Towards the Sustainability of our Ecosystems

ICRECC-2025

Book of Abstracts

The International Conference on Renewable Energy, Climate Change and Restoration of Ecosystems

Eldoret City, Kenya

2025

https://icrecc.mu.ac.ke/

The International Conference on Renewable Energy, Climate Change and Restoration of Ecosystems

The County Government of Uasin Gishu & Moi University

Book of Abstracts

Editorial Board

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Welcome

ICRECC-2025 Committees

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1. Renewable Energy : **Dr. Silas K. Leting**
2. Emerging Trends in STEAM: **Prof. Dr. Fredrick Nyamwala**
3. Restoration of Ecosystems, Ecosystem Biodiversity and Natural Resource Management **Dr. Rose Ramkat**
4. Pollution and Waste Management: **Dr. Charles Rono**
5. Cross Cutting Themes: **Dr. Charles Mutai**

II. Logistics Committee

1. **Dr. Sarah Cherono**
2. **Naomi Nkonge**
3. **Mr. Philip Lagat**
4. **Sonia Sanga**
5. **Francis Karemeri**

III. Local Organizing Committee

1. **Dr. Rose Ramkat**
2. **Dr. Silas K. Leting**
3. **Mr. Philip Lagat**
4. **Ms. Naomi Nkonge**
5. **Dr. Charles Mutai**

6. **Dr. Sarah Cherono**
7. **Ms. Sonia Sanga**
8. **Mr. Francis Karemeri**
9. **Dr. Charles Rono**
10. **Dr. Njira Pili**
11. **Mr. Kipchumba Barno**
12. **Mr. Emmanuel Kipkosgei**
13. **Mr. Caleb Tum**

IV. ICRECC Scientific Committee

1. **Dr. Rose Ramkat**
2. **Dr. Njira Pili**
3. **Dr. Faith Kandie**
4. **Dr. Viola Kosgei**
5. **Dr. Charles Mutai**
6. **Dr. Sarah Cherono**
7. **Prof. Samwel Rotich**
8. **Prof. Ann Mwangi**
9. **Dr. John Biwott**
10. **Dr. Titus Rotich**
11. **Dr. Kiptiemoi Korir**
12. **Dr. Richard Koech**
13. **Prof. Mathew Kosgei**
14. **Dr. Nixon Ronoh**
15. **Dr. Charles Rono**
16. **Dr. Nixon Ronoh**
17. **Dr. Silas K. Leting**

Program

Conference day 1: Tuesday April 22, 2025

7:05 AM - 7:50 AM: *Arrival and registration*

7:50 AM - 7:55 AM: *Opening Session*

8:00 AM - 8:10 AM: *Arrival of invited guests*

8:10 AM - 8:20 AM: *Prayer*

8:20 AM - 8:30 AM: *Anthems*

8:30 AM - 8:40 AM: *Opening remarks*

9:00 AM - 9:30 AM: *Tea Break*

9:50 AM - 10:20 AM:*Keynote*

10:25 AM - 11:25 AM: *Presentations*

11:25 AM - 11:45 AM: *Feedback and engagement*

10:25 AM - 11:25 AM: *Exhibition*

12:06 PM - 12:56 PM: *Panel Session 1*

1:00 PM - 1:55 PM: *Lunch Break*

2:25 PM - 4:25 PM: *Presentations*

4:25 PM - 4:40 PM: *Feedback and engagement*

4:40 PM - 5:00 PM: *Emerging issues for policy direction and briefs*

5:00 PM - 5:20 PM: *Tea Break and networking*

Keynote

Prof. Igadwa Mwasiagi: Valorization of Agricultural Waste: Preliminary results of the proposal to establish a spinning unit for banana fibers in Eldoret, Kenya

Plenary

Title: Stakeholder responsibility in the restoration of ourEcosystems

Panelists: Mr. Kipchuma Barno (County Government of Uasin Gishu), Dr. Godffrey Chesang, Blessings Msungu (Old Uganda Road Youth Group), Prof. Frederick Nyamwala (Moi University)& Mr. Anthony Sitienei (County Government of Uasin Gishu)

Conference day 2: Wednesday April 23, 2025

7:05 AM - 7:50 AM: *Arrival and registration*

7:50 AM - 7:55 AM: *Arrival of invited guests*

8:00 AM - 8:30 AM: *Keynote*

8:30 AM - 8:50 AM: *Presentation*

8:50 AM - 9:05 AM: *Tea Break*

9:05 AM - 10:05 AM:*Presentations*

10:05 AM - 10:25 AM: *Feedback and engagement*

10:25 AM - 11:25 AM: *Presentations*

11:25 AM - 11:45 AM: *Feedback and engagement*

11:45 AM - 12:00 PM: *Exhibition*

12:00 PM - 1:00 PM: *Panel Session 2*

1:00 PM - 1:50 PM: *Lunch Break*

1:55 PM - 2:25 PM: *Keynote*

2:25 PM - 4:50 PM: *Presentations*

4:50 PM - 5:10 PM: *Feedback and engagement*

5:10 PM - 5:20 PM: *Emerging issues for policy direction and briefs*

5:20 PM - 5:35 PM: *Tea Break and networking*

Keynotes

1. *Prof. Julius Kipkemboi*: Contextualizing, localizing and actualizing ecosystem restoration
2. *Prof. Ann Mwangi*: Harnessing AI for Resilience: Addressing Climate-Induced Health, Food Security, and Livelihood Challenges in Africa

Plenary

Title: The role of financing in mitigation of the effects of climate change

Panelists: Uasin Gishu County Government CEC Environment, Practitioner, Members of faculty (Invited University) & Climate change financiers (Kingdom Bank, Stima Sacco)

Conference day 3: Thursday April 24, 2025

7:05 AM - 7:50 AM: *Arrival and registration*

7:50 AM - 7:55 AM: *Arrival of invited guests*

8:00 AM - 8:30 AM: *Keynote*

8:30 AM - 9:50 AM: *Presentations*

9:50 AM - 10:10 AM: *Feedback and engagement*

10:10 AM - 10:25 AM: *Tea Break*

10:25 AM - 11:45 AM: *Presentations*

11:45 AM - 12:05 PM: *Feedback and engagement*

12:05 PM - 12:45 PM: *Climate Financiers*

12:45 PM - 1:33 PM: *Lunch Break*

1:35 PM - 2:05 PM: *Keynote*

2:05 PM - 3:25 PM: *Presentations*

3:25 PM - 3:45 PM: *Feedback and engagement*

3:45 PM - 4:05 PM: *Policy briefs, resolutions and beyond ICRECC-2025*

4:05 PM - 4:50 PM: *Closing remarks*

1. *Prof. Kiplagat Kotut, The Vice Chancellor Moi University*
2. *H.E Hon Jonathan Bii, Chelilim, EGH, The Governor - Uasin Gishu County*
3. *H.E Lee Kinyanjui - Cabinet Secretary, Trade and Industrialization*

4:50 PM - 4:55 PM: *Closing prayer*

4:55 PM - 5:00 PM: *Anthems*

5:00 PM - 5:30 PM: *Tea Break and networking, guests and participants interact and leave at their convenience*

Keynotes

1. *Prof. Esidor Ntsoenzok*: Renewable: Reviews and Prospects
2. *Prof. Elijah Wanda*: Current trends in managing pollution and wastes management

Stakeholders / Climate Financiers

1. *Amos Mungo (Stima Sacco)*: The role of SACCOs in Enabling community engagement towards adaptation and mitigation of climate change.
2. *Jane Kahuhia (Kingdom Bank)*: Financing Renewables to enhance adaptation, resilience and sustainability

Excursion: Friday April 25, 2025

8:00 AM - 8:30 AM: *Arrival and registration*

8:30 AM: *Departure to Marura (excursion site 1)*

9:00 AM: *Arrival time Marura*

9:00 AM - 10:00 AM: Site activities

10:05 AM : *Departure to Cheborорwa (excursion site 2)*

11:00 AM: *Arrival time Cheborорwa*

11:00 AM - 2:00 PM: Site activities

2:00 PM - 2:45 PM: *Lunch Break*

2:45 PM - 3:15 PM: *Review of ICRECC 2025*

3:30 PM: *Departure back to Eldoret*

5:00 PM: *Arrival time Eldoret*

Abstracts

Valorization of Agricultural Waste: Preliminary results of the proposal to establish a spinning unit for banana fibers in Eldoret

Prof. Igadwa Mwasiagi

Affiliation 1 · Affiliation 2 · Affiliation 3 · Affiliation 4 · Affiliation 5

Abstract with number of words less than 300

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Contextualising, Localising and Actualising Ecosystem Restoration

Prof. Julius Kipkemboi

Kaimosi Friends University

Ecosystem restoration entails deliberate efforts to assist a degraded ecosystem towards recovery pathway. Restoration encompasses a wide continuum of practices, depending on local conditions and societal choice. It also extends to conserving the ecosystems that are still intact. Premised on the fact that healthier ecosystems provide us with better ecosystem services (ES) it will be beneficial to start by reflecting on what goes wrong during degradation. Conceptualization of restoration entails understanding what is to be transformed, how, by whom and to what extend. Climate change is expected to exacerbate the effects of degradation whilst aggravating the implications on humanity, nature and businesses and hence compromise the attainment of Sustainable Development Goals (SDGs). Contextualization ecosystem restoration should be viewed from the lens of global and local frameworks. The United Nations Decade on Ecosystem Restoration (2021-2030) challenges everyone to scale up restoration efforts that breathe new life into our degraded ecosystems. In the Kenyan context such guidelines and regulations buttress the Environmental Management and Coordination Act (EMCA). Localizing restoration efforts should focus on sustainable management of ecosystem. Such efforts should include but not limited to capacity strengthening, promoting sustainable cities and green businesses and Agrifood Systems within the landscapes in question. Actualizing restoration entails initiating projects and initiatives at local level. Such initiatives could be in form of transformative pathways whereby stakeholders are brought together through a T-Lab approach in diagnosing and visioning how to deal with environmental and societal change through practices and structures can be used as one of the approaches for sustainable natural resource management. Another recent notable restoration effort in Kenya is that of Nairobi river in which a commission has been formed engage in rehabilitation, protection, restoration of the riparian and from a basin approach. Ecosystem restoration is not without challenges. Some of the challenges that can slow down ecosystem restoration efforts include limited scientific knowledge and community capacity, inadequate government support and financial resources.Nevertheless„ ecosystem restoration is an essential component of regaining the lost ecosystem service in any landscape and pathway towards sustainability of our ecosystems.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Harnessing AI for Resilience: Addressing Climate-Induced Health, Food Security, and Livelihood Challenges in Africa

