Conference Theme and Thematic Areas

Welcome to the

International Conference

From Science to Integrated Socio-economic Development - Understanding Ecosystem Degradation, Restoration Ecology and Water Management in the Lake Basin Region of Kenya

3rd - 6th February, 2015 in
Port Florence HALL

Kisumu Hotel - Facility of
Maseno University – Kenya

Moi University Press, Moi University, Eldret, Kenya

Contents

Conference Organization:

In Collaboration between Maseno University; Moi University; Lake Basin Development Authority; - Kenya; BayCEER-CREATE at University of Bayreuth - Germany and ARIDnet - China-USA; Ministry of Environment, Water and Natural Resources;- Kenya.

Conference Theme

Integrated Ecosystem and Water Management in the Lake Victoria Basin Region of Kenya

Thematic Areas:

1. Ecosystem Services Research and Management
2. Ecosystem Restoration Studies
3. Water Dynamics and Soil Integrity
4. Reforestation and Tree Planting
5. Nutrient Management Technologies
6. Valuation, Maintenance and Productive Use of Wetland Ecosystems and Services
7. Information and Outreach Material Aimed at Communities.
8. Governance, Management Insights and Analysis of Institutional Designs
9. Bio-economic Research and Development
10. Biodiversity and Key Species
11. Water Quality Issues
12. Diversification in Small Holder Farms
13. Social Motivation and the Response to Global Change
14. Land degradation and Desertification

Preface

Consortium for Research in East African Tropical Ecosystems

From Science to Integrated Socio-economic Development - Understanding Ecosystem Degradation, Restoration Ecology and Water Management in the Lake Basin Region of Kenya

Lake Victoria Basin ecosystems are increasingly affected by human activities as a consequence of global change. Working to best support community activities and improve human well-being is a complex task facing development agencies, policy makers and managers, who, in turn, require scientific advice on which to base their resource management decisions. In this regard, conceptualization of social-ecological-system drivers and their interactions, forefront scientific advances, innovative approaches to problem solving, applied methodologies to improve human well-being, and enhancements in education must be combined in order to improve livelihoods. For success in this effort, the Lake Basin Development Authority (LBDA) and Western Kenya universities strive to form alliances with many actors, who in the past have worked independently by sector, or who have focused their work on areas that are ill-defined with respect to the Lake Basin boundaries. Currently, a large sector of the Western Kenyan population complies neither with scientific advice or legal norms; or fails to respond to socio-economic instruments of existing organizations intended for improved natural resource management. Thus, the regulatory measures meant to influence long-term change, along with socio-economic opportunities, and their compatibility with local environmental perceptions and local environmental knowledge must be reassessed and redirected.

Discussions on how to best organize integrated science and management that will draw on new approaches, contribute to resource integrity, achieve new gains in provisioning services, as well as find acceptance among the local population are planned for a conference held in Kisumu, Kenya during February 2015. The conference goal is to develop new partnerships, information exchange and cooperative initiatives that contribute to education, problem solving and resource management in the Lake Basin region. In particular, the meeting will foster a strong cooperation among Maseno University, Moi University and the Lake Basin Development Authority and with international input from the Consortium for Research in East African Tropical Ecosystems (CREATE). The CREATE platform is open to all researchers interested in advancing human well-being in the East African region (see http://www.bayceer.uni-bayreuth.de/CREATE/).

The conference is oriented to establishing new partnerships among BayCEER-CREATE and Kenyan researchers (e.g., project development) within a framework that integrates LBDA's vision in the Kenyan portion of the Lake Victoria basin. LBDA is a development agency whose socio-economic enhancement activities must be based on informed scientific foundations to ensure long-term profits of communities in the basin. CREATE, LBDA and local researchers are dedicated to promoting focused and ongoing communication that leads to maximum returns from environmental, conservation, and applied science research. The conference should lead to key analysis and demonstration project research for linking science to environmental preservation, social justice and economic efficiency.

Welcome Notes

Message from the Vice Chancellor, Maseno University

On behalf of the Maseno University (MSU) fraternity, conference organizers and sponsors, it gives me great pleasure and privilege to welcome you all to Maseno University Kisumu Hotel, Kenya and to this year's conference. Maseno University has championed the globalization process by developing and transmitting knowledge and skills through research and training both locally and internationally. The University's commitment to research is reflected through our actualization and hosting of this year's International Conference where researchers and scholars will converge to share and discuss ideas under the theme *"Integrated Ecosystem and Water Management in the Lake Victoria Basin Region of Kenya."*

We are anticipating the largest and most important convention in the field of Ecosystem and Water Management ever seen in this region, addressing all the relevant aspects of current ecosystem, water management, and health in the global world. The interest of the scientific community became apparent by the remarkable number of participants, as well as the overwhelming number of submitted abstracts. The conference will bring together ecological scientists, Agriculturalists, environmentalists, public health professionals, water industries representatives and NGO's with the aim of providing updates on research and education agenda related to main subject areas of "The Challenges of Social-Ecological-System Management in Lake Victoria Basin of Kenya and Tools and Approaches for the Environmental Management".

You will be delighted to find a programme of the highest scientific quality with keynote lectures, symposia, meet-the -expert sessions, educational workshops, and additional meetings of the study and working groups. We have invited the most knowledgeable specialists on the selected subjects with speakers in the oral sessions having been chosen from among the authors of the best abstracts, according to the rating by the reviewers.

As we all know global dynamics require concomitant and appropriate change in skills and technology through value systems and policies in order to push the world's development in the right direction. Proper adaptation to the challenges and opportunities of global dynamics will require leveraging knowledge, technology and socio–economic diversity in every part of the world. The aim of this conference is to present papers that will highlight changes in key areas of the world's development and to give insight to well integrated strategic approaches to dealing with the challenges of global dynamics relating to the ecosystem and water management. Globalization will be meaningful through enhanced sharing and exchange of research and scientific ideas.

It is our hope that you will not only enjoy the conference in one of the world's first-class conference venues (Kisumu-Hotel) but also get a chance to meet and interact with friends and colleagues from around the world. Whilst the programme is packed and of a top-notch quality, you should not miss the opportunity to discover the serene environment of Kisumu; one of the most beautiful and dynamic city in Kenya and if possible take a trip to Maseno University main Campus.

I wish you all the best during your stay here.

Professor Dominic W. Makawiti, EBS, HSC, FKNAS, FAAS
Vice Chancellor

Message from the Vice Chancellor and Chairman of the Advisory Committee of the Conference

On behalf of the Advisory Committee and on my own behalf I wish to take this opportunity to welcome participants to the conference. Moi University was established in 1984 as the second public University in Kenya with a student population of 83 in the faculty of Forestry. It has grown over the years and currently has over 50,000 students enrolled in fourteen Schools namely:

School of Medicine; School of Information Sciences; School of Human Resource Development; School of Law; School of Aerospace Sciences; School of Biological & Physical Sciences; School of Engineering; School of Education; School of Arts & Social Sciences; School of Business & Economics; School of Nursing; School of Dentistry; School of Public Health and School of Tourism, Hospitality & Events Management

What makes Moi University "tick" are the unique programmes we roll out which address the needs of the country and contribute towards the realization of the Kenya Vision 2030 and Millennium Development Goals. These programmes enable us to produce qualified and practical oriented personnel in health, education, law, business, technology, sciences and even aviation sectors.

