversity. This paper examined how Kenya’s Competency Based Curriculum is geared towards conservation and management of both drylands and wetlands biodiversity. The paper concludes that Kenya’s Competency Based Curriculum is aligned to equip learners with information, knowledge, attitudes and skills for the 21st Century that would enable them conserve and manage biodiversity. The paper recommends that education be made accessible to all through open education practices and that learner centered approaches be used in building capacity of citizenry to conserve and manage both drylands and wetlands biodiversity.

Keywords: Open Education Practices; Learner-centered Education; Skills for the 21st Century
Capacity building on ecological research and biodiversity conservation in Tropical Asia

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Abstract
The uniqueness and significance of biodiversity in tropical Asia has been widely recognized while preserving this heritage of all mankind confronts a wide range of challenges. The challenges have many dimensions: biogeographic, cultural, linguistic, political, and religious. In the past 15 years, through several initiatives in this region, XTBG has successfully created and fostered regional networks of young scientists and conservationists. These initiatives include, 1) Set up the Asia-pacific Chapter of the Association of Tropical Biology and Conservation (ATBC-AP), which holds regular annual conferences in Asia since 2007 (https://tropicalbiology.org/atbc-meetings/asia-pacific-chapter-meetings/), 2) Provide high quality training courses (6 weeks), namely Advanced Field Course in Ecology and Conservation (AFEC-X) (https://www.pfs-tropasia.org/2019/05/afec-x-2019/), which has been continued for 10 years, 3) With the setting up of CAS-SEABRI, over 70 young students from this region study in CAS institutes for professional degrees (Master or doctor degree), 4) A dozen of inventories in those underexplored remote areas for biodiversity with a lot of new discoveries have been conducted. Direct interaction and collaboration during international field courses and field inventories among students/young staffs from the many countries of the region is an effective way to overcome cultural and linguistic barriers and to inspire and educate the enthusiastic spirit of the young conservation biologists in the region. We hope the practice and experiences in tropical Asia could hold implications to elsewhere tropics, such as Tropical Africa.

Keywords: Capacity building; Ecological research; Biodiversity conservation; Tropical Asia
Biodiversity of rhizobia in African soils: insights into their phylogeny and potential utilization as biofertilizers for sustainable agriculture

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Abstract
Rhizobia are soil bacteria capable of inducing root nodules on compatible legumes leading to the reduction of atmospheric nitrogen (N₂) to ammonia (NH₃) for plant use. Because of their N₂-fixing trait, rhizobia play important roles in agroecosystems by improving overall soil health through their symbiotic relationships with legumes. Rhizobia exhibit morpho- genetic diversity and differ in their N₂-fixing efficiency. As a result, bioprospecting for highly effective strains is the first step in tapping their benefits for sustainable crop production through inoculant formulation. To provide insights into the genetic diversity, phylogenetic relationships and N₂-fixing efficiency of rhizobial microsymbionts of cowpea (Vigna unguiculata L. Walp) and Kersting’s groundnut [Macrotyloma geocarpum (Harms) Marechal & Baudet] in African soils, root nodules of these legumes were obtained from contrasting environments in Ghana, South Africa and Mozambique. Box-PCR fingerprinting revealed high diversity among the authenticated rhizobial populations nodulating the two crops, which was influenced by geographic origin. The 54 cowpea isolates evaluated were grouped into 45 Box-PCR types at 70% similarity coefficient while a total of 164 Kersting’s groundnut isolates were also grouped into 130 Box-PCR types, indicating that they were not clones. Phylogenetic analysis of 16S rRNA gene and multilocus sequence analysis of protein-coding genes (atpD, gltII, gyrB and rpoB) and symbiotic genes (nifH and nodC) showed that, both test legumes were primarily nodulated by members of genus Bradyrhizobium, which are closely related to B. daqingense, B. subterraneum, B. vignae 7-2T, B. kavangense 14-3T, B. subterraneum 58-2-1T, B. pachyrhizi PAC48T, B. elkaniiT and novel groups of Bradyrhizobium species. Canonical correspondence analysis revealed that the distribution of these rhizobial symbionts was influenced by soil pH and the concentrations of micro- and macronutrients in soils. Moreover, the rhizobial isolates identified exhibited variable N₂ fixation, with most isolates inducing greater nodulation, leaf chlorophyll concentration and photosynthetic rates on their homologous host when compared the commercial Bradyrhizobium sp. strain CB756 and/or plants fed with 5 mM KNO₃, suggesting that they could be good candidates for inoculant formulation upon field testing.

Keywords: Rhizobial diversity, N₂-fixing efficiency, photosynthesis, inoculants, Bradyrhizobium
The Global Biodiversity and Health Big Data Alliance

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Abstract
In response to the appeal of "Open Data in a Big Data World" by the International Science Council, we proposed an initiative of Open Biodiversity and Health Big Data (BHBD) Alliance to the International Union of Biological Sciences (IUBS), which was approved in 2017. The BHBD Alliance (http://bhbd-alliance.org) was officially launched in Beijing on October 14, 2018 by its five founding members from China, Pakistan, Russia, Saudi Arabia and Thailand. The aim of the project is to build the principles and mechanisms for global sharing of BHBD in accordance with laws and ethics of member countries, as well as to develop the Alliance as a world-wide open platform for data integration, sharing and translation. Since its foundation, the Alliance has made a steady progress. By July 2019, 20 organizational members from 11 countries have joined the Alliance. We have organized five international meetings, conducted trainings for over 100 people, and jointly published five research articles, sharing genomics data and implementing scientific programs with the Alliance members. The BHBD Alliance is also joining the Alliance of International Science Organizations (ANSO) to further promote data sharing and scientific collaboration among ANSO members.

Keywords: Global Biodiversity; Health; Big Data Alliance

Competency-Based Curriculum in Kenya and Learners’ Capacity Building to Combat Environmental Degradation

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Abstract
This study interrogated whether the Competency Based Curriculum in Kenya is designed to build capacity combat environmental degradation. Education is a powerful tool to help Kenya to combat environmental degradation by inculcating in its citizens, from early age, values, knowledge and skills of care of the environment and the ecosystem. Kenya has started implementing a Competency Based Curriculum, rolled out from grades one to three. This qualitative study employed document analysis of the Basic Education Curricu-
Education for Sustainable Development in Drylands and Wetlands: Need for a Comprehensive Approach and Policies in Kenya

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Abstract
Development and land use in the 21st Century in Kenya have led to biodiversity loss caused by pollution, overharvesting, deforestation, climate change, construction on riparian zones, ocean acidification among others, affecting the ecosystem. As a result, there is reduced productivity in natural and Agricultural ecosystems due to diminishing genetic base, reduced livelihood resources, loss of potential medicinal and industrial benefits, decreasing critical health nutrition inputs, erosion of traditional knowledge base, destruction of habitats for plants, animals, fungi and micro-organisms. To avert the status quo, there is need for people to make informed decisions hence education is an essential tool to transform the society. Analysis of curricula reveals that scholars have proposed mainstreaming Education for Sustainable Development in formal Education Programmes at basic and higher education levels, which leads to nature appreciation and awareness. This paper argues that a comprehensive approach, which involves all types of education: formal, informal and non-informal, should be used to target all generations of citizens through experiential learning. It involves engaging in social and service-learning, combining learning objectives with community service to provide a pragmatic, progressive learning experience while meeting societal needs hence resulting to positive change in the community which would boost ecosystem productivity. There is need for the development of policies that would act as enablers of Education for Sustainable Development in non-formal situations to homogene-
ous groups such as newly initiated youths and others. Retrogressive cultural practices that lead to loss of biodiversity should be discarded.

**Keywords:** Biodiversity; Ecosystem productivity; Experiential learning; Initiatives; Retrogressive cultural practices

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**Analysis of Faroe spp. and Cyombopogon citratus Extracts for their Beverage Potential Compared to Processed Black Coffee and Black Tea Leaves**

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**Abstract**

Prior to civilization by western nations, several communities in Kenya still prepared beverages such as tea and coffee. The Maasai community has continuously substituted these beverages with Faroe spp. (Olesesiai) concoction while the Luo community previously enjoyed preparing Cyombopogon citratus (lemon grass) concoctions in absence of coffee or tea leaves. Water extracts of these plants were characterized for physical-chemical, functional group, conjugation, antioxidant, phytochemicals, amino acids, total caffeine, total alkaloids and total flavonoids similarities with processed black coffee and black tea leaves. While the physical-chemical properties were closely related, the results indicated concise resemblance in functional groups and conjugation. Faroe spp. extracts had more pronounced antioxidants whereas their phytochemical screens closely matched those of black coffee and tea. The Faroe spp. and Cyombopogon citratus extracts showed presence of essential beverage phytochemicals such as flavonoids, alkaloids, phenolic groups and glycosides amongst others. Tyrosine and phenylalanine amino acids were more prevalent in the test samples. The order of caffeine content in the samples was black coffee (398.990 ± 0.000mg/L), black tea (169.110 ± 0.000mg/L), Faroe spp. (116.640± 0.000mg/L) and Cymbopogon citratus (38.760±0.000mg/L). The same series was observed for total alkaloids whereas black tea exhibited more total flavonoid content. In conclusion, whereas Faroe spp. was found to have a lot of similarities with black tea and coffee, Cymbopogon citratus extracts shied off from matching most of the tests conducted. Faroe spp. can thus be commercialized as another form of beverage in the region.