Prof. Ann Mwangi

Department of Mathemtics, Physics and Computing, Moi University

Africa stands at a critical juncture where climate change is intensifying vulnerabilities across health systems, food security, and livelihoods. From droughts and floods to the spread of vector-borne diseases, the impacts are widespread and disproportionally affect vulnerable populations. Amidst these growing challenges, there is a powerful opportunity to harness Artificial Intelligence (AI) to develop adaptive strategies and strengthen resilience across sectors. Here we explore the transformative potential of AI in addressing climate-induced challenges across key sectors. AI can enable more accurate climate modelling, predictive analytics that forecast disease outbreaks and optimize agricultural practices. AI-driven powered solutions such as satellite-based monitoring and machine learning algorithms, are helping detect early signs of food shortage, health risks and disruptions to livelihoods, providing a critical window for timely interventions. However, realizing this potential requires more than just technology. Key challenges include data scarcity, limited technological infrastructure, and the need for capacity at the local level. Additionally, ethical concerns around data privacy, algorithmic bias, and equitable access to AI tools must be addressed to ensure that solutions are inclusive and beneficial to all communities. As we move toward a future shaped by both climate uncertainty and digital transformation, Africa has the chance to leapfrog with contextually relevant AI applications that are equitable, scalable, and sustainable. This session aims to inspire cross-sector dialogue and collaboration, urging all stakeholders - researchers, policymakers, technologists, and citizens - to co-create AI solutions that build resilience, protect human health, secure food systems, and safeguard livelihoods acrossÂătheÂăcontinent.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Renewables: Reviews and Prospects

Prof. Esidor Ntsoenzok

Affiliation 1 · Affiliation 2 · Affiliation 3 · Affiliation 4 · Affiliation 5

Abstract with number of words less than 300

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Status of Forest Landscape Restoration in Kenya

Dr. Benjamin Kinyili

Kenya Forest Service

Kenya has set an ambitious 15 billion tree growing strategy for landscape and ecosystem restoration with goals to increase and maintain 30% tree cover by 2032, to restore 10.6 million ha of degraded landscape by 2032 and to reduce 32% of its greenhouse gas emissions by 2030. The Forest Landscape Restoration Implementation Action Plan (FOLAREP) 2022-2026 seeks to restore 2.55 million ha of degraded landscapes through integrated approaches and best practices. Additionally, a multi-stakeholder Technical Working Group on Restoration Monitoring has been convened to support sustainable Forest Landscape Restoration (FLR) efforts in the country. As part of the consultation process, seven engagement forums bringing together national government, all 47 counties, the Council of Governors and development partners were held between December 2021-March 2022. These engagements reveal that Kenya's top barriers to restoration are financial constraints, inadequate policy and legislative frameworks, low sensitization on FLR, land ownership, and limited human and technical capacity on FLR. The top drivers to degradation are population pressure, poverty, overstocking, encroachment, and overgrazing. County Environment Committees (CECs), which are crucial to mainstreaming FLR at the county level, are active in 18 of the 47 counties. In addition, 25 of 47 counties mention county climate change entities as critical to enhance the CECs' FLR functions. Top indicators selected by counties as important for a national restoration monitoring system include areas of restored forest and agricultural lands, biodiversity revived and access to safe water. Counties present unique FLR monitoring structures, with some entities and departments such the CECs, the Monitoring and Evaluation Committee and Units featuring structures across several counties.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Harnessing Community Traditional Values For Ecosystem Preservation: Case Of Kaptagat Forest of Elgeiyo Marakwet County of Kenya

Dr (Amb) Joseph Kiplagat

Dept of Mechanical, Production Energy Engineering, School of Engineering Moi University Eldoret Kenya

The expansive Kaptagat Forest is a scenic landscape of Elgeyo-Marakwet County in Kenya, covering over 30,000 hectares. It is a crucial water catchment area, serving the water needs of Elgeyo-Marakwet and Uasin Gishu counties. But this forest's fragile ecosystem is now greatly endangered by climate change and uncontrolled human activities like deforestation, overgrazing and charcoal production. Urgent remedial actions are required for its preservation. Harnessing the traditional values of the local community living next to the forest constitute one unique yet results laden action. The Keiyo History Culture & Heritage Centre: a coming together of community professionals, has initiated a number of activities to tap into this resource. The age-old community traditional values which include strict adherence to ecosystem preservation have been passed from generation to generation. However, laxity in enforcement of the relevant principles have led to numerous infringements. The Kenya Forest Service in collaboration with the local leadership has implemented various mitigative initiatives on trial stages. One is to set up a "cow bank" to keep community livestock in selected guarded spaces away from the forest. Modern renewable energy technologies are slated for installation, to tap into the water streams, the abundant sunlight and strong winds at the edges of the forest. The Archimedes Screw turbine (AST), a cost-effective, robust, simple hydropower machine is suitable for application at the low-head sites of Kaptagat Forest rivers. Most households bordering Kaptagat forest, use charcoal and firewood for cooking. An optimized conical solar cooker, has been highly recommended as an alternative, to reduce and finally stop use of charcoal and firewood from the forest. Installation of Wind Turbines at the edge of the escarpment, is under consideration, to tap the wind energy.

Keywords: Community· Energy · Ecosystem · Renewable · Values

Leveraging On Wetland Monitoring And Management App: A Case Of Kingwal And Yala Swamp Areas

Kelvin Omieno

Kaimosi Friends University · Rongo University

Wetlands play a critical role in biodiversity conservation, water purification, and climate regulation. However, these ecosystems face increasing threats due to human activities, climate change, and inadequate monitoring frameworks. This study explores the development and implementation of a Wetland Monitoring and Management App designed to enhance the conservation and sustainable use of Kingwal and Yala Swamp areas in Kenya. The app leverages emerging technologies such as GIS mapping, remote sensing, IoT sensors, and AI-driven analytics to provide real-time data on wetland health, water levels, biodiversity status, and potential environmental threats. Through stakeholder engagement, including local communities, environmental agencies, and researchers, the app aims to facilitate informed decision-making and improve wetland governance. The study evaluates the effectiveness of the application in monitoring ecosystem changes, enhancing community participation, and supporting policy implementation. The findings underscore the importance of digital solutions in promoting sustainable wetland management and recommend strategies for scaling up technology-driven conservation initiatives.

Keywords: Wetland monitoring · Environmental conservation · GIS remote sensing · AI analytics · Sustainable management · Biodiversity conservation

Urban River Ecosystems; **An Evaluation of the Proposed Restorative model for River Sosiani, Eldoret City**

Dr. Silas K. Leting ·Kipchumba Barno m· Mark Some

The County Government of Uasin Gishu

Urban river degradation resulting from rapid urbanization constitutes an acute sustainability challenge, exemplified by the Sosiani River in Eldoret−a once vibrant ecological corridor in early 1900s but now facing pollution, wetland encroachment (67% loss since 2005), and plummeting biodiversity. As Eldoret expands by 4.3% annually being the only city in Kenya's North Rift, the strain on urban ecosystems is expected to increase proportionately. The research proposes an integrated restoration framework that combines ecological science, intelligent technologies, and deliberate institutional reforms. Taking a cue from success stories like Cheonggyecheon (Seoul) and Singapore River, the framework employs geospatial mapping, hydrology modeling, and institutional diagnostics to determine root causes. Institutional problems− poor enforcement of the Water Act (2016) and fragmented urban governance − account for 68% of the ecosystem loss, study says. Failure to implement it will result in the loss of 40% of the remaining wetlands by 2045.The "modern urban river" plan employs optimized wastewater infrastructure, IoT water quality sensors, and blue-green infrastructure (i.e., bioswales, constructed wetlands) to build resilience. A County investment of KES 1.5 billion, out of which KES 500 million has been dedicated to fencing and restoring of the wetlands would decrease pollutants by 55%, lower flood risk by 40%, and yield a 9.2% per annum return on investment through eco-tourism, health savings, and disaster avoidance. The dream Sosiani River Restoration Authority (SRRA) would be grounded on enforcement, coordination, and adaptive governance. Grounded on Kenya's Climate Change Act (2016), SDGs 6, 11, and 15, and the Ramsar Convention, this dream substitutes Sosiani as a socio-ecological asset that offers a replicable model for resilient urban futures in Africa.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Integrating Climate Smart Agriculture and Rehabilitation in Mining Affected areas;A proposed initiative in Kimwarer Flourspar Region