Moi University has been at the forefront in the expansion of university education in the country by bringing education closer to the people and at the same time based our research to address problems facing the societies and humanity in general. The University takes cognisance that economic growth depends on the skills and expertise of its human resources and in order to

enhance capacity to produce experts in various fields we have enriched our curricula to incorporate strong entrepreneurship concept and also take a more practical approach in our activities.

Our vision as University of Choice in nurturing innovation and talent in Sciences, technology and development remain focused and we warmly invite all individuals with the same vision to join us so that together we can drive the vision to greater heights.

I wish to appreciate the quality of papers that will be presented on the thematic areas and hope that they will contribute in further research and the establishment of relevant policies on ecosystems and natural resources for the benefit of humanity.

Thank you

Prof. Richard K. Mibey, FWIF, EBS
Vice Chancellor

Message from the Managing Director of Lake Basin Development Authority

The Lake Basin Development Authority (LBDA) is a Regional Development Agency, under the Ministry of Environment, Water and Natural Resources. It was established by an act of parliament (Cap 442) on the 31st of August 1979 to provide an avenue for a quicker, more meaningful development in the Kenyan portion of the Lake Victoria Basin. The Act empowers the Authority to undertake overall integrated planning, co-ordination and implementation of programs in the basin through mobilization of resources and assets in pursuit of improving livelihoods and development in the region. The Authority's area of jurisdiction covers a land area of approximately 39,000-km^2 exclusive of a Lake area of about 4,000-km^2. The region covers 18 counties with an estimated population of over 16 million people.

LBDA's mission to the people of this region is to foster integrated socio-economic programs through optimum utilization of resources using appropriate technology and innovations for improved livelihoods. We have therefore taken a deliberate step to partner up with the academia. This is to ensure that development initiatives and management of the resources of Lake Basin ecosystem is informed by and built on strong scientific foundations for profitable investments and long-term sustainability.

As we welcome you to this unique conference in Kisumu City, it is my hope that the opportunities provided by this gathering will stimulate insightful thinking and discussions that will support the integration and bridging of high level knowledge with real

time sustainable development. It is also my commitment and that of my fellow conference organizers that the thoughts and suggestions which will emerge shall culminate in enhanced research and creation, as the name implies, of implementable programmes and projects in the region.

The conference is also expected to foster new partnerships between CREATE and Kenyan researchers that will focus on efforts to change the paradigms of Ecosystem development in ways that integrates LBDA's vision and ensures the attainment of environmental effectiveness, social justice and economic efficiency. I do believe that all participants in this forum have dedicated their time to come over here in Kisumu because the subject of the conference is dear to their hearts and their participation will lead to maximum returns on environmental conservation, and applied science research in the Basin.

Welcome to the LBDA region and in particular to the conference.

Dr. Eng. Kabok P. Aguko, PhD. CE.
Managing Director

Members of Advisory Committee

1. Prof. Richard Mibey	- Vice Chancellor, Moi University, Kenya (Chairman)
2. Prof. Dominic Makawiti	- Vice Chancellor, Maseno University, Kenya
3. Dr. Eng. Peter Kabok	- Managing Director, Lake Basin Development Authority, Kenya
4. Prof. John Tenhunen	- CREATE, University of Bayreuth, Germany
5. Prof. J.C. Onyango	- CREATE, Maseno University, Kenya, Secretary
6. Prof. James Reynolds	- ARIDnet, Lanzhou University, China, and Duke University, USA

Conference Technical Committee

1. Prof. J.C. Onyango	- Chairman (Maseno University)
2. Prof. Ambrose Kiprop	- Member (Moi University)
3. Dr. Chrispin Kowenje	- Member (Maseno University)
4. Dr. Evans A. Atera	- Member (LBDA)
5. Dr. Rose C. Ramkat	- Member (Moi University)
6. Ms. Lilian Akeyo	- Member (Maseno University)
7. Mr. Joseph Okotto-Okotto	- Member (LBDA)
8. Mr. Chris Okech	- Secretary (Moi University)

Keynote Speakers

Prof. J. C. Onyango

Topic: *Land Use Systems and Alternative Technologies: Lake Victoria Basin Perspectives*

Prof. John Tenhunen

Topic: *Analyzing Time Dependent Change in Ecosystem Service Provision in Regional Social-ecological-systems: A Watershed-oriented Approach*

Prof. James Reynolds

Topic*: ARIDnet: Understanding Interdependencies of Natural and Human Systems as Nonlinear Agents of Land Degradation*

Chief Guest

Opening Ceremony

By

Prof. Judi W. Wakhungu,
Cabinet secretary
Ministry of Environment, Water and Natural Resources

Conference Programme

Day 1 Tuesday, February 3, 2015		
Conference Opening Ceremony		
Venue: Port Florence Hall		
Time	**Activity**	**Responsibility**
08.00 am - 08.20 am	Registration of Participants	Secretariat
08.20 am - 08.30 am	Introductory Remarks	Prof. J.C Onyango
	Chair: Prof. Richard K. Mibey Rapporteur: Dr. Pauline Andago and Mr. Chris Okech	
08.30 am - 09. 30 am	Welcoming Remarks	VC Maseno University; MD Lake Basin Development Authority; and VC Moi University
09.30 am - 10.20 am	Guest of Honor's Address and Official Opening	Prof. Judi W. Wakhungu

10.20 am – 11.00 am	**GROUP PHOTO / HEALTH BREAK/ TEA/ COFFEE**
	"The Challenges of Social-ecological-system Management in the Lake Basin Region of Kenya" Presentation session 1-1: KEY NOTE SPEAKERS Chair: Dr. Eng. Peter A. Kabok Rapporteur: Dr Musyimi D. Mutisya and Mr Philip Oloo
11.00 am - 11.30 am	1-#1-1 Land Use Systems and Alternative Technologies: Lake Victoria Basin Perspectives J. C. Onyango
11.30 am - 12.00 am	1-#1-2 Analyzing Time Dependent Change in Ecosystem Service Provision in Regional Social-ecological-systems: A Watershed-oriented Approach John Tenhunen
12.00 am - 12.30 pm	1-#1-3 ARIDnet: Understanding Interdependencies of Natural and Human Systems as Nonlinear Agents of Land Degradation James Reynolds

	"The Challenges of Social-ecological-system Management in the Lake Basin Region of Kenya" Presentation session 1-2: Oral Presentations Chair: Prof. Dominic Makawiti Rapporteur: Dr. David M. Musyimi and Mr Oloo P
12.30 am - 12.45 pm	1-#1-4 Opportunities and Limitations of Remote Sensing for Ecological Studies. Examples from Sub-Saharan Africa Cyrus Samimi
12.45 am - 13.00 pm	1-#1-5 Integrating Former Data Sources and Modern Geo-Information Technology for Ecosystem Research and Management – Potentials and Challenges Gertrud Schaab
13.00 pm – 13.15 pm	1-#1-6 Converting Savanna into Agro-ecosystems: Impacts on Ecosystem Structure and Function under Changing Precipitation Regime Dennis Otieno
13.15 pm - 14.00 pm	HEALTH BREAK/ LUNCH BREAK