**Keywords:** Faroe spp.; Cymbopogon citratus; Beverages; Caffeine
Species diversity of birds in Mountains of Southwest China and the Horn of Africa

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Abstract
Mountain systems harbour the high species diversity and endemism which attracts ecologists and conservationists to understand the species richness patterns along the elevational gradients since the last two decades. Distributional data for breeding birds were collected to document the species richness patterns along elevational gradients and its driving factors in the Horn of African Mountains and Mountains of Southwest China (two global biodiversity hotspots). The study revealed that species richness patterns were hump-shaped in both areas, but temperature range and productivity were significantly related with the richness pattern in the Horn of African Mountains, while climatic (seasonality) and energy (productivity) factors were well correlated with the richness pattern in Mountains of Southwest China.
Collecting, Depositing, and Scientific Researching on Biological Collections of the Chinese Academy of Sciences

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Abstract
There are over 20 millions biological specimens are deposited in the Biological Collections of the 18 institutes belonging to the Chinese Academy of Sciences (CAS), which construct the largest system in China of preservation and research on specimens of animals, plants, fungi and fossils, as well as of scientific education of biology. There are also two national science and technology resources sharing infrastructures - the National Animal Collection Resource Center, and the National Plant Collection Resource Center in this system. Based on a comprehensive analysis of its overall status, the basic orientation, composition and layout characteristics of the Biological Collections of CAS, and the scale, composition and characteristics of the specimen collection were expounded in present report. The authors also summarized achievements of CAS rely on Biological Collections in the fields of strategic biological resources collection and preservation, classical taxonomic research, Fauna and Flora compilation, specimen information digitization, science popularization and so on, and showed the supporting role of the Biological Collections of CAS in frontier scientific research, and national economic construction. Some suggestions for international cooperation based on biological collection were proposed.
Study and Utilization of Artificial Rice Resources Tetraploid Rice

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Abstract
The development of autotetraploid hybrids \((2n = 4x = 48)\) has been suggested as a new method for increasing heterosis in hybrid rice. Using standard experimental protocols, the elite diploid rice male sterile, maintainer, and restorer lines were colchicine-doubled, and autotetraploid counterparts were obtained. Seven resulting hybrids were analyzed for heterobeltiosis (HB), where the F1 was compared to the male parent, and the degree of heterosis, where the F1 was compared to the diploid commercial hybrid, Shanyou 63. The HB among the autotetraploid hybrids ranged from 1.4 to 105.9% for the productive panicles per plant, 0.5 to 74.3% for total kernels per panicle, 17.6 to 255.7% for filled kernels per panicle, and 9.6 to 130.4% for seed set. Improvements in these yield components resulted in the HB for kernel yield ranging from 64.8 to 672.7% among the seven hybrids. Hybrids T461A/T4002 and T461A/T4193 yielded 46.3 and 38.3% more, respectively, than Shanyou 63, and all other hybrids but one yielded the same or more than Shanyou 63. The high heterosis for yield suggests that hybrid sterility between two rice subspecies may be overcome by using tetraploid lines followed by intensive selection. Also, the gigantic features of the autotetraploid hybrids may establish a plant structure able to support the higher yield.

Keywords: Utilization; Artificial Rice; Resources; Tetraploid Rice
Discourses on the Kenyan Competency Based Curriculum (CBC) - A Critique

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Abstract
Kenya is phasing out the 8-4-4 system of education which has been in place since 1985. The Competency-Based Curriculum (CBC) is replacing the 8-4-4 system of education and it is in the pilot phase of implementation. The CBC is designed to emphasize the significance of developing skills and knowledge and also applying those competencies to real life situations. The launch of CBC has elicited much controversy among politicians, parents, media practitioners and the basic and the tertiary level academia. The university academia who are key stakeholders however have largely remained silent on the raging discourse on the process which will definitely alter the education sector and significantly affect them in a few years time when they receive the first batch of CBC grade 10, 11 and 12 graduates. Therefore, the objective of this work is to initiate constructive discussions within the university academics on the CBC. It is hypothesized in this paper that, university academia is a major education stakeholder and opinion shapers. The work has drawn insights from the Conversational Analysis and Critical Discourse Analysis Theories. The research design was descriptive survey. Data for the research was media clips, excerpts and interview responses. The justification for the research lies in the analysis and reconstruction of the ongoing discourse which will help speed up consensus on the education system review and eventual implementation. The views of the University academia will be a welcome enrichment to the already existing views.

Key words: Education; Competence; Content; Curriculum; Perspectives; Stakeholder; Participation
Challenges of E-Government Communicating Disaster Information in Wetlands and Drylands: Case of Narok County, Kenya

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Abstract
Risk communication and risk perception are critical factors in disaster management. Governments at all levels play a part in communicating risk, whereas the perception of risk entails active roles by community participants, including potential and actual victims of disasters. This paper discusses these matters in relation to the use of Information Communication Technology (ICT) regarding floods in Maa Community. The findings are based on interviews with representatives of households whose dwellings or business premises were fully or partially inundated by water. Electronic government (E-government) is a phenomenon that is a link to the information society in terms of the application of the internet and networking technologies to digitally enable government and public sector agencies in relationship with its citizens. E-government is an attempt to take an advantage of ICTs as a modern tool to facilitate the citizen’s access to government information, service delivery and provide a platform for citizens to interact with government institutions and processes. These are the major challenges that are the government agencies where their ingredients are inadequate, where the ICT infrastructure is not widely available to rural population. This paper addresses four major objectives of E-Government of Kenya. Disaster warning information is vital to the Maa Community. The paper concludes with recommendations.

Keywords: Information Communication Technology; E-Government; Disaster Response; Risk Communication; Risk Perception
Advances of Molecular Biology and Genetics of Biodiversity and its Impacts on Drylands and wetlands

Development of Next-Generation Sequencing (NGS)-based SSRs in African Nightshades: Tools for Analyzing Genetic Diversity for Conservation and Breeding

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Abstract

African nightshades (section Solanum) are indigenous leafy vegetables in sub-Saharan Africa valued for their high nutrient content and potential to generate income. Efforts to improve this crop have been hampered by limited information available on intra- and interspecific genetic diversity due to lack of locus specific markers. To this end we developed new simple sequence repeat (SSR) markers specific for this section using next generation sequencing. A total of 6,824,250 paired sequences were generated from Illumina sequencing. De novo assembly of the sequences produced 122,663 contigs of which 31% contained SSR motifs. The newly developed SSR markers were applied to a broad collection of entries (gene bank accessions, landraces from farmers, breeding lines and commercial cultivars) from two species of African nightshades, Solanum scabrum (Mill.) and S. villosum (Mill.). Polymorphic SSR markers revealed genetic diversity within and between the 54 entries collected from various geographic locations in Sub-Saharan Africa. High levels of polymorphism were detected within entries, indicating gene flow between entries and/or a low intensity of selection during development of breeding lines and improved cultivars. As a consequence, they have retained sufficient variation for further selection within the improved germplasm. The two species were clearly distinct, and S. scabrum was found to be less diverse compared to S. villosum. Landraces had higher allelic richness and rare alleles than did developed cultivars and could serve as a useful gene pool for future breeding of superior germplasm.
Keywords: Breeding lines; Cultivars; S. scabrum; S. villosum

Physiological and molecular behaviour of microsymbionts nodulating Polhillia, Wiborgia and Wiborgiella species of the South African Cape Fynbos Region

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Abstract
The legume-rhizobia symbiosis is an important process for agriculture and the environment. In natural environments like the Cape fynbos region of South Africa where soils are known to be low in plant available nutrients and summer droughts are longer, shrub legumes endemic to this region, including Polhillia, Wiborgia, and Wiborgiella species are able to grow and reproduce effectively under these conditions. This is mainly due to their ability to fix atmospheric nitrogen in symbiotic relation with soil bacteria called “rhizobia”. However, information on genetic diversity, phylogeny and their morphophysiological characteristics of rhizobia associated with these species is still very scarce. Therefore, the aim of this study was to assess rhizobia nodulating Polhillia, Wiborgia and Wiborgiella species physiologically and molecularly. The Enterobacterial Repetitive Intergenic Consensus (ERIC) PCR amplification and nucleotide sequence analysis of 16S rRNA and housekeeping genes (gyrB, gltA and glnII) were studied for the diversity and phylogeny of the associated rhizobia. The ERIC-PCR banding pattern results placed the 53 test isolates into four major clusters in the constructed dendrogram, with 31% similarity coefficient. The 16S rRNA and concatenated housekeeping genes analysis of root nodule isolates showed that a diverse and novel Mesorhizobium sp. are the nodulating symbionts of the test legume species. Furthermore, physiological studies of isolates showed that they were tolerant to NaCl (1-3%), temperature (45°C), different antibiotic drugs (Streptomycin, Kanamycin, Chloramphenicol, Ampicillin, and Neomycin) and pH (5-10). The test isolates also had the ability to solubilise inorganic phosphate (Ca₃PO₄) and produce phytohormone indole acetic acid (IAA). Conclusively, the present results showed a good initiative for utilization of microsymbionts in nutrient depleted soil to enhance the growth and proliferation of wild legumes of the Cape fynbos and other regions with similar conditions.
Molecularly imprinted polymers selective to polychlorinated biphenyls and their integration in QCM Sensors

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Abstract
Molecular recognition displayed by naturally occurring receptors has continued to inspire innovations aimed at developing systems that can mimic this natural phenomenon. Since 1930s, a technology called molecular imprinting for producing biomimetic receptors was introduced. In this technology, specific binding sites are introduced in a polymer matrix by polymerizing functional monomers and cross-linking monomers in the presence of a target analyte. Subsequent removal of the target analyte, leaves behind binding sites or cavities specific to the analyte for the rebinding process. The inherent specificity of these materials referred to as molecularly imprinted polymers (MIPs), has been well demonstrated, whereby bioassays based on MIPs have achieved results comparable to enzyme based assays. In addition, these materials have successfully been applied as sorbents in separation science, recognition elements is sensors, and are promising candidates for smart drug release. This paper explores molecularly imprinted polymers selective to polychlorinated biphenyls, which have been classified as probable carcinogens, and potential integration of these polymers with sensors towards achieving ultra-trace level detection of PCBs in aquatic environment.