Eda Chebet Kapkea ·Janet Kirui

Hug a cedar foundation

Mining has long been a vital economic activity in the Kimwarer-Fluorspar region of Elgeyo Marakwet County. For years, fluorspar mining made Kimwarer a lively business town, offering jobs and attracting trade and services that sustained the local economy. However, this economic boost came with significant environmental consequences. Over time, deforestation, soil erosion, and the degradation of fertile land became widespread. These effects not only reduced the land′s agricultural value but also damaged local ecosystems, leaving behind barren landscapes and vulnerable livelihoods. The closure of the mine in 2016 intensified these challenges, leading to both economic and environmental decline. In 2024, with mining activities resuming, new opportunities for both economic revival and ecological restoration have emerged. This youth-led initiative proposes the integration of climate-smart agriculture, agroforestry, and sustainable land management in tandem with ongoing mining activities. The goal is to reclaim degraded land, restore soil fertility, and enhance environmental resilience while ensuring that mining and conservation work together for the benefit of the local community. Field visit to Kimwarer Fluorspar mine on 20th Feb 2025, interviews with local community members and analysis of secondary data were used to gather insights for this research. Findings show mining has degraded land and reduced agricultural value. However, community interest in land restoration and youth-led initiatives presents strong potential for integrating mining with sustainable environmental practices. Mining and environmental restoration can coexist. With youth-led initiatives, Kimwarer's revival offers a chance to restore degraded land, improve livelihoods, and promote sustainable development aligned with climate action goals.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Seed Banks for Tree Cover and Forest Restoration in Kenya

Dr. Benjamin Kinyili

Kenya Forest Service, P. O. Box 30513-00100, Nairobi, Kenya · Affiliation 2 · Affiliation 3 · Affiliation 4 · Affiliation 5

The massive forest degradation caused by anthropogenic activities and exacerbated by climate change has signaled the need for forest habitat restoration efforts. The most appropriate way of restoring these forests through tree planting where the need for seeds is paramount. Traditionally, seeds for restoration activities have mainly been sourced through collections from the wild, which is unsustainable. In order to ensure responsible restoration practice, Foresters and restoration practitioners continued to explore other options of economical, ethical and sustainable sourcing of seeds. Seed banks can leverage on technical and infrastructural capacity to play a greater and more direct role in supporting biodiversity and ecosystem conservation and restoration, particularly through the supply of quality ecologically and genetically suitable seed. This paper reviews the use of seed banks in enhancing tree cover and forest restoration in Kenya. This review focuses on status of seed banks in Kenya, seed collecting, field-based seed bulking, handling and storage, seed quality control as well as experience and capacity in facilitating germplasm exchange. Five key roles of seed banks in Kenyan forestry sector include preserving genetic diversity, biodiversity conservation, protect species from extinction, plant breeding programmes and ecological restoration. Technical and physical capacity for ecosystem restoration seed supply available in seed banks in Kenya included availability of germplasm, seed processing, storage, quality assurance and control and germplasm exchange. In Kenya, seed banks have established close working relationships with various experts in making it easy to find information on species phenology, distribution patterns, optimum collecting time and sites with appropriate restoration seeds. Most restoration projects in Kenya give little consideration to seed quality control and assurance. There is a need to explore how the resources amassed through the largely successful ex situ conservation initiatives and efforts can be used to support in situ conservation and restoration activities.

Keywords: Biodiversity Conservation· Genetic Diversity · Genetic Diversity· Restoration · Seed Banks · Seed Bank Collection·Germplasm·Seed Quality

In Vitro Evaluation of Green−Synthesized Silver Nanoparticles (AgNPs) for the Management of Xanthomonas citri and Tylenchulus semipenetrans

Sadiq Bishir ·Jacqueline Kubochi ·Njira Pili ·Rose Ramkat

Moi University

Citrus production faces major threats from Xanthomonas citri subsp. citri, the causative agent of citrus canker, and Tylenchulus semipenetrans, the citrus nematode, both of which contribute to significant yield losses worldwide. Emerging evidence suggests potential interactions between these pathogens, exacerbating disease severity and complicating management. Conventional control methods, including chemical pesticides and antibiotics, pose environmental risks, contribute to antimicrobial resistance, and may negatively impact non-target organisms. Therefore, there is an urgent need for sustainable and eco-friendly management strategies. This study will investigates the efficacy of green-synthesized silver nanoparticles (AgNPs) in controlling X. citri and T. semipenetrans through in vitro assays. AgNPs will be synthesized using plant extracts as reducing and stabilizing agents, ensuring an environmentally friendly production method. Characterization of the synthesized AgNPs will be conducted using UV-Vis spectroscopy, Fourier-transform infrared (FTIR) spectroscopy, and scanning electron microscopy (SEM) to confirm their properties. The antibacterial activity against X. citri will be assessed using agar well diffusion and minimum inhibitory concentration (MIC) assays, while the nematicidal effect on T. semipenetrans will be evaluated through motility inhibition and mortality tests. Additionally, co-inoculation studies will be performed to investigate possible interactions between the bacterium and the nematode in vitro and assess whether AgNPs can disrupt these interactions. By developing a green nanotechnology-based alternative, this research aims to promote an environmentally sustainable and innovative approach to citrus disease management. The use of biosynthesized AgNPs could minimize reliance on chemical pesticides, reduce environmental contamination, and contribute to climate change mitigation by promoting sustainable agricultural practices.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Integrated Multi−Trophic Aquaculture (IMTA) of seaweed and rabbitfish: A low-Carbon Bio−mitigation Strategy for climate resilience and multi−dimensional poverty reduction

Joel Onyango·Victor Omondi ·Anne Maina ·Bernard Simiyu

African Centre for Technology Studies

Coastal Kenyan communities rely heavily on marine resources for food, income, and ecosystem services. However, marginalized groups, particularly women, face systemic barriers to accessing these resources, exacerbating vulnerabilities to climate change and food insecurity. This study investigates the potential of IMTA systems−integrating seaweed (*Eucheuma denticulatum*) and rabbitfish(*Siganus sutor*) −as a low-carbon, gender−inclusive solution to address multidimensional poverty and climate resilience. The IMTA model leverages symbiotic interactions: fish excreta and feed residues fertilize seaweed, while seaweed absorbs excess nutrients (reducing eutrophication risks by $16.58tPO_4^{3-}eq.and32.29tNeq.$) and sequesters CO_2, mitigating coastal acidification. Trials demonstrate 60% nutrient recovery efficiency, tripling biomass output compared to monoculture systems. Seaweed′s carbon sequestration capacity further supports global climate goals, while rabbitfish provide protein−rich food, enhancing dietary diversity and income streams. Economically, IMTA reduces reliance on costly external inputs, lowering production costs by 40% and diversifying revenue through sale of fish, seaweed. This targets poverty indicators like unemployment and food insecurity, while alleviating pressure on overfished wild stocks. Socially, IMTA empowers women through inclusive aquaculture training and ownership opportunities, challenging entrenched gender norms in Kenya's coastal regions. Preliminary data from the Blue Empowerment Project (Kwale County, Kenya) highlights IMTA′s dual role in fostering climate resilience and equitable livelihoods. However, scaling requires addressing socio-technical barriers, challenges and opportunities for leveraging IMTA of seaweed and fish as a low−carbon, gender-transformative, environmentally and economically sustainable innovation for equitable empowerment.âĂİThis study proposes a holistic analysis of IMTA's viability, integrating social, technological, and institutional dimensions. By collaborating with local stakeholders−including Bahari CBO and Sea Moss Corporation−the project aims to co−design replicable, gender−responsive IMTA models. Policy recommendations emphasize the need for climate-smart aquaculture incentives and equitable resource access to position IMTA as a pillar of Kenya's blue economy transition.

Keywords: IMTA ·seaweed · rabbitfish · climate change·poverty

Assessment of nutrient retention In Yala Wetland Ecosystem, Kenya

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The Yala Wetland, a key ecosystem in Kenya, plays a vital role in provision of ecosystem services and by extension, a source of livelihoods for local communities, and a natural shield against environmental pressures. This study investigates nutrients retention capacity at the Yala Wetland, focusing on the selected parameters at the inlet and outlet within a selected temporal span. Key parameters, including dissolved oxygen (DO), electrical conductivity (EC), water temperature, pH, total suspended solids (TSS), nitrogen (N), and phosphorus (P) concentrations, were monitored to assess temporal changes and nutrient retention. The mean DO concentration at the inlet exhibited significant temporal variation ($F = 7.315, p = 0.051$), while the outlet showed no significant changes ($F = 5.657, p = 0.063$). EC values at both sites varied significantly ($F = 28.387, p = 0.004$), with the inlet reaching a maximum of 341.1ÎijS/cm in March. Nutrient analyses revealed that ammonium concentrations significantly differed across months at both the inlet ($F = 8.257, p = 0.035$) and outlet ($F = 7.463, p = 0.028$). Nitrate and total nitrogen concentrations showed no significant variation during the study period. Notably, the wetland acted as a nutrient sink, retaining 40% of ammonium, 30.52% of nitrate, and 28.57% of total phosphorus. Understanding these relationships is vital for safeguarding water quality and supporting biodiversity. In conclusion, ongoing research and proactive management approaches are key to preserving the integrity of Yala Wetland and strengthening its resilience against future environmental challenges.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Soil Stabilization Using STEIN

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Soil in its natural state is usually unsuitable for engineering applications and must be treated to improve its load bearing characteristics. Emerging technologies make it possible to improve soil properties. STEIN is a commercial product that is mixed with cement and used for the stabilization of soil. It has been used in road pavements and in lining of water canals and other water retaining structures in south−east Asia and is now being introduced to Kenyan and Africa. There is little in the literature on its strength, hydraulic characteristics and environmental impacts. This paper presents the findings of laboratory experiments on soils stabilized with STEIN−cement. Six local soil types from different parts of Kenya were used: planosols, ferrosols, acrisols, andosols, nitisols, and unclassified local soil. X−ray diffraction tests was performed on the soils and the STEIN. Two types of cement were used: pozzolanic Portland cement (PPC) and ordinary Portland cement (OPC). The soils were stabilized in three categories: cement only (control); cement containing 3% STEIN; and cement containing 5% STEIN. The specimens were prepared, cured and tested for unconfined compressive strength (UCS) at 7, 14, and 28 days. The results showed that STEIN and cement consist of numerous similar minerals but in different proportions. There was significant increase in the strength of the soil when STEIN is introduced into the cement compared with stabilizing with cement only. The 5% STEIN-cement specimens gave higher UCS values than the 3% STEIN−cement specimens confirmed by the paired T−test. From the foregoing, it was inferred that STEIN−cement stabilizes soil by combined hydraulic and pozzolanic reactions leading to enhanced strength. The reactions are inorganic, cementatious and thus create stable medium for multi-purpose engineering use. However, further research is recommended on the cost, hydraulic characteristics and environmental impacts of the STEIN−cement stabilized soil.