	"The Challenges of Social-ecological-system Management in the Lake Basin Region of Kenya" Presentation session 1-4: Oral Presentations Chair: Prof. John Tenhunen Rapporteur: Dr Fredrick Kengara and Mr J. Gambo
14.00 pm – 14.15 pm	1-#1-7 Land Use Change, Food Security, and Ecosystem Services in the Lake Victoria Basin Sebastian Arnhold and Eun-Young Jung
14.15 pm – 14.30 pm	1-#1-8 Assessment of the Impact of Community Participation in Management of Kuywa Sub-catchment Herbert Chamwada, Joshua Obiri, Denis Masika, George Anyona and Julian Ogondo
14.30 pm – 14.45 pm	1-#1-9 Communicating Sustainable Development: The Role of Social Sciences Omondi Ahawo
14.45 pm – 15.00 pm	1-#1-10 From Science to Integrated Socio-economic Development – Scientific Planning and Community Response Kurt Beck

15.00 pm – 15.15 pm	1-#1-11 Poverty Vulnerability and Natural Resource Dependency under Environmental Change Trung Thanh Nguyen
15.15 pm – 15.30 pm	1-#1-12 Tradeoffs between Crops and Other Benefits Derived from Wetland Areas: Short-term Gain versus Long-term Livelihood Options in Ombeyi Watershed, Kenya Serena A. A. Nasongo, Charlotte de Fraiture, J.B Okeyo-Owuor
15.30 pm – 15.45 pm	1-#1-13 The Error of Management: Recent Experiences in Implementing Fisheries Co-Management in Lake Victoria, Kenya Kevin Odhiambo. Obiero, Richard O. Abila, Murithi J. Njiru, Phillip O. Raburu, Alfred, O. Achieng, Rodrick Kundu, Erick Ochieng Ogello, Jonathan Mbonge Munguti
15.45 pm – 16.00 pm	1-#1-14 To Conserve or Convert Wetlands: Evidence from Nyando Wetlands, Kenya Francis Onyango Oduor, Phillip Okoth Raburu and Samuel Mwakubo
16.00 pm – 16.15 pm	1-#1-15 Flood Management: A Sustainable & IWRM Approach – Kapsoya, Eldoret, Kenya Ehagi Hyuga
16. 15 pm – 16.30 pm	**HEALTH BREAK/ TEA/ COFFEE**

	"Tools and Approaches for Environmental Management" Presentation session 1-5: Oral presentations Chair: Prof Ambrose K. Kiprop / Prof. Gehard Rambold Rapporteur: : Dr Fredrick Kengara and Mr J. Gambo
16.30 pm – 16.45 pm	1-#2-16 Defining an Ecologically Meaningful Seasonality to Assess the Impacts of a Changing Climate on Carbon and Water Cycling in Semi-arid Ecosystems Christoph Thomas
16.45 pm – 17.00 pm	1-#2-17 Enhancing Wetland Ecosystem Services Through Integrated Aquaculture Production Systems (Fingerponds) at the Shores of Lake Victoria J. Kipkemboi
17.00 pm – 17.15 pm	1-#2-18 Assessing Vegetation Impact on Ecosystem Water Cycles with Stable Oxygen Isotopes Christiane Werner
17.15 pm – 17.30 pm	1-#2-19 Soil Water Monitoring in Savannah Ecosystems Bernd Huwe

17.30pm – 17.45 pm	1-#2-20 Surface-groundwater Interactions in Ombeyi Watershed Floodplain Wetlands Kosgei J. R., M. McClain, C. de Fraiture and J. Kipkemboi
17.45pm – 18.00 pm	1-#2-21 What matters? Unraveling the Complexity of Slow and Fast Variables to Determine Sustainability of Agroecosystems in Northern Tajikistan Corrie Hannah
18. 00pm – 21.00 pm	Conference Cocktail Ms Lilian Akeyo & Ms Betty Okoko

Day 2 **Wednesday, February 4, 2015**	
Time	**Activity**
08.00 am - 08.15 am	Day one highlights: Day 1 Rapporteurs
	"Tools and Approaches for Environmental Management" Presentation session 2-1: Oral presentations Chair: Dr. Evans A. Atera / Prof. Christoph Thomas Rapporteur: Dr. Were L.L Munyendo. and Ms. Winnie N. Nyairo
08.15 am – 08.30 am	1-#2-22 A Development of Forest Fire Forecasting and Monitoring Information System in Vietnam *Pham Van Dien, Phung, Nam Thang, Trung Thanh Nguyen and John Tenhunen*
08.30 am - 08. 45 am	1-#2-23 The Locality of Knowledge Production: Power Differentials in Expert and Practical Knowledge in the Lake Victoria Basin *Eberhard Rothfuss,*
08.45 am - 09. 00 am	1-#2-24 Options to Monitor Microfungal Diversity in Western Kenya *Gerhard Rambold*

09.00 am - 09.15 am	1-#2-25 Stable Isotope Natural Abundance Data as a Tool to Elucidate the Complex Nutrition Pathways of Orchids *Gerhard Gebauer*
09.15 am - 09.30 am	1-#2-26 The Value of Kenyan Aquatic Biodiversity and Implications of Climate Change on the Future Biodiversity *Musyimi D.Mutisya*
09.30 am - 9.45 am	1-#2-27 Structural and Functional Responses of Macroinvertebrate Assemblages to changes in Water and Habitat Quality in the Upper Reaches of the Nzoia River Basin, Kenya *Frank O. Masese, Phillip O. Raburu and Mucai Muchiri*
09.45 am – 10.00 am	1-#2-28 Impacts of Human Disturbance on Macroinvertebrate Assemblages within Chepkoilel River Swamp, Upper Nzoia River Basin *Patrick Oduor Orwa, Phillip Raburu, and Steve Omari Ngodhe*
10.00 am – 10.15 a.m	1-#2-29 Delineating Lake Victoria Fishes: A Key to Managing the Fishery *Dorcas Lusweti and Rose Ramkat*

10.15 am – 10.30 a.m	1-#2-30 Phylogenetic Study of the 'endangered' Ripon Barbel, *Barbus altanialis* (Boulenger, 1900) (Cyprinidae) in Lake Victoria Catchment Based on Mitochondrial DNA Sequences *Emily J. Chemoiwa, Jennifer Lamb, Romulus Abila, Elizabeth W. Njenga, Angus Macdonald, James Barasa*
10.30 am - 11.00 am	**HEALTH BREAK/ TEA/ COFFEE**
	"The Challenges of Social-ecological-system Management in the Lake Basin Region of Kenya" Presentation session 2-2: Oral presentation Chair: Prof. Getrud Schaab / Prof P.O. Owuor Rapporteur: Dr. Were L.L Munyendo and Ms. Winnie N. Nyairo
11.00 am - 11.15 am	1-#1-31 *Striga* Pandemic in Western Kenya: A Limiting Biological Constraint to Food Production *Evans A. Atera and John C. Onyango*
11.15 am - 11.30 am	1-#1-32 Development of Cowpea (*Vigna unguiculata*) Varieties Resistant to *Striga gesnerioides* and *Alectra vogelii.* *Rose C. Ramkat, Dorcas Lusweti, and Evans A. Atera*