Keywords: Molecular recognition; molecularly imprinted polymers; natural receptors; polymerization; polychlorinated biphenyls
THEMATIC AREA 6

Public health and its impact on drylands and wetlands

Education level and HIV/AIDS Knowledge, awareness, attitudes and practices among the online partner and spouse seekers in Kenya

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Abstract
The current study was conducted to assess the level of perception, awareness, knowledge, attitude and practice (PAKAP) towards HIV and AIDS scourge amongst sexually active online partner and spouse seekers through a media company in Kenya. Data were obtained from 820 advertisements (respondents) while considering their educational level, age, and socio-economic backgrounds. The Pearson Chi-Square and Fisher’s Exact Tests were used to analyze data. Study results showed that respondents had a statistically significant perception towards HIV and AIDS (p < 0.05). Knowledge and awareness of HIV and AIDS was significant (p < 0.05) by level of education and economic status and not by gender, age, marital status, type of relationship sought and bearing of children before marriage. Attitude towards HIV and AIDS was significant by level of education (p < 0.05) and not by gender, age, economic status, marital status, type of relationship sought and bearing of children before marriage (p > 0.05). Practices to manage, control and prevent HIV and AIDS were significant by gender (p = 0.01) and not by age, level of education, economic status, marital status, type of relationship sought and bearing of children before marriage (p > 0.05). Since
the results indicated that PAKAP was significant \( p < 0.05 \), efforts should be made by all stakeholders in HIV and AIDS management, control and prevention programmes to equally target persons dating through social media in order to have a wider coverage for this kind of dating is becoming a common practice amongst the sexually active group.

**Keywords:** Human immunodeficiency virus; Acquired immune deficiency syndrome; Sexual partners; Epidemiology; Kenya

### Adsorption of Chromium (VI) by Magnetized Quaternary Activated Carbon-Silica Composites

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**Abstract**

In this study, the adsorption capacity of magnetized quaternary activated carbon-silica composites was explored as a cost-efficient adsorbent for the removal of chromium (VI) from aqueous solutions. Magnetic silica-coated quaternary adsorbent AC-Fe\(_3\)O\(_4\)-SiO\(_2\)-N\(^+\) (CH\(_2\)CH\(_3\))\(_3\) was achieved by co-precipitation over *Macadamia* nutshell activated carbon. Batch adsorption studies were performed with optimum conditions of pH 1 and 3, 5 and 2.5 ppm initial concentration, 2 hours contact time, 45 and 6 °C for both AC-Fe\(_3\)O\(_4\) and AC-Fe\(_3\)O\(_4\)-SiO\(_2\)-N\(^+\) respectively. Fourier transform infrared (FTIR) spectroscopy displayed successive attachment of Fe, Si, epoxy and amines with bands at 404 and 786 cm\(^{-1}\) bands assigned to the asymmetric vibration of Si-O-Si and symmetric stretch of Si-O-Si and asymmetric Si-OH at 1066 cm\(^{-1}\). The stretching vibration of an OH- was observed as the epoxy and amine were being attached shifting the peak to 3397 forming an asymmetric -NH band. O=C-O-C peaks at a region of 11560-1210 and the C-O stretch at 1086 and 1014 represented the attached epoxy. EDX showed the presence of Fe, C, O, N, Si and S at different percentages proving successive functionalization. Both adsorbents displayed an endothermic reaction and goof adsorbents for the removal of chromium (VI) from aqueous solutions.

**Keywords:** adsorption capacity, centrifuge, percentage removal, reduction, sonication.
Characterization of Ground Water Quality in Southern and Northern Region of Zanzibar Island

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Abstract
Millions of people from different countries depend on groundwater, which might contain elevated levels of unhygienic constituents. Poor quality of drinking water in many countries has been forcing people to use bottled water. In the present study, groundwater samples were collected in November 2014 leading to twenty-nine analysis of groundwater samples. Fourteen and fifteen underground water samples were collected from North and South regions of Zanzibar Island respectively. The purpose was to determine the quality of water for drinking as an establishment of preliminary baselines on groundwater constituents. Physical parameters (Turbidity, oxidation-reduction potential Eh, pH, salinity, and Electrical conductivity (EC) were determined in situ using Horiba multiparameters digital meters. Analysis of anions (NO₃⁻, Br⁻, SO₄²⁻, F⁻, NO₂⁻) was carried out using Ion chromatography (IC). The order of relative abundance for anions in samples collected at Northern region of Zanzibar Island, was NO₃⁻ > Br⁻ > SO₄²⁻ > F⁻ > NO₂⁻, while for the Southern region the order was NO₃⁻ > Br⁻ > NO₂⁻ > SO₄²⁻ > F⁻. In both regions, the orders for other parameters were; Turbidity > pH > salinity; and EC > TDS > ORP > Eh. Almost all the measured parameters were within the WHO guidelines for drinking water. However, for nitrate and bromide, the percentage that exceeded the WHO limits were 7%, and 10.3%, respectively. Based on toxicological perspective, although few samples had concentrations above groundwater quality criterion it is fundamental to estimate the intake by humans through the drinking water pathways.

Key words: Drinking water; nitrate; bromide; toxicological perspective; Ion chromatography
Fabrication of Aptamer Conjugated Gold Coated Iron Oxide Nanoparticles for Breast Cancer Diagnosis

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Abstract
Magnetic nanoparticles have attracted significant attention in the biomedical field, triggering numerous research interests in evaluating their biological sensing, drug delivery, cancer therapeutics and molecular imaging abilities. Bare magnetic nanoparticles have limited biological application due to their restricted functions and aggregation. However, these limitations can be overcome by surface modification using suitable ligands required to facilitate their usage. Iron oxide (Fe₃O₄) nanoparticles were synthesized and coated with gold, a mild reducing agent was utilized to reduce gold while avoiding the formation of new gold nuclei. The nanoparticles were functionalized and bioconjugated to a UL apta 1 binding aptamer. The nanomaterial was characterized using various techniques including Fourier-transform infrared spectroscopy (FTIR), High-resolution transmission electron microscopy (HRTEM), High-resolution scanning electron microscopy (HRSEM), Raman spectroscopy and superconducting quantum interference device (SQUID) magnetometer. The synthesized gold coated nanoparticles were successfully conjugated the aptamer. Furthermore, the properties of the magnetic nanoparticles (Fe₃O₄) were not lost during coating with gold or conjugation of aptamer.

Keywords: Aptamer; nanoparticles; Breast cancer
Red Wine Gold Nanoparticles Efficacy on Prostate Cancer

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Abstract
This paper seeks to address the limitation of cancer therapeautics which is invasive, toxic with insufficiency of drug delivery to the target. Most recently, several diverse nanoparticles such as gold are usable due to their chemical stability and biocompatibility. However, their syntheses appear expensive involving toxic reducing agents. Hence preference is given to the alternative environment-friendly methods of green chemistry. Red wine, has been suggested to play a key role in the prevention of cardiovascular disease and other chronic pathologies, including cancer. Its regular and moderate consumption has been found in numerous epidemiological studies to correlate inversely with vascular disease and mortality, despite the presence of risk factors such as high consumption of saturated fats, elevated smoking and low physical activity. This phenomenon, known as the ‘French Paradox’, would be explained mainly by the high levels of polyphenols present in red wine, making it more advantageous than beer, spirits and even white wine. \textit{In vitro} studies showed that resveratrol inhibits cyclo-oxygenase-2 gene transcription, a factor favouring the growth of cancers. Experimentally, aqueous solution of HAuCl$_4$, 10$^{-3}$ M was reduced with red wine in a flask at room temperature. The wine served simultaneously as a reducing agent and a stabilizer of the solution. The changed color of the solution pointed to the formation of nanoparticles in it. In conclusion, Gold nanoparticles of different geometric shapes and sizes were synthesized which indicates the prospects of their application to target delivery of prostate cancer cells.

\textbf{Keywords:} Gold; Nanoparticles; Polyphenols; Wine
The Synthesis of Antimicrobial Peptide (Amp) - Loaded Chitosan Nanoparticles for Treatment of Sexually Transmitted Infections (STI’s)

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Abstract
Chitosan is an antimicrobial polymer from polysaccharide chitin. It has been used in pharmaceutical industries as a biomedical material because of its wound healing properties, biodegradability and biocompatibility. This natural polymer contains numerous hydrophilic components such as amino and hydroxyl groups in its molecular structure. Chitosan has mucus penetrating properties and also promote tissue growth. It can, therefore, be used for the delivery of microbicide peptides used for the treatment of sexually transmitted diseases (e.g. cervical cancer) that is caused by viruses such as Human Papilloma Virus (HPV). By using chitosan nanoparticles as delivery vehicles, microbicide agents can be delivered more efficiently. Peptides are among the main drugs which attract much attention because of their great potential in treating sexually transmitted diseases and other chronic diseases. There has been a major challenge of delivering these drugs in mucosal sites with low pH environment. The aim of this study is to synthesize acidic pH stable peptide-loaded chitosan nanoparticles that could penetrate mucus layers covering the epithelial cells and kill HIV virus. Peptide-loaded chitosan nanoparticles was synthesized by a crosslinking method called Ionic gelation with Sodium tripolyphosphate. A series of peptide-loaded chitosan nanoparticles with different concentrations of TPP were produced using medium molecular weight (MW) of chitosan. The nanoparticles were characterized by ultraviolet-visible absorption spectroscopy (UV-Vis), scanning electron microscopy (SEM), dynamic light scattering (DLS) and high resolution transmission electron microscopy (HRTEM). These nanoparticles were further exposed in different pH conditions to test their stability in the environment that mimic the vaginal mucus.

Keywords: Polymer nanoparticles, Ionic gelation, Kn2-7, Microbicides, pH stability.
Rule of Law and Climate Change Governance in Kenya

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Abstract
Climate variability in Kenya is recognized as a direct impact of climate change effects that are not only global but shared across different eco-systems. It is estimated that 95% of actions leading to adverse effects of climate change are associated with anthropogenic activities. This has led to erratic rainfall patterns, extreme and high temperatures in most unlikely places, besides unpredictable behavioural trends of water bodies, including signs of extended desertification. These are not necessarily new but an extension of failed governance in natural resources and environment. Most writers and experts have focused more on the absence or slow imposition of mitigation and adaptation mechanisms, which to a good extent is true. However, the bigger problem is related to how as country there has been failure to implement laws, policies and regulations of natural resources and environment. This study therefore, seeks to create a body of knowledge that impeach the culture of abuse of the rule of law, as the most demeaning factor for fast and ever-expanding negative effects of climate change. It is important to interrogate if this country has an appropriate legal and institutional framework to guard against negative impact of climate change. Secondly, to understand whether, the country has the necessary work ethic and attitude to prepare it in harvesting likely opportunities offered by climate change: In the context of this discourse, we argue that if the rule of law would have been followed to the letter, then effects of climate change would have been less magnitude. Particularly Mau Forest would still be intact, the rivers Tana and Athi would not be overflowing with sewer and other effluents, similarly our lakes including Victoria and Naivasha would have lesser receding rate. If as country we faithfully implemented the Constitution among other statutes on forests, water, land management and use, air and agreed to development that is well insulated against developmental inadequacies and excesses, then this country will have less impact of climate change.