Keywords: Soil stabilization · STEIN · Unconfined compressive strength

Optimizing Sweet Potatoes Yield: An Advanced Modelling using SORDs Constructed using Trigonometric Functions

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Moi University

Sweet potato (Ipomoea batatas) is a vital food crop with the potential to enhance global food security. However, its yield optimization remains a challenge due to soil fertility variations, climatic factors, and inefficient agronomic practices. Traditional experimental designs often fail to capture complex interactions between variables, necessitating advanced optimization techniques. This study employs second-order rotatable designs (SORD) constructed using trigonometric functions to model and optimize sweet potato yield under different organic fertilizer applications. The objective is to determine the most effective combination and application rate of poultry, goat, and rabbit manure for maximizing yield. A SORD with 23 design points was implemented to ensure uniform precision across the factor space. Field experiments were conducted using randomized block designs, and data were an- alyzed using response surface methodology (RSM). The results indicate that poultry manure significantly enhances sweet potato yield compared to goat and rabbit manure. However, a combination of poultry and goat manure in a 3 : 2 ratio provided the highest yield increase. The trigonometric-based SORD approach effectively captured interactions and quadratic effects, leading to precise yield optimization. The study concludes that SORD constructed with trigonometric functions offers an efficient framework for optimizing crop yield under varying soil fertility conditions. It is recommended that farmers adopt a mixed manure approach to improve sweet potato productivity sustainably. Further research should explore the integration of addi- tional soil amendments, long-term soil health effects, and the impact of climate variability on sweet potato yield using advanced modeling techniques.

Keywords: Keyword 1 · Keyword 2 · Keyword 3

Restoring our landscapes: The use of Artificial Intelligence in curbing Global warming

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Moi University

Global warming, fueled by fossil fuel combustion, deforestation, and industrial pollution, endangers ecosystems, notably the biodiverse Great Rift Valley. This study explores four Artificial Intelligence (AI) strategies to mitigate climate change through landscape restoration: (1) AI−optimized agroforestry, boosting yields by 20% in India while sequestering carbon; (2) Integrated landscape initiatives in Africa, using drones to restore 500,000 hectares; (3)AI-driven forest fire management, predicting wildfires 48 hours in advance; and (4) Smart Archive Models, enhancing climate data accessibility to inform restoration policies. These approaches reduce greenhouse gas emissions by $15-20\%$, protect biodiversity, and foster sustainable rural development. Based on a systematic review of 200+ studies, we urge policymakers to invest in AI−driven solutions to restore 10 million hectares by 2030, safeguarding regions like the Great Rift Valley.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Assessment of Water Quality in Selected Fish Farms in Uasin Gishu County

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University of Eldoret

This study evaluated water quality across five farms to assess their suitability for fish farming. Efforts to promote fish farming in Uasin Gishu County persist, but research on enhancing fisheries productivity through better pond management remains limited. Most studies focus on production techniques or market development, neglecting the importance of effective pond management for sustainable growth. Key physicochemical parameters, including pH, Biological oxygen demand, Chemical oxygen demand, salinity, conductivity, and temperature, were measured in-situ in selected fish ponds using a Multi−probe $HQ40D$ meter, while water samples for nitrate analysis were collected in triplicate and transported to the laboratory for further analysis. Data analysis involved $ANOVA$ and Kruskal−Wallis tests, with Tukey′s and Dunn′s tests identifying variations and Fisher′s exact test assessing associations between water quality parameters and farm, pond, type, and measurement date ($P \leq 0.05$). Most farms maintained suitable water temperatures ($25 - 30°C$), with salinity, pH, and TDS within acceptable limits. However, dissolved oxygen levels often fell below the recommended range ($60 - 100\%$ or $0.1 - 0.2mmol/L$), which could negatively impact aquatic life. Conductivity showed slight variations, while high COD and BOD levels (exceeding $50mg/L$ and $20mg/L$, respectively) indicated organic pollution. Although nitrate levels remained stable, microbial contamination was a significant concern, with coliform and bacterial counts frequently surpassing $10,000\ CFU$. These findings highlight the need for improved water management to control pollution and ensure sustainable aquaculture. This study found most water quality parameters suitable for aquaculture, but low dissolved oxygen, high BOD and COD, and microbial contamination in some farms could harm fish health and productivity. To enhance water quality, regular pond cleaning, controlled feeding, and monitoring should be prioritized to reduce organic pollution, maintain optimal BOD and COD levels, and control microbial contamination.

Keywords: Water quality ·Aquaculture · coliforms · Nitrates

Creating Sustainable Solid Waste Management Practices: An Analysis of the Proposed Solid Waste Management Solutions for Eldoret City, Kenya

Evans Kapkea · Dr. Silas K. Leting · Divinah Salim

The County Government of Uasin Gishu

The 20^{th} century saw a radical shift in population dynamics, with rural-to-urban migration transforming small towns into mega cities. This rapid urbanization, particularly in low − and middle-income countries, has accessioned an increased generation of solid waste within the municipalities and major cities, thereby piling pressure on sustainable environmental programs, public health, and local government finances. Uasin Gishu County, home to the rapidly growing Eldoret City, is a case in point. Eldoret city chunks out approximately 250 metric tons of waste daily, of which 55% are organic, 23% recyclable, and 22% inert waste. The Kipkenyo dumpsite is already more than full, as is the case with other global landfill disasters such as Minamata (Japan) and Kiteezi (Uganda). Projections indicate a 220% volume growth in waste by 2044. Policy loopholes (70%) and infrastructural deficiencies (35%) cause waste management inefficiencies. This study proposes an integrated investment scheme of USD 12.3 million involving modular bioreactor landfills, composting facilities, PPP-funded recycling parks, and data-driven logistics optimization. Containerization has already reduced litter by 32%, and route optimization has reduced operational costs by 18%. The proposed system is projected to yield a 14% return on investment per annum, reduce disease incidence by 25%, and create over $1,200$ green jobs. Sustainable solid waste management is positioned here as not merely an environmental necessity, but also a corner stone of urban resilience, inclusive economics, and climate-congruent governance. The model accommodates SDGs 11 and 12 and offers an export template for use in other fast-developing cities in the Global South.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Multi−level and Multi−actor governance in the management of air pollution in Kenya: case of Nairobi and Kisumu Counties

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Air pollution remains a critical environmental and public health challenge in Kenya, particularly in urban centers such as Mombasa, Nakuru, Eldoret, Kisumu and Nairobi. In response, the country adopted a devolved, multi−level, and multi-actor governance system intended to improve environmental management by decentralizing responsibilities to County Governments. However, the effectiveness of this devolved structure remains under−explored, and this study sought to investigate the effectiveness of Kenya′s devolved multi−level and multi−actor governance system in managing air pollution, focusing on the interactions between National and County Governments and other stakeholders a case of Nairobi and Kisumu cities. The study adopted a qualitative, exploratory case study design guided by the Governance Analytical Framework (GAF) to assess the governance of air pollution in Nairobi and Kisumu counties. Data was collected through literature review and structured interviews with 19 purposively sampled stakeholders from Government, Civil Society, and the Private Sector. The findings reveal significant governance challenges including role ambiguity between the National and County Governments, limited enforcement powers and financial autonomy at the county level, and weak coordination and citizen participation mechanisms. While the National Government retains oversight through policy formulation and regulatory enforcement through NEMA and other agencies in the Ministry of Environment, counties are expected to implement localized air quality initiatives. However, overlapping mandates have led to accountability gaps and operational inefficiencies. The study underscores the urgent need to empower County Governments not only through capacity building and fiscal decentralization but also through integrated co−management mechanisms. Future research should focus on simulating governance scenarios to explore models of synergy such as joint licensing and inspection, co-financing frameworks, and shared enforcement mandates. These scenario simulations will help determine whether harmonized governance structures can resolve current coordination failures, thus answering the broader question of how empowerment should be structured between the two levels of government. Ultimately, this paper argues for a shift from fragmented to collaborative environmental governance, enabling both National and Sub-national actors to collectively address Kenya′s air pollution crisis through well-aligned institutional arrangements and policy coherence.

Keywords: Air Pollution, · Multi−level · Multi−actor · Devolution· Air quality

Assessing the Diversity of Parasites and Microbes in Fish from Selected Fish Farms in Uasin Gishu County

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University of Eldoret

Fish farming plays a crucial role in food security and economic development, yet bacterial and parasitic infections threaten productivity and fish health. This study investigates the distribution and prevalence of bacterial and parasitic species in fish organs across different farms, ponds, and pond types in Uasin Gishu County, Kenya. A total of 468 fish samples were analyzed, yielding 154 bacterial isolates and various parasitic infestations identified through cultural, biochemical, and microscopic characterization. The Kruskal-Wallis test revealed significant differences ($p \leq 0.05$) in bacterial prevalence across fish organs, farms, and measurement dates. Dunn′s post hoc test further highlighted significant pairwise differences. The results revealed significant differences ($p \leq 0.05$) in bacterial and parasitic prevalence across fish organs, farms, and measurement dates. Escherichia coli was the most prevalent bacterial species, followed by Pseudomonas aeruginosa, Vibrio harveyi, and Vibrio alginolyticus. The gills exhibited the highest bacterial diversity, while the kidneys had the lowest. Parasitic infestations, including nematodes, cestodes, and protozoa, were predominantly found in the intestines and gills, with variations influenced by farm location, pond type, and seasonal factors. To mitigate these infections, regular water quality assessments, improved biosecurity measures, routine fish health monitoring, and antiparasitic treatments should be implemented. Further research on antibiotic resistance and parasitic control strategies is recommended to enhance sustainable aquaculture management and minimize disease risks.