11.30 am - 11.45 am	1-#1-33 Horticultural Biodiversity for Sustainable Diets, Long Term Health and Economic Development *Abukutsa Mary O.O*
11.45 am - 12.00 noon	1-#1-34 Determinants and Extent of Diversification in Smallholder Rice Farms in the Face of deteriorating climatic Conditions: Case Study of Bunyala Rice Farmers in Bunyala District, Busia County *David Okong'o, Jared Gambo, Joseph Okotto-Okotto and Peter Kabok*
12.00 noon - 12.45 pm	1-#1-35 Evaluation of Upland Rice Response to Interseasonal Variations in Water Availability: Regulation of Carbon Gain and Water Use in Relation to Yields *Wei Xue, John Tenhunen, J. C. Onyango*
12.45 pm – 13.00 pm	1-#1-36 Effects of Ridge-furrow and Plastic-mulching Tillage on Maize Production and Water-saving at Melkassa in Ethiopia *Bin-xian Wang, Ben-qiang Gao, Zhi-qiang Yua_Dinka Zewudie, Dejene Abera, Rong Zhang, Feng-min Li*

13.00 pm - 13.15 pm	1-#1-37 Ecological Factors Influencing Spatial Distribution of Large Grazing Herbivores in Ruma National Park of Homabay County, Kenya *Kanyi Luke Lukaria*
13.15 pm - 14.00 pm	**HEALTH BREAK/ LUNCH BREAK**
	"Tools and Approaches for Environmental Management" Presentation session 2-3: Oral presentation Chair: Dr. Rose Ramkat Rapporteur: Dr. Dorcas Lusweti and Mr. J. Obiri
14.00 pm – 14.15 pm	1-#1-38 Nutrient Load and Heavy Metals in the Water Along Rivers Amala and Nyangores Tributaries of Mara River in Kenya for Assessment of Recent Increase in Anthropogenic Activities *W. Nyanduko Nyairo, P. Okinda Owuor and Fredrick O. Kengara*
14.15 pm – 14.30 pm	1-#1-39 Influence of Anthropogenic Activities on Seasonal Variations of Nutrients in Spring Water along Amala and Nyangores Tributaries of the Mara River Basin *James J. Owuor, Fredrick O. Kengara, P. Okinda Owuor*

14.30 pm – 14.45 pm	1-#1-40 Assessment of Water Quality using Multivariate Techniques in River Sosiani; Upper Catchment of Nzoia River *Achieng' A. O, Raburu. P. O, Kipkorir. E. Obiero K. O, Ngodhe S. N and Sabwa J. A*
14.45 pm – 15.00 pm	1-#1-41 Luffa-Aqua Purifier as A Source of Domestic and Industrial Water *Malala J.B, Jiveri B.K, Ochieng E.M, Njiru C, Kahindo J.M, Matoka C.M. and Chimbevo L.M*
15.00 pm – 15.15 pm	1-#1-42 Suitable Combination of Selected Locally Available Materials for Domestic Water Purification *Erick Omondi Agunja and Chrispin Ounga Kowenje*
15.15 pm – 15.30 pm	1-#1-43 A Comparison of Adsorption Equilibrium, Kinetics and Thermodynamics of Aqueous Phase Clomazone between Faujasite X and a Natural Zeolite from Kenya *Victor Odhiambo Shikuku, Kowenje O. Chrispin, Renato Zanella, and Osmar D. Prestes*

15:30 pm – 15.45 pm	1-#1-44 Prediction of Gold Speciation in the Environs of Kakamega Mines using Sulphates Concentrations as Species for WATCH Computer Program in Water Quality Management *Were L.L. Munyendo, Christine Adika, Ambrose K. Kiprop and Joshua Kibet*
15. 45 pm – 16. 15 pm	HEALTH BREAK/ TEA/ COFFEE
16. 15 pm – 18. 00 pm	ARIDnet Plenary Session

DAY 3 Thursday, February 5, 2015	
Time	**Activity**
08.00 am - 08.15 am	Day two highlights: Day 2 Rapporteurs
	Tools and Approaches for Environmental Management Presentation session 3-1: Oral presentation Chair: Prof. Bernd Huwe / Prof. Abukutsa Onyango M.O. Rapporteur: Dr. Kosgei J. and Dr Fredrick O. Kengara
08.15 am - 08. 30 am	1-#2-45 Technologies, People and the Environment Uli Beisel
08.30 am - 08. 45 am	1-#2-46 Impacts of Selective Logging on Regeneration, Population Structure and Dynamics of a Canopy Tree (Olea capensis) in Kakamega Forest Tsingalia, H. M
08.45 am - 09. 00 am	1-#2-47 Land and Water Resource Planning and Management Options in Floodplain Wetlands: A Case Study of Ombeyi Watershed; Nyando Basin. J. R. Kosgei, S. Nasongo, J. Kipkemboi, N. Kitaka, J.B. Okeyo-Owuor

09.00 am - 09.15 am	1-#2-48 Comparing daily Precipitation Indices on the Chinese Loess Plateau Jian-Sheng Ye
09.15am - 09.30 am	1-#2-49 Why the Sum is Less Than the Parts: Some Recent and Ongoing Research on Nzoia River Basin Joel Kibiiy, Job Kosgei, Lawrence Muku, and Patrick Willems
09.30am - 09.45 am	1-#2-50 Potential of Lubricating Oil (MGALO) and Organic Bio-fertilizer Production from Marine Green Algae (Patent Number, KE/UM/2012/00295) Bonface Jiveri, Malala Bonface, and Sylvester Anami
09.45 am – 10.15 am	**HEALTH BREAK/ TEA/ COFFEE**
	Presentation session 3-2: Group discussions Chair: Prof Cyrus Samimi Rapporteur: Dr. Kosgei J. and Dr Fredrick O. Kengara
10.15 am - 10.30 am	Day three highlights: Day 3 Rapportuers
10.30 am - 13.00 am	Venue: Port Florence Hall Parallel Group Discussions {CREATE / ARIDnet}

13.00 pm -13.30 pm	**CLOSING REMARKS BY** **H.E. Hon. Jackton Ranguma** **The Governor of Kisumu County**
13.30 pm - 14.15 pm	**HEALTH BREAK/ LUNCH BREAK / DEPARTURE**
14.15 pm – 17. 30 pm	Excursion: Impala Reserve, rice paddies, rice mill, fish farm In charge: Mr. Joseph Okotto Okotto and Prof. Ambrose K. Kiprop
18.00 pm -	Cocktail Ms. Lilian Akeyo & Ms. Betty Okoko