Keywords: Climate change, law; Legal and institutional framework; Environmental protection; Natural resources management
Electrospun Zein/PVA/Mn$_2$O$_3$ Nanocomposite Fibers as an Adsorbent for Chrysoidine G from Aqueous Media

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Abstract
Azo-dyes are one of the problems of industrial effluent such as textile industries which contribute to the continuous deterioration of water quality causing severe health hazard problems, therefore development of nanomaterials exhibits great prospective in improving the efficiency of water purification. In this study Mn$_2$O$_3$ nanoparticles were synthesized by co-precipitation method and embedded into zein/PVA polymer fiber blends via electrospinning technique. The formation of the nanocomposites were confirmed by scanning electron microscopy which revealed that increment in concentration of nanoparticles resulted in improved morphology of the nanocomposite and the electrospinnability was enhanced. X-ray diffraction revealed the amorphous phase of the zein/polyvinyl (alcohol) fiber blends and small peaks of Mn$_2$O$_3$ nanoparticles. FT-IR confirmed the functional groups of Mn-O and Mn-O-Mn bonds which clearly indicated the formation of Mn$_2$O$_3$/zein/PVA nanocomposite. Adsorption studies were conducted using UV-Vis spectrophotometer and it revealed that the prepared nanocomposites material were efficient adsorbents for the removal of chrysoidine G (CG) dye in aqueous media and a promising approach for textile effluent.

Keywords: Polymer; nanoparticles; fiber blends; electrospinning and nanocomposites.
Analysis of Microbial Composition and Abundance in Drinking Water Sources in Narok Town, Kenya

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Abstract
River water, pan water and tank water meant for domestic use in Narok North sub-county, Kenya, was analyzed for bacterial abundance and diversity during the dry and wet seasons. Presence and quantity of microorganisms in drinking water is an indicator of its quality. Total coliform bacteria are the most commonly used indicators to assess water quality. In addition, presence of faecal coliform bacteria is evidence of contamination by faecal material and henceforth a health risk. Multiple tube fermentation method was carried out on the water samples and bacterial isolates identified. The total coliforms were found to range between $2.3 \times 10^1$ MPN/100ml and $1.1 \times 10^3$ MPN/100ml during the dry season and $4.6 \times 10^2$ MPN/100ml and $1.1 \times 10^3$ MPN/100ml during the wet season, respectively. Faecal coliforms ranged between $0.9 \times 10^1$ MPN/100ml and $3.9 \times 10^1$ MPN/100ml during the dry season and $2.3 \times 10^1$ MPN/100ml to $2.4 \times 10^2$ MPN/100ml during the wet season respectively. Bacteria isolated included *E. coli*, *Shigella* spp., *Enterobacter* spp., *Klebsiella* spp., *Citrobacter* spp., *Proteus* spp. and *Salmonella* spp. All the water sources under study contained bacteria with higher levels than the ones recommended by the WHO, EPA and KEBS. Proper waste management, separation of water pans meant for human and animal consumption and use of hygienically placed and maintained water tanks should be implemented in order to improve drinking water quality at the point of use and protect water sources from contamination.

Keywords: Total coliforms; faecal coliforms; bacterial diversity; domestic use; Public health.
Social Workers’ Roles in Palliative Care in Kenya

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Abstract
Social workers have made a significant contribution to the development and delivery of palliative care. Both palliative care and social work are rapidly evolving. Advances in treatment of life-threatening illness mean that people live longer in a period of palliative care. This paper aims to explore the current and potential role of the social worker in palliative care for people with cancer and other prolonged life-threatening illness. It is based on secondary data collected through review of studies, reports, policy documents and surveys from various data sets from national, regional and international organizations. Social workers play a leading role in the delivery of specialist palliative care, as heads of multidisciplinary teams in some cases. The role of the hospice and palliative social worker is often ambiguous and misunderstood by colleagues and fellow team members. One reason for this is the lack of identified, clearly delineated roles, skills, and tasks employed by these specialty social workers in their daily work. The study highlights six areas of concern in which social-work assessment and intervention will impact dying patients’ quality of life and that of their carers: loss and dependency, family-centered issues, carers’ needs, practical tasks, emotional and spiritual struggles, and finally, support needs of staff. As a way forward the study recommends that each medical facility in Kenya that handles terminally ill patients should have a social worker for psychosocial assessment, diagnosis and psychotherapy.

Keywords: Family-centered issues; Psychosocial assessment; Psychotherapy

Photocatalytic degradation of acetaminophen using polyene modified TiO\textsubscript{2} under visible light

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Abstract
The presence of pharmaceuticals in wastewaters, particularly acetaminophen a commonly used analgesic drug also known as paracetamol, is of great environmental concern. Titanium oxide (TiO\textsubscript{2}) is a well known photocatalyst for mineralization of many organic pollutants, however, its inability to absorb visible light radiation, limits its wider applicability. The present work focuses on the synthesis of conjugated polyene modified TiO\textsubscript{2} (CPE-TiO\textsubscript{2}) nanocomposite using a facile homogenized sol-gel procedure and the investigation of its photocatalytic activities under visible light. The coexistence of multiple bonds in polyconjugated carbon chain with a reduced band gap in CPE-TiO\textsubscript{2} composite does enhance charge separation and migration. After the synthesis, the materials were appropriately characterized and used in visible light photodegradation of 25mg/L paracetamol using LED-light as a source of visible light radiation. The results indicated that the visible light
range absorbance improved with CPE-TiO$_2$ in comparison with pure TiO$_2$. The Uv-vis DRS spectra of the CPE-TiO$_2$ showed a better absorption ability in the wavelength range of 400-800nm. Hence, CPE-TiO$_2$ nanocomposite exhibited higher photocatalytic properties as compared to pure TiO$_2$ under visible light. For the photocatalytic degradation of paracetamol using CPE-TiO$_2$, the results showed a significant increase (>90%) in degradation efficiency as compared to pure TiO$_2$ (<40%) and most of this analgesic drug was degraded within 210 min of visible light irradiation. The visible light range absorbance was improved by CPE-TiO$_2$ in comparison with pure TiO$_2$.

Keywords: Conjugated-polyene; Visible-light; Titanium dioxide; Photodegradation; Paracetamol

**Photodegradation of Methylene Blue using Bismuth Oxy-halide (Bi-OBr$_x$I$_{(1-x)}$) Nanomaterials**

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**Abstract**

Recent rise in environmental pollution has stimulated researchers to focus on new ways to break down pollutants into less toxic compounds. Photodegradation, which is an advanced oxidation process, has shown to be a better method in breaking down these pollutants. The main aim of this study is to investigate the synthesis and the photocatalytic activity of Bi-OBr$_x$I$_{(1-x)}$ nanomaterials towards the degradation of methylene blue dye. A series of hierarchical bismuth oxyhalides (BiOBr$_x$I$_{(1-x)}$) nanomaterials were prepared via hydrothermal method. To test for the photocatalytic activity of the as-prepared nanoparticles, 40 mg of the photocatalyst was dispersed in methylene blue solution (60 mL, 10 mg/L). Prior to exposure to ultraviolet irradiation, the mixture was stirred in the dark for 30 min to establish the adsorption-desorption equilibrium. The mixture was then exposed to ultraviolet irradiation for degradation process, which was monitored using a UV-Visspectrophotometer. Compared to the individual BiOBr and BiOI, BiOBr$_{0.8}$I$_{0.2}$ showed the highest photocatalytic activity with 95.1% degradation of the methylene blue dye after 120 min of irradiation. The result shows that engineering of the band gap via doping affects the activity of the nanoparticles. From the study it can be concluded that BiOBr$_{0.8}$I$_{0.2}$ is an effective material
in the treatment of methylene blue under ultraviolet irradiation and thus holds huge promise in environmental remediation.

Keywords: Heterogeneous; Methylene blue; Nanomaterials; Photocatalysis; Ultraviolet

Primary Healthcare Services and Sustainable Development in the 21st Century: Impacts and Challenges in Kenya

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Abstract

Primary healthcare is well-positioned to respond to rapid economic, technological, and demographic changes, all of which impact health and well-being, it is the bedrock of any nation; no nation could strive to sustainable development without reference to structures and policies that promotes primary healthcare. The paper provides measures towards ameliorating inadequacies and urges to relevant stakeholders to consider the recommendations for policy design. It is based on content analysis and fact-finding on Kenya to gain insights from key stakeholders in the Kenyan healthcare sector as a potential valuable partner. Mortality rate is evidenced to be increasing due to factors outside the health sector (such as, water and sanitation, education, economic growth). The paper proves Primary healthcare to be a highly effective and efficient way to address the main causes and risks of poor health and well-being today, as well as handling the emerging challenges that threaten health and well-being of tomorrow. It also shows it to be a good value investment, as there is evidence that quality primary healthcare reduces total healthcare costs and improves efficiency by reducing hospital admissions. In addition, stronger primary healthcare would be essential to achieving the health-related Sustainable Development Goals (SDGs) and universal health coverage. It will also contribute to the attainment of other goals beyond the health-related goals of SDGs, including those on poverty, hunger, education, clean water and sanitation, work and economic growth.