Keywords: Bacterial diversity · parasitic infections · fish farming · aquaculture management

Energy Access

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Challenges and Opportunities in Kenya′s Energy Sector: Addressing Rural Electrification, Consumer Prices, and Power Losses on Distribution. Kenya's energy sector faces significant challenges in rural electrification, high consumer prices, and substantial power losses during distribution. As of 2018, only 56% of Kenyan households had access to electricity, with rural areas lagging at 31%. The high cost of grid extension to remote areas and inefficiencies in distribution systems, including technical losses (up to 18%) and non-technical losses (up to 15%), exacerbate the issue. These losses, totaling over 33% of generated power, inflate consumer costs and hinder economic growth. Opportunities for improvement include investing in renewable energy sources like solar and wind, modernizing the distribution network, and implementing smart metering systems to reduce losses. Deregulation and liberalization of the sector could also foster competition and innovation, potentially lowering prices. However, these measures require careful regulatory frameworks to protect consumers and manage transitions effectively. Addressing these challenges through comprehensive policy adjustments can enhance the reliability, efficiency, and affordability of Kenya's electricity supply, contributing to sustainable economic development.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Effects of matter deposition on the Power output of Mono− and Poly−crystalline solar panels and assembling of automated GSM−based cleaning system

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Effects of matter deposition on the Power output of Mono− and Poly−crystalline solar panels and assembling of automated GSM−based cleaning system. The over reliance on unsustainable fossil fuels has shifted attention to the adoption of renewable sources such as solar energy, which also faces power efficiency problems due to low solar energy capture. Accumulation of particulate matter, particularly dust, significantly affects the performance of photovoltaic (PV) solar panels by obstructing light transmittance, thereby reducing output power and degrading system efficiency. This study investigates the effects of dust accumulation of varying particle sizes on the power output of mono−crystalline and poly−crystalline solar panels installed in Eldoret, Kenya. Dust samples collected from a nearby tarmac road were classified into particle size ranges of 0.748 mm to 3.447 mm and applied in controlled amounts to the panel surfaces. The results indicated that dust particle sizes below 1.97 mm on polycrystalline panels retained more efficiency, while mono−crystalline panels performed better for dust particles above 1.97 mm. An average 91% power reduction on poly−crystalline panels and 96% on mono−crystalline panels was observed for a 60 g dust spread of the mixture of unsorted dust particles on the panels. To mitigate power losses due to dust accumulation, an innovative telecommunications-based cleaning system was developed, leveraging GSM feature phone technology to automate panel cleaning. This system achieved a 64% power restoration by removing accumulated dust without requiring internet connectivity, making it an ideal solution for remote or off-grid regions. This study provides crucial insights into panel selection for dusty environments and introduces a cost-effective, accessible maintenance solution for PV systems.

Keywords: Photovoltaic· Dust particles · efficiency· GSM−based cleaning system

Financing clean Energy Transition for rural households in Western Kenya; Insights from the Bidhaa Sasa Social Enterprise Model

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Moi University, Clean Air Africa Unit

Polluting fuel use in households poses health, environmental and socio-economic problems. The use of clean cooking fuel is largely limited due to cost. To effectively reach the rural population, financing models supportive of the low-income earners need to be put in place. Bidhaa Sasa Social Enterprise Model (BS) is a social marketing approach that distributes clean cooking equipment to the rural poor and has been in operation in Western Kenya since 2017. This study evaluated how Bidhaa Sasa initiative supported rural households in Western Kenya to adopt clean, improved cooking fuel and technologies. This study adopted a mixed method approach. 1006 households, who bought cooking products from Bidhaa Sasa either in Kapsabet or Moi's Bridge hub, were surveyed. The participants were identified from the Company customers through their coordinators and Group Leaders. Quantitative data was analyzed using descriptive and Inferential statistics. Thirteen participants from the survey were purposively sampled for in−depth interviews. Qualitative data was analyzed thematically. Significant number (93%) of those who bought clean stoves are still in possession of them, and up to 97% are using them. The study found household income as the main predictor of the main cook stove used before Bidhaa Sasa ($P = 0.029$), however, the association could not hold after the initiative ($P = 0.409$) instead there was a significant improvement in the use of cleaner fuel ($P = 0.000$). Qualitative findings indicates that the initiative was popular due to flexible repayment period, good customer relations, quality products and product demonstrations. Enablers of transition to clean fuels included; health issues, convenience, challenges in procuring the previous fuel and cost. There was a significant improvement in transition to use of cleaner fuels after Bidhaa Sasa Initiative. However, fuel stacking is still common among rural households. Similar models involving peer support could be explored as we move towards attaining SDG 7.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Effect of Selected Dopants (Bi, Sb, and Sn) on the Optoelectronic Properties of Formamidinium based Lead Halide Perovskite materials: An Ab Initio Density Functional Theory Study

Gloria Mumbi · Richard Koech · Kiptiemoi Korir

Moi University

Organic−inorganic hybrid perovskite solar cells (PSCs) are promising for next-generation photovoltaics due to their high power conversion efficiency, tunable bandgaps, and cost-effective fabrication. However, lead toxicity and material instability remain key challenges. This study explores the effects of Bismuth (Bi), Antimony (Sb), and Tin (Sn) doping on the optoelectronic properties of formamidinium-based mixed lead halide perovskites using an ab initio Density Functional Theory (DFT) approach. DFT calculations using the Generalized Gradient Approximation (GGA-PBE) exchange-correlation functional were performed to analyze the structural, electronic, and optical properties of the undoped perovskite. The bandgap of undoped $FAPbI_3$ was calculated to be 1.28 eV, aligning well with values suitable for efficient light absorption in solar cells. Structural relaxation confirmed lattice stability in the pristine material. Currently, one of the selected dopants, Sn doping simulations are in progress to evaluate its effects on bandgap modulation, defect states, and charge transport properties. Preliminary insights suggest that Sn incorporation could enhance light absorption and improve charge carrier dynamics, contributing to overall device performance. Further analysis, including defect formation energies and optical absorption spectra, will provide deeper insight into the viability of doping for optimizing perovskite solar cell efficiency. This study aims to determine optimal dopant concentrations for enhanced optoelectronic performance while maintaining structural stability. Further analysis, including defect formation energies and charge transport characteristics, provided deeper insights into the impact of doping on perovskite solar cells.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Neutron capture reaction of Au^{197} characterized by $\Gamma_y = 0.124eV$ and $\Gamma_n = 0.007E^{(b\frac{1}{2})}eV$ and the role of exotic neutron rich nucle

Joseph Maritim · Prof. S.K Rotich

Moi University

The use of nuclear energy offers numerous peaceful applications in the generation of electricity, medical diagnostics and treatment, agricultural advancement and food preservation. The main aim was to apply the concept of the cross-section to resonance in a quantitative manner. It gave the value of a single resonance level formed by an incident particle with zero angular momentum and charge zero so that the spin and the coulomb effects were not taken into consideration. The level of compound nucleus is bound, the excitation by incident particle was treated as oscillation produced by electromagnetic wave. We varied the nuclear cross-section with the incident energy, the same way the energy in a forced oscillation varies with incident frequency. In classical treatment, resonant circuits absorb energy because of resistive levels. For the case of nuclear, damping arises because of decay possibilities, hence nuclear states have a finite width . A decaying state wave function of mean energy corresponds to an exponential decrease of intensity of excitation. It is via the r-process that exotic neutron rich nuclei play an important role in the formation of heavy elements. The result showed that a decaying state is not a function of definite energy . A sharp resonance corresponds to a narrow width, hence the peak cross-section is 3 barns and was analogous to the dispersion formula. The compound formed nucleus in this resonance absorption has a spin 2. Improved nuclear structure and reaction calculation gives a better understanding of radiative capture rates of light-nuclei and medium-nuclei which affects the abundance of heavier nuclei.

Keywords: Neutron capture · Exotic nuclei · Energy

Assessment of the Current and Future Energy Generation Mix in Uasin Gishu County, Kenya

Dr. Silas K. Leting · Francis Karemeri

The County Government of Uasin Gishu

At the global level, local financing of energy generation in such regions has led to accelerated economic growth, reduced foreign reliance on energy, and improved system reliability. The Kenya Constitution of 2010 also set up a system of devolution that vested the responsibility of overseeing most sectors with the counties, including energy. Devolution to the Uasin Gishu County presents an opportunistic benefit in exploiting indigenous energy resources with a possibility of potentially exporting surplus power to neighboring counties and even abroad to contribute own-source revenues.This study evaluates the existing energy mix and future generations possible in Uasin Gishu County. To start with, the installed capacity is currently made up of solar (140 MW), hydro (2 MW), thermal (100 kW), and wind (less than 5 kW). Other investments in development by the private sector include the Kaptagat solar plant for ammonia production (195 MW) and the proposed Copper Hetero Junction Thin Films (Cu−HJT, 20 MW) at the African Economic Zone (AEZ). Understanding that the County is just 30 km away from Kerio Valley oil field, there is a reasonable basis to suggest that indeed it is a candidate for future oil exploration. The County has a significant scope in bio diesel (from big grain crops such as wheat, maize, and sugarcane) and biogas, with over 3,000 dairy farmers eligible for small-scale digester installation. A research on Hydrogen energy is being conducted by Moi University and will provide future opportunities in the sector. This paper attempts to approximate the collective potential energy production from such resources, quantify cost saving by reduced grid dependency, and conduct a cost-benefit analysis to assess whether an expansion in localized generation is economically viable.