Closed Session Day 4 By Invitation Only Friday, February 6, 2015	
Time	**Activity**
08.00 am – 10.00 am	Presentation session 4-1: Group Discussions-2 Chair: Prof. Cyrus Samimi & Prof. J.C. Onyango Rapporteur: Dr. Pauline Andago and Mr. Chris Okech
10.00 am - 10.30 am	**HEALTH BREAK/ TEA/ COFFEE**
10.30 am - 13. 00pm	Plenary/Group presentations
13.00 pm – 14.00pm	**HEALTH BREAK/ LUNCH BREAK**
14.00 pm	**DEPARTURE / BON VOYAGE**

Abstracts for Presentation at Create-Conference

3rd – 6th February 2015

1-#1-1

Land Use Systems and Alternative Technologies: Lake Victoria Basin Perspectives

J. C. Onyango, University Botanic Garden, Maseno University
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Climate change is a function of land use systems that leads to continual changes in the weather patterns in Lake Victoria region. Currently, there are diverse alternative land use activities in the Lake Victoria Basin (LVB) that are more consumptive than conserving of the available natural resources. These land uses are less sustainable and have resulted in widespread resource degradation, leading to continued poverty. Although the general population, farmers, politicians, and development agents within the basin are enthusiastic about potential economic benefits and use of the land and land systems to revitalize regional and national economies, and specifically within the rural landscapes, it is worth noting that the rapidly expanding, highly visible and potentially polarizing investments and decisions are being made in an often chaotic manner that is not consistent with value-based and data-based information. Frequently, there has been little or no long-range planning or perspectives and no visible efforts to consider the externalities (such as natural resource and community impacts) that will occur as a result of these activities.

Current investments are ignoring the foundational principles of sustainability: profiting producers, benefiting the environment, and providing long-term assets to the community as a whole. Critical questions must be addressed.

- What are the effects of current land use practices and technologies that largely entail increased removal of crop residues, monoculture, continuous cropping, and increased nutrient and pesticide inputs on environmental sustainability, especially soil erosion, soil organic matter, and water quality?
- What are the effects on food and feed costs throughout the region?
- How will local communities deal with increased transportation and other infrastructure requirements, and environmental damage done to community resources, especially the land?
- Will investments really create wealth for local communities or will they enhance the current extractive economy in which wealth derived from local natural resources is removed from rural economies?

Key words: *land use systems, technologies, sustainability, natural resources*

1-#1-2

Analyzing Time Dependent Change in Ecosystem Service Provision in Regional Social-ecological-systems: A Watershed-oriented Approach

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The management of social-ecological-systems (SESs) for the sustainable acquisition of ecosystem services (ESs) requires us to understand the influences of variables acting at different time and spatial scales, as well as the complex interactions among social and biophysical system components. In fact, any analysis of an SES is based on educated choices and focuses on a selected and limited number of processes and variables, and their interplay. Analytical traditions in the social sciences, in economics and in ecosystem science provide us with partial frameworks within which to describe SESs. While even within these partial frameworks critical simplifications are required, the major problem facing us today is how to profitably link together these differently constructed frameworks and relate them to potential global change impacts and long-term natural resource management. This problem has no clear or single solution but is best addressed in an experimental context, exploring possible system descriptions with respect to a clearly defined question and in a defined cultural frame of reference. A project design is described which examines historical and future trajectories in regional change; ecosystem processes, especially in farming

areas that are hotspots of non-point water pollution; process-based assessment modeling; watershed level carbon, water and nutrient balances; economic gains, losses due to environmental impacts, and environmental efficiencies; regional management efforts; and the educational approaches that will support a new paradigm in adaptive resource management.

The potentials for applying such an approach in the Nzoia River Basin of Kenya with regard to de- versus re-forestation, as well as to pollution of water resources and/or erosion versus supplying the needs of rural stakeholders are discussed. The need for a vision that allows new bridging between sophisticated scientific endeavors and end-user applications is emphasized. Commitment and willingness to develop new channels of communication between academics and dependent stakeholders must be given equal priority with science research required to understand critical components of the natural resource base. The solution to environmental problems depends on community-based approaches where local stakeholders are informed and convinced about potential undesirable losses in ecosystem services; services that are part of their heritage. As an example, we discuss experiences with local stakeholders, steps in communication that have led to local change in areas surrounding Saiwa National Park, and alternatives that have been accepted and have permitted wetland rehabilitation. Future resource management depends strongly on this type of acceptance and support by local stakeholders or ecosystem service end-users. The end-users must be tied into resource management networks embodying new partnerships between natural scientists, social scientists and communities.

Key words: *social-ecological-systems, resource management, environmental problem solving, linking science to end-user applications*

1-#1-3

ARID*net*: Understanding Interdependencies of Natural and Human Systems as Nonlinear Agents of Land Degradation

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Following the inaugural scientific conference at the 2008 COP-8 meeting in Buenos Aires, the United Nations Convention to Combat Desertification (UNCCD) adopted a 10-year (2008-2018) strategic plan. This plan – known as the VISION – identifies actions to "*forge a global partnership to reverse and prevent desertification/land degradation and to mitigate the effects of drought in affected areas in order to support poverty reduction and environmental sustainability*". This is a complex, daunting, and multifaceted challenge. In this talk, I describe ARID*net*, an international think-tank that was established as an initiative to address some of the VISION challenges. ARID*net* is a loosely-organized consortium of researchers, stakeholders and policy-makers that emphasizes the roles of natural and human systems as interdependent, nonlinear agents of land degradation. Although some progress has been made, there remains a pressing need for new and creative interdisciplinary approaches for tackling land degradation in drylands, as well as for new ways of thinking that transcends traditional approaches for addressing national, regional and/or disciplinary concerns. The UNCCD VISION lists numerous desired outcomes, the following of which are most relevant to ARID*net* activities:

- Desertification/land degradation and drought issues must be addressed in relevant international forums, including those pertaining to agricultural trade, climate change adaptation, biodiversity conservation, rural development, sustainable development and poverty reduction;
- Policy, institutional, environmental, and socio-economic drivers of desertification/land degradation and barriers to sustainable land management must be identified and assessed, and appropriate measures to remove these barriers must be recommended;
- Knowledge on biophysical and socio-economic factors and on their interactions in affected areas must be improved to enable better decision-making;
- Knowledge of the interactions between climate change adaptation, drought mitigation and restoration of degraded land in affected areas must be improved in order to develop tools to assist decision-making; and
- Effective knowledge-sharing systems, including traditional knowledge, must be in place at the global, regional, subregional and national levels to support policymakers and end-users.

ARID*net* utilizes the Dryland Development Paradigm as a conceptual framework to address these desired outcomes via the following objectives: (i) to promote international cooperation and exchange of ideas about land degradation (with the goal of avoiding traditional biases that have previously hindered creative thinking); (ii) to open communication channels to foster practical interactions with stake-holders in sustainable land management; and (iii) to use the concepts, experiences, and applications developed by participants to support on-going international discussions.