Keywords: Kenya health sector; Policy design; Universal health coverage; Stakeholders
Antimicrobial Activity of Titanium Dioxide Nanoparticles Immobilized on Electrospun Polyacrylonitrile-Cellulose Acetate Polymer Blended Nanofibers

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Abstract

The issue of contaminated water with microorganisms has become a threat to both the physical and social health of living organisms. Nanotechnology brings greater hope to offering new improved antibacterial agents that are very effective with minimal side effects. Hence, in this study, the sol-gel method was used to synthesize the TiO₂ nanoparticles at different calcination temperatures and those nanoparticles were immobilized on polyacrylonitrile-cellulose acetate (PAN/CA) polymer blended nanofibers using the electrospinning technique. The immobilization of TiO₂ on polymer substrate enhanced the antibacterial properties of the TiO₂ nanoparticles. Electrospinning of polymer blends improves poor chemical, thermal and dynamic mechanical properties of each polymer. In this study, 10 wt% of PAN and 16 wt% of CA were blended together and the optimum blend ratio was found to be 80/20 PAN/CA. TiO₂ nanoparticles (1, 2 and 3 wt%) were incorporated into PAN/CA blended polymers using applied voltages of 22 kV at a spinning distance of 15 cm. The fabricated nanocomposite was tested for antimicrobial activity against selected microorganisms. The synthesized nanomaterials were characterized using SEM, TEM, EDX and FTIR. TEM showed the spherical morphology of the nanoparticles with average diameter of 12.2  nm for nanoparticles calcined at 500 °C. SEM illustrated the diameter of nanofibers and composites with the average diameter of 220, 338,538 and 294 nm for PAN, CA, PAN/CA and PAN/CA-TiO₂, respectively. FTIR and EDX signified the presence of TiO₂ nanoparticles on the PAN/CA-TiO₂ composite corresponded to the Ti-O stretching and Ti-O-Ti bands on FTIR.PAN/CA-TiO₂ revealed antibacterial activity against selected microorganisms.

Keywords: TiO₂ nanoparticles; PAN/CA polymer blend; Incorporation; Electrospinning and Antibacterial activity
Removal of CU$^{+2}$ Ions from Domestic Water Using Extracted Cellulose From *Typha Augostifolia*

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Abstract
The source of safe drinking water is diminishing the world over due to contaminations from agrochemicals, endocrine disrupters and synthetic effluents from industries due ever-increasing human pressure. The drylands are even more affected by contaminations due to lack of reliable rainfall whereby the inhabitants in this area depend on the water pans for both domestic and agricultural purpose. These water pans are a source of contaminants and hence there is need of preventing the contamination. This study used extracted cellulose from *Typha augostifolia* for removal of Cu$^{+2}$ ions using AAS and batch experiments were done to determine the type of adsorption isotherm and kinetics involved. The results showed adsorption maxima at pH 6 and both adsorption isotherm where applicable even though the Langmuir was more pronounced.

Keywords: CU$^{+2}$ Ions; Domestic Water; Extracted Cellulose; *Typha Augostifolia*

An Assessment of Environmental Impacts of Quarrying: The Case of Narok Town

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Abstract
Environmental conditions of quarries in developing countries are not favourable. Therefore, there is need of analyzing the Kenyan situation on environmental impacts of quarrying. There being few studies conducted in Kenya relating to the same, more so in Narok county, the researcher developed the need to assess the environmental impacts of quarrying during their daily quarrying activities, specifically in Narok town ward in Narok county. The objectives were to determine the environmental impacts of quarrying in Narok town, Kenya. The study area of the project was Narok town ward and the target population was 28 respondents. Out of the 28 respondents, 25 individuals were used as the sample size.
The sampling techniques used were simple random sampling and purposive sampling. The instruments used in data collection were questionnaires, interviews, and observation. The findings indicated that workers did not have protective gears necessary for their working resulting to health risks caused by factors such as; exposure to dust, noise and vibrations produced in the quarries. Injuries were caused by accidents in the when the mines collapse. It was also observed that the quarry workers were not aware of adverse health effects that they may encounter. The quarry workers also lacked insurance covers denying them a chance to access proper medical care in case of illnesses or injuries. Most of them preferred buying over-the-counter drugs that are likely to be wrongly diagnosed. It was recommended that the County government of Narok should get more involved with quarry workers and even provide them with protective gears.

**Keywords:** Quarrying; Environmental Conditions; Health Effects; Narok Town

**Antimicrobial Potential of Solanum muricatum, Conyza canadensis and Aster subulatus Extracts against Bacteria and Fungi**

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**Abstract**

Antimicrobial resistance to antibiotics poses a global challenge to human and animal health as well as that of the environment. The objective of this study was to determine the antimicrobial potential of Solanum muricatum, Aster subulatus and Conyza canadensis extracts. Bioassay was done in Maasai Mara University to determine the inhibition zone of *Escherichia coli* Staphlococcus aureus and Candida albicans. The results showed that all these plant extracts exhibited antimicrobial properties against *E. coli* S. aureus and C. albicans. Fresh leaves of *A. subulatus* against *S. aureus* had inhibition zone of 9.2mm and 9.0mm against *E. coli* while fresh stem of *S. muricatum* against *S. aureus* had 9.6mm and 9.3mm for *E. coli*. The leaves of *C. canadensis* exhibited antifungal properties against *Candida albicans* with an inhibition zone of 7mm.

**Keywords:** Antimicrobial; Antifungal; Extracts and Inhibition

**Hexavalent Chromium Adsorption onto Magnetite-Pine Cone composite: A Mechanistic Study**

Immaculate L.A. Ouma*, Augustine E. Ofomaja and Eliazer B. Naidoo
Abstract
The high toxicity and mobility of hexavalent chromium [Cr(VI)] in the environment poses a challenge during remediation of contaminated water. Most techniques applied in wastewater treatment have suffered drawbacks due to high costs and complex operations. Adsorption makes use of low-cost materials with the potential of pollutant sequestration and employs simple operation procedures. The mechanism of Cr(VI) adsorption has however not been fully explored and reported. A composite material consisting of magnetite particles and pine cone powder was prepared and used in the adsorption of Cr(VI), the study focused on the determination of the mechanistic pathway of the adsorption process and the regeneration potential of the adsorbent material. The mechanism was determined to be adsorption-reduction coupled where toxic Cr(VI) ions were reduced to less toxic Cr(III) ions on the adsorbent surface. The adsorbent was regenerated by desorption using NaOH and was subsequently re-used three times maintaining more than 85% of its initial sorption capacity.

Keywords: Desorption; Regeneration; Remediation; Toxicity
Promoting Tree Planting for Climate Change Mitigation as a Platform for Public Education and Community Outreach Programme for Environmental Conservation in Narok County

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Abstract

Globally, the forest cover is estimated at 21.4% while in Africa, it is approximately 9.3%. In Kenya, forest cover is a measly 1.7%, way below Africa’s and global averages. Most of Kenya forests are in her protected water towers, including the Mau Forest Complex (MFC). The MFC is a critical ingredient of the Mara-Serengeti ecosystem, which supports countless wildlife, local and national economies through wild-based tourism, both in Kenya and Tanzania. However, the MFC has witnessed immense environmental degradation in the recent past due to the burgeoning human population. The situation is not dissimilar in the wider Narok County, where part of the MFC falls. Consequently, many hitherto natural areas have been, and continue to be, converted into small- and large-holder farms, pastoral lands, and human settlements. The resulting environmental degradation, especially from wind- and rain-driven soil erosion, is unprecedented in scale. To help in mitigating some of the adverse anthropogenic impacts, including climate change, on the environment, we established a tree nursery at Maasai Mara University. Specifically, the project seeks to inculcate environmental conservation values in local schools and communities through tree planting, and robust public education and community outreach programmes. The role local communities and school children/students can play in environmental conservation and challenges to environmental conservation are identified and discussed. The project recommends that Narok County establishes specific Habitat Action Plans to spearhead management and conservation of forests, wetlands, grasslands, and other critical habitats for the persistence of biodiversity and local livelihoods dependent on healthy ecosystems.

Keywords: Environmental conservation; Forest cover; Mau Forest Complex; Habitat Action Plans; Tree planting
Investigating the Quality and Quantity of Briquettes Fuels Prepared from Waste Bones

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Abstract
Meat consumption is increasing day by day both in the developed and developing countries, this has led to proportionately increased accumulation of waste bones in the environment, the waste bones lack immediate industrial uses. The accumulated waste bones have result into adverse impact on land, air and water. There is a need to mop out waste bones from the environment in a valuable product. This research project investigated the quality and quantity of briquettes fuel prepared from waste bones. The waste bones were carbonized (pyrolysis process) in a metal kiln, yielded 80\% bone char. The bones char and binder were characterized by the Infrared spectroscopy and their physical parameters were analyzed: the bone char recorded 4.17\% moisture Content (MC), 40.83\% Ash Content (AC), 23.67\% Volatile Matter (VM), 31.33\% Fixed Carbon (FC) and calorific value (CV) of 18.6842 kJ/g and the binder 4.25\%MC 89.5\%AC, 5.0\%VM, 1.85\%FC and calorific value of 2.2755kJ/g. Three samples of the briquettes were prepared (75\% binder: 25\% bones char, 40\% binder: 60\% bones char and 20\% binder: 80\% bones char) and recorded; 6.0792 kJ/g, 12.8869 kJ/g and 13.9085 kJ/g respectively. In conclusion bone char can be used to prepared briquettes fuels which can be used as substitute of the charcoal fuels. More research to be conducted on the level of particulates emitted and their composition during the carbonization of bone waste and how to curb them.