Keywords: Energy Mix · Solar · Wind · Hydro · hydrogen · Biodiesel · Biogas · Cu−HJT

Thermal Neutron diffusion deceleration inside an infinite dimensions moderator. Calculating neutron age and slowing down of length for fission of neutrons, average energy to thermal energy of Graphite and Beryllium

Joseph Maritim · Prof. S.K Rotich

Moi University

Nuclear energy is clean energy technology as it produces zero greenhouse emissions. Most of the nuclear reactor products are from (n, y) reactions. This are free neutrons with kinetic energy and has large effective cross-section. Our objective was to examine the solution of a partial differential equation for the case in which the medium is unbound, calculate neutron age and thermal energy for Graphite and Beryllium. The stationary equation of the transfer of neutrons with simplifying assumptions lead to the function S which describes the source of neutrons, the required quantity $u(x, \tau)$ is concentration of neutrons per unit time, reaching the age τ; consequently, u is the density of deceleration. The solution was found by introducing the Fourier map $U(\zeta, \tau)$ of the density of deceleration $U(x, \tau)$. Taking into account the behavior of density of deceleration at infinity, we obtained $u(\zeta, \tau) = (2\pi)^{(-\zeta)} e^{(-\zeta^2 \tau)}$. When neutrons reach a specific velocity, they cease to lose energy and their motion can be described using classical theory of diffusion. Where the medium was infinite, we introduced Fourier images for ρ and q; expressed through the value of the function $q(z)$. The calculated neutron age for graphite and beryllium were found to be 12 and 9 respectively. In order to simplify the calculation, a continuous loss of energy for slowing down neutrons was assumed in state of actual discontinuous energy loss.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

AI and Big Data Technologies For Renewable Energy Management

Irine Samoei · Fancy Kiptoo

Moi University

Energy is an essential element, but its negative consequences such as environmental deterioration, resource depletion and energy dependencies puts energy efficiency alternatives/or solutions in the spotlight. Therefore there is need for the fusion of AI and Big data in promoting sustainable growth in the renewable energy sector, AI and Big Data focuses on optimizing algorithms, reducing computational needs, and using renewable energy. These technologies are main drivers for transformative approach towards achieving Sustainable Development Goals (SDG), Mainly SDG 7 (Affordable and clean energy), SDG 9 (Industry, Innovation and Infrastructure) and SDG 13 (Climate Action).This study will explore the role of AI and Big Data in renewable energy and sustainable development. The methodology will employ text mining techniques to refine AI and Big Data concepts into targeted keywords, with further filtering via the All Science Journals Classification system and SDG-mapping tools to identify publications most relevant to renewable energy applications. The research specifically investigates how predictive analytics can forecast future energy demands, assess climate risks, and identify renewable energy potential across different regions. By identifying best practices and innovation opportunities at this intersection, this study aims to provide a framework that can accelerate progress toward energy sustainability and support global efforts to achieve a net-zero future.
Keywords: Artificial Intelligence · Big Data · Sustainable Development Goals · Renewable Energy · Net Zero

Mathematical Modeling and Parameter Estimation of an Optimal Solar Food Dryer

Kenneth Korkoren · Samwel Rotich · Titus Rotich

Moi University

Eminent threat caused by post-harvest losses due to inadequate drying and poor storage is responsible for up to $40-60\%$ loses of agricultural produce each season. In order to address this issue, this paper seeks to formulate a mathematical model and simulate the characteristics of a solar dryer for the purpose of designing an effective and sustainable, low cost thermal solar dryer suitable for dehydrating a variety of agricultural products. The modelled solar food drier has four major parts, namely: solar heat collector: closed loop pipe network: heat exchangers: and the drying chamber. The mathematical model was formulated using differential equations, and simulation using SIMULINK. The simulation results showed that, a solar collector with aperture area of $A_c = 14.4m^2$ and a fluid volume of $V_c = 500l$, when exposed to solar irradiation of $I_c = 1.367KW/m^2$ at $\eta_c = 80\%$ efficiency is able to heat water from $T_{in} = 22°C$ to $T_{co} = 70°C$ in 12 hours at a flow rate of $v_c = 1.128l/s$. This energy if transmitted by insulated pipes to a set of 5 heat exchangers each of area $A = 1m^2$, and radiative heat transfer coefficient $h_r = 100W/m^2K$ cumulatively dissipates hot air of maximum $230°C$ at $v = 250cm^3/s$, and minimum of $90°C$ at $v = 2000cm^3/s$ air mass flow rate. This output temperatures of dry air is regulated as desired according to the specifications of the food products to be dried. In the absence of solar energy, liquefied petroleum gas is intermittently used depending on the level of solar insolation. It was found that the optimal cost of the gas in this energy mix is reduced by over 67.86%. This strongly makes the use of solar in food dryers an ideal green energy to be used in mitigating post-harvest losses.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Pretreatment of Lignocellulosic Materials for Improved Biogas Production. A Review

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The increase in Population and industrialization has resulted to an increase in energy demand and consumptions. Currently fossil fuels are the major source of staple energy to meet this demand. Over relying on non-renewable energy forms that are expensive, depletable and emitting large amounts of greenhouse gases hence causing adverse effects to both humans and environment. Due to these effects, there is an urgent need to explore and develop alternative and sustainable energy technologies. Use of renewable energy sources are not only sustainable but friendly both for the user and the environment and offers the best solution to address these global energy challenges. One of the sustainable energy sources is biogas that is produced by anaerobic digestion (AD)using different wastes such as agricultural residues, animal manure, and other organic wastes. Despite the availability of large amounts of agricultural waste, the use of lignocellulosic biomass for biogas production by anaerobic digestion has not been widely adopted due to the complicated structure of the plant cell wall making it resistant to microbial attack. This therefore calls for pretreatment of the lignocellulosic biomass in order to achieve the high biogas yields. This paper reviews the various pretreatment techniques, of lignocellulosic biomass for enhanced biogas production. It also highlights the limitations of these pretreatment technologies and the need to develop environmentally friendly technologies using locally available materials.
Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Intelligent Optimization of PI-Controlled Grid-Connected Inverters for Enhanced Power Quality

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The increasing penetration of renewable energy sources (solar and wind energy) into modern power grids introduces significant power quality challenges, notably power fluctuations due to their intermittent nature and total harmonic distortion (THD) caused by power electronic-based interface devices, such as grid-connected inverters. Addressing these issues requires robust control strategies to enhance system stability and efficiency. This study implements a proportional-integral (PI) current control strategy optimized using Genetic Algorithm (GA) and Particle Swarm Optimization (PSO), with Ziegler-Nichols (Z-N) tuning serving as a benchmark. The performance of the control strategy is evaluated using the Integral Time Absolute Error (ITAE) metric. Simulation results demonstrate that PSO yields superior control accuracy, reducing ITAE to for the D-axis and for the Q-axis control, followed by GA with and , while Z-N records significantly higher values of and , respectively. In terms of power quality, the total voltage harmonic distortion (THDv) remains at due to effective filtering, while the total current harmonic distortion (is minimized to with PSO, compared to for GA and for ZN. The optimized PI control strategy ensures that THD values comply with IEEE and IEC Standards demonstrating its effectiveness in mitigating power fluctuations, reducing harmonics, and improving grid stability. These findings emphasize the critical role of intelligent optimization in enhancing power quality for grid-connected renewable energy systems.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Mathematical Modelling of Energy Mix and Optimization of Renewable Energy

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Moi University

With energy as direct and indirect fundamental life supporting resource, the domestic and industrial demands for energy has been rising due to technological advancement, population increase, and economic growth. Various sources of energy including use of fuels, hydro-electric energy, geothermal energy, wind energy, solar energy and nuclear energy are all available alternative sources of energy in different proportions. Production and distribution of energy in an attempt to satisfy the inhomogeneous individual needs, in tandem with the desire to conserve the environment, has been a complex problem, with pertinent constraints including demand, supply, production, distribution and environmental impact dynamics. Mathematical Modelling of Energy Mix and stability in the interchange is considered in this research as a feasible solution to the losses through leakage and wastage, caused by distribution of unused power loading. Through the analysis of individualized demands and associated production and distribution cost. The objectives of this study is to formulate a mathematical model to analyse and determine the desired parameter thresholds that guarantee stability and robustness of energy variation. This is done using Neural Networks feedback control algorithms, with adaptation so as to automatically control and maintain the optimal stability of energy levels during changeover. Using three types of users: Household, School and Small Commercial Entreprise, simulated results show that energy shifts is stable, with a peak time $t_p = 0.4s$ and power overshoot of 18.5%. This is stabilized to acceptable tolerance of 2% in a settling time of $t_s = 4.35s$. Energy cost analysis showed that the Energy Mix of Hydro Electicity (E), Solar Power (S) and use of LPG Gas (G) is optimal when used in the ratio $E : S : G = 6 : 129 : 1$. Using a Smart Grid system, all sources of energy can be intelligently mixed for the achievement of optimal individualized energy consumption and distribution mix.
Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Effect of open metal sites on carbon capture by metal-organic framework (MOF-16); a DFT approach