Key words: *desertification, land degradation, interdisciplinarity, policymakers, socio-economic factors*

1-#1-4

Opportunities and Limitations of Remote Sensing for Ecological Studies. Examples from Sub-Saharan Africa

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Remotely sensed data play an important role in quantifying land cover change and in quantifying ecological parameters. These data are used to examine land cover change in relation with climate variability and climate change as well as direct human impact on ecosystems, on one hand. On the other hand, many models use ecological parameters derived with remote sensing. Thereby, so-called satellite products are of increasing importance. They are often produced using standard global algorithms. Some examples are global data sets as GIMMS (Global Inventory Modeling and Mapping Studies) based on NOAA AVHRR which are used in the debate on the greening phenomena in the Sahel. Others are global land cover products from NASA (MODIS Land Cover) and ESA (GlobCover), fire products (MODIS active fire, MODIS burned area), the MODIS LAI product but also climatological data sets as TRMM (Tropical Rainfall Measuring Mission). The number of these products are steadily increasing like the number of satellite sensors while the possibilities to validate the data often declines. With examples from Southern Africa, Eastern Africa and Western Africa, the potentials and limitations of remote sensing are demonstrated and the importance of ground truthing and

scale is emphasized. While especially the land cover products and certain rainfall products have to be used carefully and need thorough validation, the MODIS LAI product provides satisfying information. Additional to the critical evaluation of products methods for quantifying eco-climatological data and for deriving land cover changes are presented.

Key words: *ecological parameters, fire products, eco-climatological data*

1-#1-5

Integrating Former Data Sources and Modern Geo-Information Technology for Ecosystem Research and Management – Potentials and Challenges

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Global change studies require an understanding not only of what society might experience in the future but also a thorough knowledge of the past developments. Today's ecological situations are the result of former conditions, practices and impacts. By studying these we can further learn about society's ability to cope with adverse situations. In this context, geospatial data processing is a valuable means for integrating data from a range of disparate sources like remote sensing, cartography, archival documentaries and reporting, or interviews and oral histories. By providing a spatial reference to any dataset, the data can be jointly analyzed and offer time series information for extrapolation of e.g. ecosystem services in space and

time. The geodata can in turn be used to inform the various stakeholders involved in decision making, but also to create tools for environmental education.

For the Kakamega-Nandi forests area in western Kenya, a myriad of geospatial datasets have been processed in order to reveal the history of forest use over the past 100 years and beyond. Case studies are used to exemplify the methods involved for drawing a spatially explicit picture of the local and commercial disturbances experienced. The work has been successful in informing forest management planning and serves as a source for sensitizing the local people for forest conservation. The approach can provide a framework for an in-depth study of forest ecosystem change in the western region of Kenya over at least the past century. As historical information is likely to be piece-meal and data processing can become rather labour-extensive, the challenge is to elaborate a methodology which allows for details where available but at the same time also for overview and complete-coverage information, ideally generated in an automated workflow. Here the idea is to work with a nested, multi-scale approach that serves the various needs. Nowadays geo-information technology supports the set-up of an infrastructure which allows for versatility in data input and storage as well as wide access over the Internet, thus being of benefit to many potential contributors and users.

Key words: *global, oral histories, geospatial datasets, Kakamega-Nandi forests*

1-#1-6

Converting Savanna into Agro-ecosystems: Impacts on Ecosystem Structure and Function under Changing Precipitation Regime

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East African ecosystems are becoming increasingly vulnerable and have experienced a significant decline in vegetation biomass and biodiversity in the last 3-5 decades. Changes in climate (increasing aridity) and land use maybe responsible, however, there are no direct scientific evidences linking them to the regression. Characterization of the change processes, the driving forces of change, their effects on vegetation dynamics and ecosystem capacity for resilience and service delivery are urgently needed in order to adapt to the environmental changes. In Lambwe valley in western Kenya (34°10' and 34°20'E;0°30'and 0°50' S), biophysical processes linked to climate and human activities involving vegetation clearing and overgrazing have been blamed for the decline in biomass and biodiversity of its humid savanna. Studies conducted between 2009 and 2014 show that the herbaceous layer of this savanna is the most fragile and sensitive to changes in precipitation and management. Unlike the tree layer, responses of the herbaceous layer to changes in precipitation input are subject to the management regime. Seasonal fluctuations in soil moisture significantly ($P<0.05$) influence species composition, productivity and CO_2 fluxes in this layer. Contrary to our expectations, soil carbon (C) concentration remains relatively stable even after 20 years of

cultivation. Also, ecosystem respiration (R_{eco}) is insensitive to changes in land use and temperature. Although grazing lowers the total aboveground biomass, it increases the productive efficiency of the herbaceous vegetation. Complete removal of grazing, however, is associated with increased tree cover and shading, which completely eliminates the herbaceous vegetation. We predict that this could as well increase water use by the tree layer and accelerate competition for resources (moisture, nutrients and light), making the ecosystem less resilient. Overall, we show that converting the natural savanna into agro-ecosystems lowers its resilience, alters species composition and lowers the net ecosystem CO_2 exchange, changes that are accelerated by reduced precipitation.

Key words: *vegetation, biomass, biodiversity, humid savannah, CO_2 fluxes*

1-#1-7

Land Use Change, Food Security, and Ecosystem Services in the Lake Victoria Basin

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Population growth and increasing resource demand have caused dramatic land use changes in the Lake Victoria Basin in recent decades. Deforestation and the degradation of soil and water resources constitute a major threat for food security and fresh water supply especially for poor rural communities. Increasing

dependencies and high pressure on natural resources will further exacerbate soil and water quality degradation and poverty. Land translocations through international markets and investments are becoming increasingly important for land use changes in East Africa but regional impacts have been rarely quantified.

Main objectives of this research initiative are the identification of the driving forces and trajectories of land use changes in the Lake Victoria Basin and the quantification of the associated impacts on ecosystem services with focus on food and fresh water provision. Together with the Lake Basin Development Authority, we are planning to develop a conceptual modeling framework that links global and national economic and political drivers to local decision making and management strategies. In parallel, we will conduct a biophysical characterization of the major land use and management types at selected sites in order to assess their suitability for food and water provision with special focus on soil conditions and plant functional traits. Soils and plant functional characteristics play a key role for agricultural biomass production and the nutritional value for grazing livestock. Moreover, plant functional diversity is essential for soil stabilization, erosion control, and nutrient retention and contributes considerably to fresh water quality. Based on these information, the SWAT (Soil and Water Assessment Tool) and EPIC (Environmental Policy Integrated Climate) simulation models will be parameterized in order to quantify the impacts of land use change on food provision and water quality at the Lake Basin scale. Final goal is the development of potential market and policy scenarios associated with global economic changes and the biophysical quantification of their impacts on major provisioning ecosystem services important for the livelihood

of local communities and the environment. While integrating regional interconnections through national and international trade networks, these scenarios will allow us to estimate future impacts of land use changes in the Lake Victoria Basin as well as potential consequences of those changes in regions elsewhere.