Keywords: Briquettes; Bone char; Binder; Calorific value; Fixed carbon content
Management and use of Renewable Energy and other New Advanced Technologies in the Drylands and Wetlands

Combined Ozonolysis Pre-treatment and Anaerobic digestion of Municipal Waste Activated Sludge

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Abstract
Municipal wastewater generated from different domestic sources such as toilets, showers, and the kitchen is widely treated through the activated sludge treatment (AST) process, with waste activated sludge (WAS) generated as a major by-product in large amounts. The WAS consists majorly of biomass from cell growth and decay, and odorous and volatile organic compounds, thus posing the risk of secondary environmental pollution. Handling of WAS has been a major challenge legally, environmentally, and economically. Moreover, anaerobic digestion (AD), the preferred treatment technique, is hindered by the low biodegradability of WAS. Introduction of a pre-treatment step such as ozonolysis that would enhance WAS biodegradability is therefore necessary. In the current study, ozonolysis pre-treatment in a fluidized bed reactor followed by anaerobic digestion in an upflow sludge blanket anaerobic (UASB) reactor were carried out for WAS treatment. Ozonolysis pretreatment solubilized the extracellular polymeric substances (EPS) in WAS thereby re-
leasing the biodegradable cellular contents and increasing the biochemical oxygen demand (BOD$_3$) from 1 520 to 3 520 mg/L. The soluble chemical oxygen demand (COD) increased from 1 700 to 2 300 mg/L with a corresponding increase in dissolved organic carbon (DOC) from 155 to 245 mg/L. Also, the BOD$_3$:COD ratio significantly improved from 0.06 to 0.16, confirming improved biodegradability. In the ensuing anaerobic process, WAS pre-treatment led to improved reduction of the total suspended solids and COD and a 230% increase in the cumulative biogas production. A combined ozonolysis-anaerobic process, with ozonolysis as a pre-treatment is thus a promising technique for WAS treatment.

**Keywords:** Ozone; Solubilisation; Suspended Solids; Biodegradation; Biogas

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**A Compact Decentralized System for Wastewater Treatment for Re-use in Remotely Located Higher Learning Institutions and Settlements**

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**Abstract**

Many higher learning institutions in Africa are not connected to municipal sewer line because most of them are located away from urban centres. As a result, most of the institutions rely on their own wastewater treatment facilities. Constructed wetlands and maturation ponds have been widely used but these facilities do not treat wastewater to quality fit for agricultural re-use and often emit unpleasant odour. A technology called SPRAS (sludge reduction activated sludge process) has been introduced to help in the treatment of wastewater to a quality suitable for agricultural re-use without odour and sludge production. Performance analysis of a SPRAS plant installed at Glen College, in South Africa has confirmed the suitability of the technology for remotely located institutions and settlements. The treated wastewater is used for irrigation with COD <25 mg/l, ammonia <2 mg/l, nitrate <15 mg/l, phosphates <5 mg/l, sulphates <2 mg/l, suspended solids <25mg/l, E. coli and Coliform <10 counts/100ml. Assessment of sludge in the SPRAS digester over a period of two years showed a constant value of about 33% v/v indicating that there is no sludge build up, therefore no need for desludging. The power consumption of the SPRAS plant is 0.54 kWh/m$^3$ which is less than the expected average of 1 kWh/m$^3$ for conventional wastewater treatment technologies. SPRAS technology is therefore effective for decentralized wastewater treatment and the use of the treated wastewater for irrigation makes it suitable for adoption in water stressed areas.
Keywords: SPRAS Technology; Wastewater treatment; Wastewater re-use; Irrigation

Production of biomass briquettes from *Eichhornia crassipes* ((Mart.) Solms) and *Eucalyptus globulus* (Labill.) leaves

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Abstract
Dried *Eichhornia crassipes* biomass was ground into <5mm particle size powder then mixed with pulverized *Eucalyptus globulus* leaves in the ratio of 4:1. Water was added to the mixture and put in the briquetting machine. The produced briquettes were sun-dried and their compressed density, relaxed density, water resistance, durability and calorific value evaluated. A compressed density of 0.55g/cm³ and a relaxed density of 0.51g/cm³ were obtained. A relaxation ratio was 1.08, indicating that the briquettes were stable in form and structure. Water resistance capacity was 45%, while durability was 66.34%, thus indicating ease of disintegration in humid conditions and low ability to withstand mechanical handling. The calorific value of the biomass briquettes was 1090.43kj/kg, compared to 1422.97kj/kg of charcoal. With these promising results, and further in-depth scientific studies, the biomass briquettes may be very efficient and effective source of bioenergy, particularly for communities dependent on charcoal.

Keywords: Bioenergy; Briquettes; *Eichhornia crassipes*; *Eucalyptus globulus*; Charcoal
Synthesis, Preparation and Characterization of Silver Sulfide, Silver Selenide and Silver Telluride Nanoparticles with their Polymer Nanocomposites

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Abstract
Nanoparticles of silver sulfide, silver selenide and silver telluride have attracted attention in the scientific community for their chemical and physical properties. Many methods have been used to synthesize nanoparticles, but these methods involve the use of high temperatures and reagents which are toxic. Hence, there is an ongoing search for environmentally friendly methods to synthesize nanoparticles. In solution, bare nanoparticles are thermodynamically unstable and tend to agglomerate. As a result of this, protection of the surface of the nanoparticles is needed in order to prevent agglomeration. Polymers such as polyvinyl alcohol and chitosan are used as capping agents to prevent agglomeration. However, polymers do not only control the growth of nanoparticles. They can also be used to modify the surface of the nanoparticles. Surface modification of nanoparticles can be of great interests for possible use in water treatment application. This work reports on the synthesis of silver sulfide, silver selenide and silver telluride nanoparticles capped with polyvinyl alcohol for control growth and together with chitosan to modify the surface of the nanoparticles for possible use in water treatment. The nanoparticles were synthesized using water as a solvent in the presence of sodium borohydride as a reducing agent, silver nitrate as silver. Ultraviolet-visible spectroscopy confirmed the formation of the nanoparticles and polymer nanocomposites. Fourier transform infrared spectroscopy confirmed the presence of the functional groups of polyvinyl alcohol and chitosan on the synthesized nanoparticles and polymer nanocomposites. On the basis of synthesis, the mechanism formation of the polymer nanoparticles is discussed.

Keywords: Characterization; Silver sulfide; Silver selenide; Silver tell; Polymer nanocomposites
The Preparation and Catalytic Activity of Iron-oxide Silica Nanofibers for the Fenton Degradation of Methylene Blue

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Abstract
Industries utilize many species of synthetic dyes that are found in their wastewater, which is passed out in the environment. Methylene blue is one of the organic dye that plays a role in water pollution. It course damage to the aquatic eco-system and health problems to human. It is non-biodegradable due to its chemical nature and aromatic structure. Therefore Method have been developed for the degradation of these dyes, however some of these methods are limited due to their high cost and low efficiency. Among these methods catalysis has been proven to be an effective method due to its low cost, high efficiency, and its re-usability. Therefore in this work iron oxide based catalyst supported on silica nanofibers were fabricated via electropinning of silica sol incorporated with iron oxide, using three different route the silica sol incorporated with iron oxide nanoparticles, direct addition of iron precursor to the sol and incipient impregnation. The effect of iron oxide concentration loading and calcination was studied on the fibers diameter. The product was characterized using Scanning electron microscope (SEM), X-ray diffraction Patten (XRD) and Fourier Transform Infrared spectroscopy (FTIR). The SEM results showed a decrease in fiber diameter with an increase in voltage and a further decrease upon calcination. XRD showed a crystalline phase of magnetite. The degradation of methylene blue was monitored by UV-vis spectroscopy, where the Fenton catalytic activity of the iron-oxide supported on silica nanofibers showed some improvement compared to the unsupported material with higher activity.

Keywords: Iron oxide-silica nanofibers; Fenton degradation; Methylene blue; Electro-spinning
Leveraging on the Language of the Catchment Area for the Use and Management of Renewable Energy in North Rift, Kenya

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Abstract
Kenya is blessed with year-round sunshine and is quickly waking up to realization that she can successfully tap into one of the vast natural resources on the planet-the sun. Dry lands in comparison with wet lands offer great opportunities for large-scale generation of energy from renewable source. However, renewable energy in these areas is not being used to full capacity due to language barrier in disseminating the findings to the target group. The business men, scientists and the academia have the information in complex language in their business premises, science laboratories, books, shelves and archives. Therefore, there is need for scientists to package their researches and innovations on use and management of renewable energy in the language of wider communication so as to reach the target group. Hence, this study purposed to bridge the gap with the sole objective of leveraging on the Language of the Catchment Area for knowledge on use and management of renewable energy in dry lands of the North Rift Region. The methodology focused on secondary information on sustainable use and management of renewable energy. The innovations and findings on renewable energy though in use have not been utilized fully by intended beneficiaries due to language barrier. Therefore, we recommend that the information about the products be communicated in the language best understood by prospective users.

Keywords: Language; Communication; Renewable Energy; Catchment Area
The Effect of Fe/Mn ratio on a Bimetallic Oxide Heterogeneous Catalyst supported on Silica for the Degradation of Methylene Blue

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Abstract
Water contaminated with hazardous organics like methylene blue is becoming increasing problematic with industrialisation. These organics resist biodegradation, therefore the removal of such organic contaminants is of importance by the use of the Fenton oxidation degradation reaction. An active heterogeneous Fenton-like catalyst is required, thus the aim of this research is to increase the activity of an iron oxide based Fenton catalysts. Literature has showed that a bimetallic oxide catalyst is more active than a monometallic iron oxide. The catalyst were prepared with incipient wetness and calcined in either a conventional oven or microwave oven. Microwave calcination yielded a more active catalyst. Bimetallic oxide catalysts were prepared by combining oxides of manganese, cobalt and copper with iron oxide. The manganese-iron bimetallic catalyst was found to be the most active. The relative amounts of manganese and iron oxide were varied while keeping the total metal content in the catalyst the same. The optimum ratio of Fe to Mn was 1:7.5 since it yielded the most active catalyst. A 96.6 % removal of methylene blue was achieved after 1 hr of degradation.