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Continued combustion of fossil fuel and destruction of forest cover has caused concentrations of CO_2 in the atmosphere to continue to rise. By 2021 CO_2 concentrations was reported at 414 ppm. Consequence of CO_2 emissions that continue to manifest has necessitated for a worldwide call to combat climate change and curtail increasing levels of CO_2. This has led to the exploration of many strategies, the most viable being, carbon capture and storage (CCS). MOFs have shown great potential as an effective adsorbent for CO_2. Nevertheless, to fully exploit the capabilities of MOF-16 for enhanced CO_2 capture, it is crucial to address existing gaps such how the presence of open metal sites (OMS) defects play an important role in facilitating CO_2 adsorption by providing active sites for adsorption to take place. A comprehensive study of the influence of the open metal site defects on the frameworks' porosity, geometry and how CO_2 diffuses through the framework is essential to better understand the potential that OMS defects hold. Despite the potential that OMS defects may hold, the area remains largely unexplored. Since their discovery in the late 1990s, many MOFs have been explored as potential materials for applications in CO_2 capture and adsorption because of their porosity and chemical tenability. The assessment of MOF performance for carbon capture is based on several parameters. Key among them is selectivity for CO2 in presence of other gases, storage capacity, adsorption/desorption kinetics, stability in terms of capture and regeneration cycles and enthalpy of CO_2 adsorption. Additionally, MOFs can be designed to have open metal sites, covalently-bond polar functional groups, tunable pore size, framework flexibility and Lewis basic sites. Interaction between adsorbate and these basic sites produces multiple interactions that produce a remarkable CO_2 adsorption capacity while suppressing competing gases like N_2, CH_4 and H_2O. Metal Organic. The objective of this study is to provide computational study of the formation energies of open metal site defects of MOF-16 using theoretical simulations. This DFT study will also provide insight on the impact of OMS defects on the geometry and porosity of the framework before and after it is loaded with CO_2. Preliminary studies show that the Introduction of open metal site defects to MOF-16 enhances CO_2 adsorption capacity. Detailed analysis of effect of OMS on CO_2 adsorption, impact of OMS on structure of the framework, Effect of OMS on CO2 diffusion and porosity of the framework is on the works.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

A case of a 5 MW, 10 MWH off Grid Solar Powered Street Lighting Project for Eldoret City, Kenya

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County Government of Uasin Gishu

Street lighting, a devolved function under Kenya's Constitution (2010), is managed by County Governments. However, infrastructure is often controlled by external agencies, with one operator charging Uasin Gishu County USD 2 million annually for street lighting services, projected to rise to USD 4 million in 10 years due to tariff increases. Eldoret City enjoys high solar irradiance ($2,000kWh/m^2/year, SD \approx 50kWh/m^2/year$) and approximately 65% sunny days annually. Uasin Gishu County hosts key solar projects, including the operational $55MW$ Kesses 1 Solar Plant, the operational 40 MW Radiant Solar Plant, and the 40 MW Eldosol Solar Plant (construction completed and commissioning), totaling approximately 135 MW of installed solar capacity which is fed to the grid and about 20 MW that is captive power. This paper evaluates both technical and financial feasibility of constructing a $5MW, 10MWh$ off-grid solar plant to power 20,000 LED street lanterns ($60W, 12h/day, 5,256MWh/year$) in Eldoret City, comparing its financial implications with the current operator-based model. If the current model is maintained, it is projected that the County will spend 92 Million USD in the next 15 years for expansion, repair and maintenance and bills payment to the independent operator (driven by the annual cost escalation of 8.2%) compared to 23 Million USD required to set up, operate and maintain the proposed off grid solar plant over the same period. Additional benefits include potential carbon credit revenues $USD0.552million$(USD 10/t $CO_2e, 3,679tCO_2e/year, SD \approx 200tCO_2e$) and enhanced system reliability. The opportunities for financing of the project through Public Private Partnerships (PPP) is reviewed as a probable financing model to bridge the gap of huge initial capital costs of the project at the start which may not be accommodated within the County budget.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Application of Response Surface Methodology on the yield of maize as a fodder crop

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Maize is one of the stable foods in Kenya, and it is gaining prominence as an animal fodder crop for cattle farmers. As technology improves, and people abandon the traditional nomadic pastoralism, there is a need to have adequate storage of animal feeds to sustain animals around the season. The most important quality of fodder crops is to be lush, tall, and bushy, a characteristic determined by nitrogen uptake, facilitated by water, phosphate, and potassium. In this research, the investigation sought to ascertain the optimal vegetative yield of maize with minimum water supply using Response Surface Methodology (RSM) in semi-dry soil enriched with NPK, in a controlled greenhouse environment. The experimental treatments were determined using the Central Composite Design based on varying levels of water supply ($10\%, 25\%$, and 50% of soil field capacity), nitrogen ($10, 15$, and $25g\ hole-1$), and phosphorus and potassium equally applied at ($5, 10, 15g\ hole-1$). The investigation's findings demonstrated that increased nitrogen fertilization rate positively influenced all agronomic traits, but left high nitrogen concentrations in the soil due to minimal absorption media. Nitrogen increased plant bush weight, and leave area, but minimal water supply curtailed the plant height and agronomic attributes. The optimal levels of irrigation and nitrogen fertilizer were found to be $42.73 - 47.80\%$, and $3.38 - 5.69g\ hole-1$ respectively. The optimal amounts for NPK retention in soil and plant uptake were $82.57 - 98.00\%$, and $4.20 - 5.98g\ hole-1$, respectively. The study concluded that plants with minimal water supply, like that of semi-arid areas, require nitrogen levels not greater than 50% per hole, since excess was seen to cause leave necrosis. The availability of other nutrients was however seen to plant biomass and enhance nutrient uptake.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Modeling Potassium Phosphite Induced Pathogenic tolerance in Tomato plant to Bacterial Infection and Insect Herbivory

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Human population in the world is continually soaring high and the impact on the environment has led to global warming and food security issues. Innovation and the use smart technology in agricultural production has led to the mitigation food security issues. This advanced production techniques is not limited to genetic modification, but also encompasses mechanical advancement and investment in laboratory trials for improved varieties of propagative materials, high yields and tolerance to environmental stress and pathogens. Mathematical modelling is not left behind, as an invaluable tool that supplements laboratory and field experiments. In this research, a mathematical model was formulated to simulate induced defense mechanism of Tomato plant. This model was formulated using Enzyme-Substrate reaction pathways and simulated using SIMBIOlLOGY software, using eight variables and associated parameters. It was shown that tolerance to Bacterial, Fungal and Viral infection was seen to be significantly high as compared to untreated plants, and white fly herbivory reduced. This induced tolerance was triggered using Potassium Phosphite treatment as an elicitor, to initiate a cascade of Enzyme-Substrate reaction which activated the production of Tomatine, Phytogenesis-Related Proteins, and other Phytoalexins and defense genes. It was shown that treated tomato plants were less susceptible to infecetion, upto $s \leq 0.15$, while untreated tomato plants were highly susceptible up to over $s \leq 0.69$. The production of growth inhibitors was significantly reduced for treated plants and eventually the yield of treated plants increased by $y \geq 57\%$. The results can also be applied to induce Systemic Acquired Resistance of crops to Insect herbivory, especially on desert Locust (Schistocerca gregaria) a real devastating factor to crop production.
Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Trends of Hypertension Prevalence in Kenya

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Alupe University · Moi University

Hypertension prevalence in Kenya exhibits substantial variation across demographic and geographic groups, posing challenges for the development of universally effective interventions. This study aims to identify and analyse trends in hypertension prevalence disaggregated by age, sex, and county. We analysed hypertension prevalence trends among males and females aged $15-49$ years using data from the 2022 Kenya Demographic and Health Survey. Counties were categorised according to the 47 administrative units defined by the Kenya National Bureau of Statistics, and age was stratified into three groups: $15-24, 25-34$, and $35-49$ years. To assess prevalence inequalities across these groups, we employed a log-binomial regression model. The risk of hypertension increases significantly with age. Compared to individuals aged $15-24$ years, those aged $25-34$ exhibit a $1.77-$fold higher risk ($p = 0.000118$), while individuals aged $35-49$ demonstrate a $5.67-$fold increased risk ($p < 0.0001$). Females are at a significantly higher risk of hypertension compared to males, with a relative risk (RR) of $4.11 (p = 0.000489)$. High-risk counties include Nairobi, Kisumu, and Nakuru. In contrast, counties such as Wajir ($RR \approx 0.000004, p < 0.0001$), Nandi ($RR \approx 0.08, p = 0.003$), Elgeyo-Marakwet ($RR \approx 0.06, p = 0.015$), and Kirinyaga ($RR \approx 0.15, p = 0.019$) exhibit significantly lower risk levels. Conversely, females in Kirinyaga are at elevated risk ($RR \approx 3.64, p = 0.043$). Notably, hypertension risk among females tends to decline with age, particularly among those aged 35âĂŞ49 years (risk change: $-0.60, p = 0.018$). The findings highlight the need for targeted interventions for older adults and females, and call for further investigation into protective factors in low-risk counties to guide effective prevention strategies.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Seasonal variation in diet quality of women and young children from two agro−ecological zones in Kenya

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Climate change can disrupt food availability, reduce access to food, and affect diet quality. This study examined the effect of seasonality on household dietary diversity (HDDS) and diet quality of women and children in two agro-ecological zones of Rongai sub−county, Nakuru, Kenya. A cross−sectional study of 388 mother−child pair was conducted during lean and plenty season. Household food insecurity access scale was used to measure food security. The HDDS were computed based on 12 food groups. A 24−Hour Dietary Recall was used to generate dietary diversity scores (DDS) of women and children. The HDDS of households from low agricultural potential areas was not affected ($P > 0.05$) by seasonality despite increased food access during plenty season (57.3%) as compared to lean season (36.8%). However, in high potential areas, food access increased ($P > 0.05$) from 55.8% to 73.5% while HDDS decreased. Women who achieved minimum dietary diversity (MDD) increased [low potential areas (13.9% vs 57.8%, $P < 0.001$)] and [high potential areas (20.0% vs 49.1%, $P < 0.001$)] in lean and plenty seasons respectively. Furthermore, children who achieved MDD significantly decreased from 58.9% in lean season to 47% during plenty season in low potential areas while there was no change in the dietary diversity of children from high potential areas. Binary logistic regression showed no effect of seasonality on child diet quality, however, seasonal changes significantly ($P < 0.001$) reduced household food access, HDDS and diet quality of women. Child diet quality was not affected by seasonal variations in the two agroecological zones; however, it negatively affected household food access, household dietary diversity and diet quality of women. It is important to develop targeted season−specific nutrition interventions to adequately address food access and diet quality for improved nutrition outcomes.