Key words: *deforestation, degradation, environmental, policy, integrated climate*

1-#1-8

Assessment of the Impact of Community Participation in Management of Kuywa Sub-catchment

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Community participation is one of the pillars of integrated water resources management (IWRM). Kenya adapted the process of IWRM in 2002 with the enactment of the Water Act 2002 and operationalised it in 2005. The Act devolved the management of water resources to the lowest level and thus the formation of water resources users associations (WRUA). One of the first WRUA to be formed in Lake Victoria North Catchment Area was the Kuywa WRUA. It covers the lower half of Kuywa sub-catchment with an area of 292km^2. This study was carried out in order to assess the impact of the conservation measures in the catchment. The specific objectives of the study were to

assess the land-use dynamics over a period of 10 years, analyze the changes in discharge over the given duration and determine the sediment load in the river. The land-use changes were determined by analyzing satellite images over the same period. Unsupervised classification was carried out to identify the land-use changes. The analysis of the land-use revealed that there is a significant change in vegetation cover attributed to WRUA activities. The discharge had also increased significantly between 2000 and 2012. However, sediment load significantly increased within the same period. This is attributed to the fact that the upper Terem sub-catchment was converted into settlement area. These results reveal that community participation had a direct bearing on the conservation of the Kuywa sub-catchment.

Key words: *land-use, community participation, catchment management, sediment load*

1-#1-9

Communicating Sustainable Development: The Role of Social Sciences

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The aim of this paper is to enlighten all researchers to the importance of interdisciplinarity in all kinds of scientific research. The paper begins with discussing the knowledge base of research and continues into discussion of sustainability and its importance for value addition and policy application

of research. Secondly, the paper discusses the rationale for devolution and localism in research and explains the importance of grass root approach to research. Thirdly, the paper discusses the different aspects of illiteracy as they relate to research in the context of development. Finally, the paper examines the role of language in research and the importance of interdisciplinarity for research to make a positive contribution to sustainable development in the 21st century. Research is always necessary for many reasons, the most important of which is the production of knowledge. An important aspect of knowledge production is communication which is an aspect of dissemination. For research to add value to human lives, it needs to be operational within the triangular milieu of context, content and process. The operational aspect of research implies sustainability. The 21st century development paradigm is moving from goal centred approach to sustainability approach, a concept that existed since the Rio Earth conference in 1992. Research adds meaning to sustainability through dissemination and communication. Apart from the conventional means of publishing and disseminating research findings, researchers have realized that for their researches to have sustainable impact, they need also to appeal to public and policy. They also need to be involving and participatory. Democracy demands that all aspects of life need to involve all citizens, i.e., participatory. Participatory approach accepts the concept of localism and illiteracy. Work done at local level must involve people at local or grass root level. The principle of localism implies involvement at individual and/or household levels. People are either educationally, scientifically or linguistically illiterate. Those who did not have chance to

go to school are illiterate; they can't read and write. We know that knowledge is power, but also understand that culture is us, i.e, we are socially made of and from culture. Furthermore, we were cultured before we went to school. Scientific illiteracy comes from "disciplinary compartmentalism", which has been witnessed by the evolution of academic "philosophies" since the introduction of formal education. For academic research to benefit humanity, it should be conducted either in *Greek* or in local language. In case there was only one language of communication for all humanity, there would be no class in terms of language of reading, writing and literature. In a historical situation that we are, there is no justification for some language to claim being superior to or more cultured than any other human language on earth. Every community where research is being conducted has a right to ensure that research is localized and that research outcomes benefit all parties in the research triangle. The only way out of this research scenario is interdisciplinarity.

Key words: *communication, localism, participatory approach, sustainability, interdisciplinarity*

1-#1-10

From Science to Integrated Socio-Economic Development – Scientific Planning and Community Response

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Kenya's Lake Basin Development Authority and Western Kenya universities in alliance with other partners aim at an integrated, science-driven approach for Lake Victoria Basin development with the overall objective to enhance resource integrity. The call for contributions to the conference draws particular attention to the need for a reassessment of the compatibility of regulatory measures meant to advance these aims with local Lake Basin communities' activities.

Science-driven plans to improve the human condition follow a rational logic of science and engineering which often differs from local communities' ways of perceiving and pursuing their welfare. At the same time, these development plans have to enlist the support of local communities. Failure to do so is one of the reasons why scientifically sound programs have often failed to achieve their rational objectives. On the other hand, there is ample evidence that programs that tie in with locally engineered solutions and build on locally available potentials are more successful. The challenge for this approach lies in the identification of these potentials and solutions and in devising procedures to make them compatible with the program's aims and provide selective support. The proposed contribution gives an account of previous experience in this field and offers insights from own research with an aim to find interested partners for cooperative research.

Key words: *science-driven plans, local communities, cooperative research*

1-#1-11

Poverty Vulnerability and Natural Resource Dependency under Environmental Change

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Environmental changes are supposed to have profound effects on small farm households in developing countries because their means of livelihoods depends primarily on agriculture which is directly exposed to environmental changes and natural resources such as water systems and forests that are also decreasing. In addition, those farm households lack of needed capacity and assets to deal with potential shocks and risks. To our understanding, sustainable development in developing countries in general and in East Africa in particular must first deal with those small farm households. Basic questions that need to be answered include, for example, (1) how vulnerable are farmers to environmental changes? (2) to what extent does their livelihoods which depend on natural resources change due to environmental change?, and (3) what can be done to support those farmers in building their needed capacity to overcome potential shocks and risks due to environmental changes. Answering those questions would provide useful information to policy makers and practitioners in designing effective programs tailored at sustainable development in the regions. It is obvious that relevant research programs can only be successfully done if and only if there is a willingness to cooperate among involved stakeholders for mutual benefits.

Key words*:* *developing countries, small farm households, vulnerability*

1-#1-12

Tradeoffs between Crops and other Benefits derived from Wetland Areas: short-term Gain versus long-term Livelihood Options in Ombeyi Watershed, Kenya

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Wetlands retain moisture for long periods and are important for agriculture and for grazing livestock. Local people's livelihoods depend on the ecosystems services that wetlands provide, such as papyrus, fish, grazing and water supply for cattle and households during the dry season when other sources dry up. Increased demand for agricultural products has put pressure on the wetlands which have fertile moist soils good for crop production at minimal costs. The Ombeyi wetland in Kisumu County, Western Kenya, is currently under immense pressure by the expansion of land under crops such as rice, sugarcane and arrow root. The irrigation schemes are registered for paddy rice production by small scale farmers. Due to poor markets for rice some farmers started changing their cropping pattern towards better marketable crops such as arrowroots which has resulted in water use conflicts, declining rice yields and loss of soil fertility due to poor agronomic practices. However, because of the high profitability of arrowroot cultivation farmers started expanding their cropped land at the expense of wetland area. The cropland expansion and the increased number of arrowroot farmers are

now a major driving force of conversion and degradation of the Ombeyi wetland. The expansion of cropland - in particular for profitable crops such as sugarcane and arrowroot - provides local farmers with a higher cash income. On the other hand, the resulting encroachment and further degradation of wetlands in the Ombeyi area leads to a loss of papyrus and breeding areas for fish. The sale of papyrus provides a steady year-round, albeit lower, income as compared to crops. Harvesting papyrus does not require prior investments and hence is a low risk activity. The dilemma between wetland conservation versus conversion into irrigated agriculture (e.g. arrowroots) clearly presents a trade-off between different livelihood strategies and different groups in society.