Keywords: Bi-metallic oxide catalysts; Calcination; Degradation; Fenton reaction; oxidation reaction
Ab-Initio Study of Electronic Structure and Thermoelectric Properties of an \( \text{XY}_2\text{Z}_2 \) Material for Waste Heat Recovery

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Abstract
Thermoelectric (TE) materials convert temperature gradients directly into electricity and vice versa. They have received renewed interest for waste heat recovery and refrigeration applications. Their outstanding reliability due to the lack of moving parts makes them attractive candidates for a series of applications. However, today's thermoelectric devices are limited by their low efficiency and high costs. The electronic structure, electrical conductivity, thermal conductivity, carrier mobility, Seebeck coefficient, density of states, band structure and figure of merit of an \( \text{XY}_2\text{Z}_2 \) material were calculated using computational methods. All calculations on the material will were within the Density Functional Theory (DFT) framework and a plane wave basis set as implemented in the Quantum ESPRESSO and VASP codes. The Projector Augmented-Wave pseudopotentials was used to describe the core-valence electron interaction with PBE chosen for the exchange–correlation functional. The temperature dependent properties including thermoelectric transport properties were calculated using VASP code and analysed using the PHONOPY code. A comparison with previous DFT and Experimental studies were done. The figure of merit for the material was found to improve by 5%. The results obtained may lead to fabrication of devices that convert waste heat energy to electricity for domestic and commercial use.

Keywords: Band Gap; Figure of Merit
Research on Sustainable Development of Industrial Parks in Africa: A Case Study of Ethiopia

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Abstract
In recent years, the industrial parks model of industrialization has gradually been recognized and valued by Ethiopia. By 2018, 22 industrial parks have been planned and built in Ethiopia. The rapid development of industrial parks has significantly promoted the economic and social progress of Ethiopia in terms of attracting foreign direct investment, increasing employment opportunities, technological progress, government revenue, and industrial development. However, the development of the Ethiopian parks is also facing challenges such as inadequate infrastructure, imperfect policies and lack of skilled workers. In the future, Ethiopia should start from improving infrastructure conditions and policy environment, and take measures such as increasing investment in education to create a favourable environment and conditions for the sustainable development of industrial parks.

Maasai Mara University Impact in Knowledge Sharing on Renewable Energy for Sustainable Development to Narok County, Kenya

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Abstract
Universities serve as a hub in knowledge generation which is the main driver for a sustainable economic growth. The National Environment Management Authority (NEMA) continues to foster a green development pathway for Kenya. Maasai Mara University being a public university in Narok County it is expected to influence the community in knowledge sharing and dissemination on various research outputs. Through the establishment of the Center for Innovation, New and Renewable Energy, Maasai Mara University has facilitated the use of green energy. With only 46% of the Kenyan households having access to electricity, 54% of the population makes use of non-renewable energy sources for their daily needs. This means that most Kenyans continue to use non-renewable energy presumably due to lack of knowledge for an alternative. Narok County counted as a marginalized county in Kenya, benefited from International Development Association (IDA) where $150 million grant was issued via the World Bank to promote access to modern energy. The Kenyan government through Rural Electrification Programme, has come up with the National Electricity Policy aimed at increasing the deployment of renewable energy. With
such concerns, there is need to determine whether or not universities actualize their role of sharing information including that of renewable energy to the community. This study adopted a descriptive survey design. The target population was 11,776 households in Narok Town sub location. With the use of stratified sampling technique, the sample size used in the study was 4122 households being 35% of the number of households in the area. Primary data was collected using open ended and closed questionnaire. The study revealed that 56.6% of the Narok Town residents were not aware of renewable energy sources. Only 17.6% of the households were able to be influenced on green energy choices by Centre for Innovation, New and Renewable Energy at Maasai Mara University. The study further indicates that 47.9% of the households would prefer seminars as the appropriate method for universities to share knowledge on renewable energy. The study therefore recommends that Institutions of higher learning should be on the forefront to influence green energy to surrounding communities.

**Keywords:** Universities; Knowledge Sharing; Renewable Energy; Maasai Mara University
ACADEMIC SCHOOLS

School of Arts & Social Sciences

Dr. Nancy Ayodi Kahaviza (Dean)

The School Arts and Social Sciences houses three Departments; Department of Languages, Linguistics and Culture, Department of Social Studies and Department of Media, Film and Communication. Currently, we have a population of 2103 students. The School delivers a variety of Postgraduate, Undergraduate and Diploma programmes. Delivering these programmes is a team of qualified competent teaching faculty and administrative staff that work together as a synergy. The School is a hub of Innovative teaching, Research and Community development. We welcome you to partner with us.

School of Business & Economics

Dr. Patrick Gudda (Dean)


School of Education

Dr. Beatrice Manyasi (Dean)

The School of Education participates in several activities to guarantee innovative teaching, research and consultancy services to ensure realization of the university niche: Environmental Resource Management and Conservation. It offers market driven programmes at both undergraduate and postgraduate levels. It is aligning the Teacher Education programmes to address the needs of the Competency Based Curriculum introduced at basic education level which focuses on acquisition of skills and global values including Environmental Education for sustainable development.
School of Science & Information & Sciences

Dr. John W. Matuya, PhD (Dean)

The School has three departments namely; Mathematics and Physical Sciences, Computer and Information Sciences and Biological Sciences. These departments offer undergraduate and postgraduate programmes. The School has a dire need for laboratories for each programme area to cope with the increasing numbers of students in Science and Technology. We welcome you to partner with us for attachment of our students, internships and Scholarships.

School of Tourism and Natural Resources Management

Prof. Aggrey D. M. Thuo (Dean)

The school offers premier undergraduate and post-graduate programmes that train leaders through experiential training, fieldwork and practical learning. The school is dedicated to offering training, research and consultancy services in the following specializations: earth sciences, GIS and remote sensing, environmental management, urban and regional planning, animal health and production. We are setting the agenda in the achievement of Sustainable Development Goals and the Big 4 Agenda through scholarly excellence.

School of Health Sciences

Ms. Jaqueline Mulongo Naulikha, (Ag. Dean)

The mission of the School of Health Sciences is to provide scientifically-based education programs to prepare students as proficient, caring health professionals engaged in evidence-based practice, advocacy, service, and life-long learning. We accomplish our mission through the following programs, Nursing and Nutrition. Within these programs, we offer Certificate, Diploma and undergraduate learning opportunities. We have well equipped modern simulation laboratories dedicated, caring, and responsive faculty and staff that ensure students’ academic experiences are of the highest quality.
School of Tourism, Hospitality & Leisure Studies (STHLS)

Dr. Erick V.O. Fwaya (Dean)

The School of Tourism, Hospitality & Leisure Studies is a new School which currently offers Diploma in Tourism and Wildlife Management, Bachelor of Hotels and Hospitality Management, Bachelor of Tourism Management, and Bachelor of Parks, Recreation and Leisure Management. Additionally, the School is in the process of developing two Master’s programs: Tourism Management and Hospitality Management. The STHLS aspires to become a symbol of excellence in tourism, hospitality and leisure studies in Kenya and globally.

University Library

Ms. Nancy Kimile (University Librarian)

Welcome to the Maasai Mara University Library which is the heart or the nerve center of the University as it supports all the academic programmes through the provision of pre-requisite hybrid resources. The library has also established an institutional repository which organizes local content for ease of access and retrieval. The local content includes lecture publications, conference proceedings and abstracts among others.

DIRECTORATES

Directorate of Innovation, New and Renewable Energy

Dr. Aloys Mosima Osano-PhD, (Director)

The Centre was established to foster the development of Renewable energy and Innovation platforms, within the University and surrounding environs. This is in view of spurring growth of new energy technologies, green energy use and innovations growth in the region as a route to conserving the environment, and industrial growth. The Centre is a hub of activity which provides clean energy fuels for domestic and industrial use and process of enhancing energy cyclic models in promoting SDGs No. 7, 9 and 13. This will go a long way in providing alternatives to charcoal and firewood use. The ripple effect will be a sustainable solution to vegetation restoration and conservation in line with achieving the SDG No. 15.
Directorate of Institute of Ethnobiology and Ethnomedicines

Prof. Dr. Wycliffe Wanza, PhD, AMATINER, MACSE, MISE, FASI.

The Institute is currently focused on developing The African Medicinal Botanical Garden (AMBG) as part of a national heritage facility for in-situ and ex-situ conservation of flora and fauna, filming industry, video recording and shooting, nature trail, picnics, etc. Plans to establish Honey Production Unit as well as Tree Nursery Production Unit, are in advanced stage. The Institute is also starting Farmers’ Field School (FFS) to help train Ethnopractitioners and support establish a Herbal Factory.

Directorate of Students Records and Fee Compliance.

Mr. Samwel Ndaita Bangara (Director)

The Directorate of Students Records and Fee Compliance was effectively established from 2nd June, 2017. Reporting to the DVC (A & SA), the Directorate is tasked with the responsibility of reconciling student financial records to ensure strict compliance with fee payment timelines as

Directorate of Board of Postgraduate Studies

Dr. Kodak Bernard (Director)

The Board of Postgraduate Studies is charged with the responsibilities of admission, training and examination of postgraduate students in the broad fields of Sciences, Humanities, Education, Environmental Studies, Tourism and Hospitality. Our students are actively engaged in research and knowledge dissemination. We apply quality standards as determined and guided by the University Senate, Commission for University Education and National and International Regulatory Bodies.
**Directorate of Examinations and Timetabling**

**Mr. Maera John (Director)**

The Directorate was established in July 2016 with aim of coordinating teaching and Examinations. It ensures that the Teaching and examination Timetables are prepared and posted to the website as per set procedures. It facilitates internal and external processing of draft question papers and results as scheduled by Senate. The processing, packaging, safe-keeping and distribution of end of semester examinations is part of its responsibility. It coordinates the printing and issuance of certificates to graduates. Further, it regulates rooms non-academic activities in the university.

**Directorate of Quality Assurance**

**Ms. Elizabeth Wakoli (Ag. Director)**

Welcome to the Directorate of Quality Assurance (QA) where its major role is to coordinate and monitor implementation of the University Quality Policy and Compliance of the University to Commission of University Education standards. The Directorate monitors quality teaching and Examination processes, Conduct internal quality assurance audits among other quality initiatives. It liaises with Deputy Vice Chancellor Academic and Student Affairs, Deans and Chair of Departments to ensure involvement in quality assurance matters related to learning and teaching.