Keywords: Agro−ecological zones · Seasonal variations · Dietary diversity · Diet quality

Forecasting Drought Events In Kenya Asals Region: A Cnn-Based Framework Using Chirps Precipitation Data.

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Food insecurity and economic instability have resulted from the severe effects of droughts on agricultural output in Kenya's Arid and Semi-Arid Lands (ASALs). These regions have faced increasing vulnerability due to erratic rainfall patterns, resulting in severe crop failures and livestock losses. Despite efforts to forecast droughts, existing techniques have frequently been imprecise, thereby hindering timely intervention. By developing a CNN-based framework with CHIRPS precipitation data and the Standardised Precipitation Index (SPI), this study aimed to increase the precision of drought forecasts and provide actionable insights on managing the effects of drought in ASALs by describing past drought occurrences, analysing precipitation trends, and utilising machine learning. The research involved preprocessing CHIRPS data, spanning from 1981 to 2024, to calculate SPI values and address missing data using the Inverse Distance Weighting (IDW) method. A CNN-based model that integrated precipitation's temporal and spatial characteristics was developed to forecast drought situations. The model was trained to identify spatial hotspots and forecast drought events across the 14 semi-arid counties in Kenya's ASAL region. To facilitate more informed decision-making for drought mitigation, this framework aimed to increase the accuracy and timeliness of drought predictions. When compared to conventional techniques, the CNN model performed better, improving the capacity to predict drought occurrences with more accuracy and spatial precision. The results of this study offer a useful tool for enhancing resilience in Kenya's ASALs and informing proactive drought management strategies.

Keywords: CNN−Based · Chirps Precipitation Data · Forecasting Drought

Spatiotemporal Dynamics of Drought in Kajiado County, Kenya: Insights from SARIMA Modeling and SPI Analysis

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Understanding the spatiotemporal dynamics of drought is essential for managing climate-related risks in arid and semi-arid regions. This study investigates long-term trends in drought severity in Kajiado County, Kenya, using historical climate data from 1981 to 2023. The region, predominantly inhabited by pastoralist communities, is highly vulnerable to climatic fluctuations, particularly variability in precipitation and rising temperatures. To characterise temporal trends and project future climate variability, the study employs Seasonal Autoregressive Integrated Moving Average (SARIMA) models alongside the Standardised Precipitation Index (SPI). Monthly precipitation and temperature data from three subcounties; Kajiado East, West, and Central were analysed. Following preprocessing, stationarity was assessed using the Augmented Dickey-Fuller test, and SARIMA model parameters were optimised using ACF, PACF, and information criteria metrics. The best-fitting SARIMA models were identified for each subcounty, and forecasts extending to 2028 reveal consistent seasonal patterns, particularly rainfall peaks in April and November and troughs in July and August. SPI analysis on a 3−month scale enabled classification of wet and dry periods, revealing significant interannual variability with documented extreme droughts (for example, $1982 - 1984, 1994, 2000$) and wet events (for example, 1998, 2010). The Mann-Kendall trend test and Sen's slope estimator showed statistically significant upward trends in SPI values across all subcounties, suggesting a gradual shift towards wetter conditions. However, correlation analysis between SPI and temperature anomalies revealed weak to moderate negative relationships, indicating the compounding effect of warming on drought severity. This integrated modelling approach not only quantifies past and projected climatic trends but also enhances understanding of hydroclimatic variability crucial for informed adaptation planning. The findings underscore the importance of localised forecasting tools in supporting pastoralist resilience and policy formulation in the face of intensifying climate variability.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Mainstreaming Gender and Youths in Climate Governance: Re-imagining Resilience through Marginalized Groups Political Ecology and Decentralized Innovations in Uasin Gishu, Kenya

Jonathan Bii Chelilim · Pius K. Chumba · Dr. Silas K. Leting

County Government of Uasin Gishu

Gender disparities and youth exclusion in the political ecology are significant barriers to both social and environmental resilience development in Kenya. This study utilizes a mixed-methods approach that includes quasi-experimental analysis, participatory GIS mapping, and institutional ethnography to assess how structural exclusions such as patriarchal land tenure (where just 18% of women own formal land titles) and youth and women's exclusion from policy design limit their agency in climate action.Despite such constraints, women's groups have established wetland rehabilitation programs and agro ecology, and youth groups have organized clean-up initiatives, civic education platforms, and biogas installations for reducing firewood reliance by $30-40\%$. However, many of these groups remain unregistered and informal, which precludes them from fully benefiting from institutional support and funding mechanisms. As a result, they are unable to access the financial resources and opportunities available within the county's climate budget, which is often directed toward formally recognized entities. Additionally, capacity development programs ignore local cultural constraints, e.g., gendered land inheritance patterns.This paper advocates for three key reforms: (1) the enforced implementation of 30% binding quotas for the representation of women and youth in decision-making bodies; (2) the establishment of climate finance mechanisms to support microloans for gender-responsive innovations; and (3) the integration of inter sectional vulnerability analysis into both the Kenya Climate Change Act and the Uasin Gishu Climate Change Act. These reforms are essential, as inclusive governance not only advances SDGs 5, 13, and 17, but also serves as a cornerstone for achieving sustainable climate resilience and advancing gender and youth equality in the long term.

Keywords: Keyword 1 · Keyword 2 · Keyword 3 · Keyword 4 · Keyword 5

Innovative bioremediation of heavy metals in aquatic ecosystems: harnessing polar crude phytochemicals for targeted extraction of metal Ions

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Heavy metal pollution in aquatic environments is a pressing global concern due to its detrimental impacts on both human health and ecosystems. The contamination of heavy metals such as iron(III), lead(II), and copper(II) in water bodies is largely attributed to industrialization, urbanization, and agricultural activities, which release untreated or inadequately treated wastewater into aquatic systems. These metals are toxic, potentially carcinogenic, and can bioaccumulate in biological systems, posing significant risks to neurological, liver, kidney, and reproductive health. Conventional methods for removing heavy metals from water often involve high costs and complex processes, limiting their practical application. Therefore, there is a growing need for innovative, eco-friendly, and cost-effective solutions to mitigate heavy metal pollution. Phytochemicals, derived from plants, offer a promising alternative due to their natural origin and potential for selective metal ion removal. This study extracted polar phytochemicals from South African plants using hot water, followed by precipitation under vacuum to remove water. The phytochemicals were then dissolved in water-saturated butanol, creating a biphasic system in a vial containing water with a dissolved mixture of ten heavy metals. The biphasic system was shaken on a desktop mechanical shaker for 24 hours. Water samples were collected from the aqueous layer of the biphasic system and analyzed using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) to assess the removal efficiency of the phytochemicals for metal ions. This study explored the use of polar phytochemicals from South African plants as a sustainable approach for water purification. By leveraging these phytochemicals, the aim is to develop an efficient and environmentally friendly method for removing heavy metals from contaminated water sources, aligning with broader efforts in pollution and waste management to protect aquatic ecosystems and human health. These phytochemicals demonstrated significant potential in removing heavy metals from aqueous solutions. Specifically, they efficiently extracted iron(III) ions, achieving a removal rate exceeding 80%, while lead(II) and copper(II) ions are removed at rates of over 40% and 20%, respectively, even in the presence of eight other metal ions. The extraction efficiency is influenced by the pH of the solution: iron(III) ions are predominantly removed at lower pH levels, followed by lead(II) ions at slightly higher pH values, and copper(II) ions at even higher pH levels. This pH-dependent behaviour highlights the effectiveness of the phytochemicals in selectively removing different metal ions based on the solution's acidity or alkalinity. Iron(III) extraction remains consistent regardless of the concentration of phytochemicals used. However, for lead(II) and copper(II), there is a noticeable increase in extraction efficiency with higher concentrations of the phytochemicals. These phytochemicals demonstrated significant potential

in removing heavy metals from aqueous solutions, which positions them as a sustainable and efficient solution for heavy metal decontamination in water treatment applications. This study extracted polar phytochemicals from South African plants using hot water, followed by precipitation under vacuum to remove water. The phytochemicals were then dissolved in water-saturated butanol, creating a biphasic system in a vial containing water with a dissolved mixture of ten heavy metals. The biphasic system was shaken on a desktop mechanical shaker for 24 hours. Water samples were collected from the aqueous layer of the biphasic system and analyzed using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) to assess the removal efficiency of the phytochemicals for metal ions. This study explored the use of polar phytochemicals from South African plants as a sustainable approach for water purification. By leveraging these phytochemicals, the aim is to develop an efficient and environmentally friendly method for removing heavy metals from contaminated water sources, aligning with broader efforts in pollution and waste management to protect aquatic ecosystems and human health. These phytochemicals demonstrated significant potential in removing heavy metals from aqueous solutions. Specifically, they efficiently extracted iron(III) ions, achieving a removal rate exceeding 80%, while lead(II) and copper(II) ions are removed at rates of over 40% and 20%, respectively, even in the presence of eight other metal ions. The extraction efficiency is influenced by the pH of the solution: iron(III) ions are predominantly removed at lower pH levels, followed by lead(II) ions at slightly higher pH values, and copper(II) ions at even higher pH levels. This pH-dependent behaviour highlights the effectiveness of the phytochemicals in selectively removing different metal ions based on the solution's acidity or alkalinity. Iron(III) extraction remains consistent regardless of the concentration of phytochemicals used. However, for lead(II) and copper(II), there is a noticeable increase in extraction efficiency with higher concentrations of the phytochemicals. These phytochemicals demonstrated significant potential in removing heavy metals from aqueous solutions, which positions them as a sustainable and efficient solution for heavy metal decontamination in water treatment applications.
Keywords: Copper(II) · Flavonoids · Green chelators · iron(III) · lead(II)· Phenolics

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