**Directorate of Gender, Equity and Culture**

**Dr. Zeddy Lemein (Director)**

The Directorate was established with an aim of harmonizing Gender Mainstreaming and monitoring progress towards Gender equality to nurture the virtue of inclusivity and creation of a fair and just Society in the University. The Directorate is responsible for development of Gender Mainstreaming policies and programmes and carrying out periodic gender audit on staff characteristics to ascertain gender compliance within the University.
Marketing and Public Relations

Ms. Nchoe (Director)
The Marketing and Public Relations Directorate focuses on enhancing the visibility of the University both locally, nationally and internationally by driving brand awareness through different marketing and public relations activities. The Directorate facilitates advertisements of University academic programmes and functions in different media platforms including Television, Radio, Newspapers, social media and on the University website. The directorate has also developed and strengthened University/Community linkages and partnerships.

Directorate of E-Learning

Prof. A. Wasike, (Director)
E-Learning involves the use of learning by utilizing electronic technologies to access the educational curriculum outside of a traditional classroom setting. In most cases, it refers to a course, program or degree delivered completely online. For instance, presently at the Maasai Mara University, it is implemented for some students enrolled in some courses being offered by various academic schools. This enables them to interact with their lecturers and/or tutors via media, LMS platform, etc.

Directorate of Endowment Fund

Prof. Kitche Magak, (Director)
The Directorate envisions collaborations and partnerships with individuals, businesses institutions and corporations to support activities that will continuously increase income-generating projects to supplement the government-limited funding. The objective of this Directorate is to creatively look for new sustainable ways of mobilizing resources through the establishment of an endowment fund. Consequently, the fund expected to guarantee a constant revenue flow to support Maasai Mara University’s teaching and research functions.
Applications are invited from suitably qualified candidates for admission into the following programmes offered at the Maasai Mara University.

SCHOOL OF EDUCATION

Ph.D Programmes
- Ph.D in Educational Administration
- Ph.D in Educational Curriculum and Media Studies
- Ph.D in Educational Psychology
- Ph.D in Educational Guidance and Counseling
- Ph.D in Educational Curriculum Studies

Masters Degree Programmes
- Master of Education (Guidance & Counseling)
- Master of Education (Educational Administration)
- Master of Education (Early Childhood Development)
- Master of Education (Philosophy of Education)
- Master of Education (Special Needs Education)
- Master of Education (Educational Psychology)
- Master of Education (Curriculum Instruction & Media)
- Master of Education (Sociology of Education)
- Master of Education (History of Education)
- Master of Education (Curriculum Studies)
- Master of Education (Comparative Education)
- Master of Education (Executive) in Leadership and Policy Studies

Undergraduate Degree Programmes
- Bachelor of Education (Arts)
- Bachelor of Education (Science)
- Bachelor of Education (Early Childhood Development Education)
- Bachelor of Education (Arts) with Special Needs Education
- Bachelor of Education (Science) with Special Needs Education
- Bachelor of Education (Arts) with Guidance and Counseling
- Bachelor of Education (Science) with Guidance and Counseling

Diploma Programmes
- Diploma in Education (Primary Option)
- Diploma in Early Childhood Development Education
- Diploma in Education (Arts)
- Diploma in Education (Science)

SCHOOL OF SCIENCE & INFORMATION SCIENCES

Ph.D Programmes
Ph.D in Chemistry
Ph.D in Pure Mathematics
Ph.D in Physics
Ph.D in Applied Mathematics
Ph.D in Applied Statistics

Masters Degree Programmes
- Master of Science in Chemistry
- Master of Science in Pure Mathematics
- Master of Science in Physics
- Master of Science in Applied Statistics
- Master of Science in Information Science
- Master of Science in Applied Mathematics
- Master of Science in Computer Science
- Master of Science in Applied Entomology

Undergraduate Degree Programmes
- Bachelor of Science in Computer Science
- Bachelor of Science in Information Science
- Bachelor of Science in Applied Statistics with Computing
- Bachelor of Science in Botany
- Bachelor of Science in Chemistry
- Bachelor of Science in Zoology
- Bachelor of Science in Physics
- Bachelor of Science in Mathematics
- Bachelor of Science in Microbiology

SCHOOL OF ARTS & SOCIAL SCIENCES

Ph.D Programmes
- Ph.D in Kiswahili
- Ph.D in Linguistics

Masters Degree Programmes
- Master of Arts in Kiswahili
- Master of Arts in Public Policy & Administration
- Master of Arts in Religious Studies
- Master of Arts in Linguistics
- Master of Arts in Philosophy
- Master of Art Social Work

Undergraduate Degree Programmes
- Bachelor of Arts in Community Development
- Bachelor of Arts in Political Science and Public Administration
- Bachelor of Arts in Criminology and Penology
• Bachelor of Arts in Sociology
• Bachelor of Arts in Religion
• Bachelor of Arts in History
• Bachelor of Arts in Social Work
• Bachelor of Arts in Language and Communication
• Bachelor of Arts in Kiswahili and Journalism
• Bachelor of Arts in Communication and Journali
• Bachelor of Arts in Communication and Public Relations.
• Bachelor of Arts in Literature, Theatre and Film
• Bachelor of Arts in Philosophy

Diploma Programmes
• Diploma in Public Administration
• Diploma in Criminology
• Diploma in Social Work
• Diploma in Community Development

Certificate Programmes
• Certificate in Social Work
• Certificate in Community Development
• Certificate in Community Work with Children and Youth in collaboration with the Africa Psychosocial Support Initiative (APSSI)

SCHOOL OF BUSINESS & ECONOMICS

Ph.D Programmes
• Ph.D in Business Administration

Masters Degree Programmes
• Master of Science in Human Resource Management
• Master of Business Administration
• Master of Science in Economics and Statistics
• Master of Science in Financial Economics
• Master of Science in Economic Policy Analysis and Management
• Master of Science in Agricultural Economics and Resources Management

Undergraduate Degree Programmes
• Bachelor of Commerce
• Bachelor of Science in Economics
• Bachelor of Science in Agricultural Economics & Resource Management
• Bachelor of Agribusiness Management
• Bachelor of Science in Human Resource Management
• Bachelor of Science in Financial Economics
• Bachelor of Science in Economics and Statistics
• Bachelor of Science in Entrepreneurship
• Bachelor of Science in Project Planning and Management
Diploma Programmes
- Diploma in Business Management
- Diploma in Human Resource Management

Certificate Programmes
- Certificate in Business Management
- Certificate in Human Resource Management

SCHOOL OF NATURAL RESOURCE AND ANIMAL SCIENCES

Ph.D Programmes
- Ph.D in Land Resource Management
- Ph.D in Environmental Planning and Management
- Ph.D in Environmental Studies

Masters Degree Programmes
- Master of Science in Environmental Studies
- Master of Arts in Geography
- Master of Environmental Planning and Management
- Master of Science in Land Resource Management

Undergraduate Degree Programmes
- Bachelor of Science in Wildlife Management
- Bachelor of Science in Forestry Ecosystems Management
- Bachelor of Science in Animal Health & Production
- Bachelor of Arts in Geography
- Bachelor of Environmental studies (Biology and Health)
- Bachelor of Environmental studies (Earth Sciences)
- Bachelor of Urban and Regional Planning
- Bachelor of Environmental Management

Diploma Programmes
- Diploma in Wildlife & Tourism Management
- Diploma in Animal Health and Production

Certificate Programmes
- Certificate in Wildlife & Tourism Management

SCHOOL OF TOURISM & HOSPITALITY AND LEISURE MANAGEMENT

Undergraduate Degree Programmes
- Bachelor of Tourism Management
- Bachelor of Science in Parks Recreation and Leisure Management
- Bachelor of Hotel and Hospitality Management
SCHOOL OF HEALTH SCIENCES

Undergraduate Degree Programme
Bachelor of Science in Nursing

Diploma and Certificate Programmes
Diploma in Nutrition and Dietetics

MINIMUM ENTRY REQUIREMENTS

- **PhD programmes:** A Masters degree in the relevant field from a recognized University.
- **Masters programmes:** 2\textsuperscript{nd} Class Honours (Upper Division) from a recognized university OR 2\textsuperscript{nd} Class Honours (Lower Division), with two years’ post qualification relevant work experience.
- **Undergraduate programmes:** Mean Grade of C+ in KCSE or a C/C- with a relevant Diploma
- **Diploma programmes:** KCSE Mean Grade of C/C- and above or a Mean Grade of D+ with a Certificate from a recognized institution.
- Diploma in Education (Arts /Science): KCSE Mean Grade of C+ and a C+ in two teaching subjects.
- Diploma in Education (Primary Option): Mean Grade of C+ or a Mean Grade of C (plain) with a P1 certificate.
- **Certificate programmes:** KCSE Mean Grade of D+ and above.

INTAKES

- Full time and Evening modes of study: January, May and September
- School based/Part time -Programmes in School of Education: April, August and December

HOW TO APPLY

Official application forms are available at the Admissions office or can be downloaded from our website [www.mmarau.ac.ke](http://www.mmarau.ac.ke). Duly completed application forms should be accompanied by a non-refundable application fee of Kshs. 500/= for Certificate and Diploma programmes, Kshs. 1000/= for Undergraduate programmes and Kshs. 2000/= for postgraduate programmes. Payments should be deposited into any of the following University accounts: Co-
operative Bank ltd, Narok Branch (01129337192600) or Equity Bank, Narok branch (0360292999764).

**CONTACTS**

For more information, please contact us through the addresses indicated below. You can also log on to our website [www.mmarau.ac.ke](http://www.mmarau.ac.ke).

<table>
<thead>
<tr>
<th>Registrar, Academic Affairs</th>
<th>Admissions Office</th>
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<tbody>
<tr>
<td>Maasai Mara University</td>
<td>Maasai Mara University</td>
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<tr>
<td>P.O. Box 861 – 20500, NAROK</td>
<td>P.O. Box 861 - 20500 NAROK</td>
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<tr>
<td>Tel: +254205131400</td>
<td>Tel: 0774 057787</td>
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<td>Email: <a href="mailto:reg.aa@mmarau.ac.ke">reg.aa@mmarau.ac.ke</a></td>
<td>Email: <a href="mailto:admissions@mmarau.ac.ke">admissions@mmarau.ac.ke</a></td>
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THANK YOU FOR YOUR Participation

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