Key words: *livelihoods, stakeholders, trade-off, wetlands*

1-#1-13

The Error of Management: Recent Experiences in Implementing Fisheries Co-Management in Lake Victoria, Kenya

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This study examines the effectiveness of co-management approach in fishery management in Kenya with reference to the implementation of the Beach Management Units (BMUs), an institutional structure for fisheries management in Lake Victoria. Although BMUs were envisioned to serve many purposes, the main objective of establishing them was to enhance the level of compliance with fisheries rules and regulations and thereby foster responsible fishing practices in the lake. However, inefficiencies have emerged on how BMUs perform their designated roles that has inhibited the effective execution of sustainable fisheries management. Data were collected from 36 randomly selected BMUs along the Kenyan part of Lake Victoria using various participatory techniques. Descriptive and inferential analyses were done using SPSS Version 20.0. Results indicated that BMUs lack adequate resources for monitoring, control and surveillance operations making them unable to control illegal fishing in their areas of jurisdiction. Only two activities had significant indices of good performance, namely;

resolving disputes and receiving visitors while curbing of illegalities was the least performed by the BMUs. Additionally, BMUs are still performing poorly in the area of financial management. The study showed that fishers are well aware of the fishing rules and regulations; but the high violation rate suggests that BMUs have limited impact on fishers' decision to comply with the regulations. These experiences show that creation of BMUs has not ensured successful implementation of co-management in Lake Victoria fisheries. BMUs are mainly involved in activities of social nature in the communities but they have poorly undertaken their core functions related to enforcement and compliance with fishing rules.

Key words: *Lake Victoria, co-management, BMUs, Nile perch fishery*

1-#1-14

To Conserve or Convert Wetlands: Evidence from Nyando Wetlands, Kenya

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Wetland resources of Nyando wetlands support important economic and ecological activities. However, it is faced with multiple pressures from different anthropogenic activities within the wetlands and upstream. The Nyando wetlands are facing increasing threats of reclamation for agriculture. This is bound to intensify as population pressure increases. The question therefore is: should Nyando wetlands be conserved or converted? Using market price and contingent valuation methods, within the benefit-cost analysis framework, an economic valuation was carried out to determine the benefits of conserving or converting the Nyando wetlands. The results revealed that Nyando wetlands yield a flow of economic benefits of the consumptive goods and services estimated at about US$ 1.5 Billion (US$ 62,500 / Ha / year) with an infinite Present Value of US$ 75.5 Billion at 2% discount rate. Thus the reclamation of the wetlands would imply high economic costs to

the government and local communities. To reduce the pressure of reclamation, it is suggested that educational campaigns on the importance of wetlands be carried out.

Key words*: wetland value, market price, contingent valuation, goods and services*

1-#1-15

Flood Management: A Sustainable & IWRM Approach – Kapsoya, Eldoret, Kenya

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Water should be managed at the lowest appropriate level. Kenya must found its future on science and innovation. She should have an agency to serve as a powerhouse of ideas, technology and skills for building prosperity, growth, health and sustainability. A successful, sustainable and integrated water resources management (IWRM) program depends on planning for the entire watershed. Urbanisation changes land use patterns, aggravating flooding. Many urban areas lack basic infrastructure to follow the increasing urbanization and this lack of planning worsens the situation. Traditional approaches basically modify the drainage network suitable to receive or dispose of flood discharges of the urbanized areas. This approach is being complemented by the IWRM concepts, which *treat the basin as a unit system*, using distributed interventions, focusing on *infiltration, storage and evaporation* measures, trying to restore *pre-urbanization* flow patterns. These measures integrate the stormwater management in terms of quantity and

quality. Low vegetation density increases runoff by lowering interception and infiltration potential, raising peak discharge. Vegetation significantly *decreases and delays flood peaks* which head downstream in small to medium size events. Soft engineering applies strategically planted vegetation (trees), wetlands and to infiltrate and temporarily store floods upstream by *delaying the release of water into the river system, dampening the peaky response, reducing the pressure* on urban areas downstream. Comprehensive planning involving *all stake-holders* is necessary to ensure the *protection of life, property, and the environment*. For effective flood management, a sustainable and integrated approach is essential for the study area, and if its implementation is successful, it should be recommended for the rest of the Eldoret Municipality and eventually to the whole country.

Key words*: sustainable management, innovation, environment*

1-#2-16

Defining an ecologically meaningful Seasonality to assess the Impacts of a changing Climate on Carbon and Water cycling in semi-arid Ecosystems

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The water, carbon, and energy cycles of terrestrial ecosystems are inherently coupled through the metabolic plant-driven processes of photosynthesis and respiration, and the energetic light-driven processes of heat exchange. The former leads to a net uptake of carbon dioxide and a simultaneous release of

water vapor as transpiration during the day and to a release of carbon dioxide at night. The latter gives rise to the sensible heat transfer, which impacts air temperature and vapor pressure deficit and thus the drying power of air, and to the latent heat transfer in form of evaporation. In semi-arid ecosystem where liquid water is only seasonally available due to location-specific prevailing atmospheric circulations such as monsoons or seasonal low temperatures locking up moisture as snow or ice, plant-available soil moisture is the main determinant of an ecosystem's carbon balance. Even small changes in the seasonality of plant-available soil moisture through changes in amount, timing, and occurrence of precipitation events may have large consequences for the onset, duration, and end of plant growth and therefore for the carbon dynamics, and may turn a net carbon sink or a carbon-neutral system into a net source. The response of a vegetated ecosystem to changes in plant-available soil moisture are complicated and often difficult to predict, since the interactions between heat, evapotranspiration, and carbon transport within the ecosystem and to the atmosphere are often non-linear, e.g., may require crossing a threshold or amplification through feedbacks between two independent processes before impacts become suddenly noticeable.

The changing climate and the resulting shifts in plant-available soil moisture prompt us to devise a concept for defining ecologically meaningful seasonality with functional seasons within a year, which we call Hydro-Ecological Years (HEYs). This system shall be sensitive and flexible enough to reflect the often subtle shifts in environmental drivers that impact the carbon-water dynamics of semi-arid ecosystems. The objective is to build a concept that by design can translate the non-linear complicated interactions into simple, linear relationships

between drivers and ecosystem responses. Having such a concept allows for diagnosing the current and predicting the future state of ecosystems. One example may be the definition of an ecologically meaningful active period of plant productivity to replace the common vegetation or growing period, which is simply based upon calendar dates. Investigating seasonality in water-limited ecosystems requires measurements of ecosystem fluxes of heat, water, and carbon exchange at the ecosystem scale over several years. Only multi-annual observations can serve as a basis to devise the proposed concept since they span the time scales of seasonal and interannual variability and that of the climate change forcing. The micrometeorological eddy covariance technique is the method of choice to directly quantify the atmospheric fluxes of energy and mass in the soil-plant-air continuum.

Key words: *water, carbon, and energy, carbon-neutral system, soil-plant-air continuum*

1-#2-17

Enhancing Wetland Ecosystem Services through integrated Aquaculture Production Systems (Fingerponds) at the Shores of Lake Victoria

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Natural wetlands around Lake Victoria are threatened by unsustainable exploitation. To prevent further encroachment, the ecosystem services provision per unit area of wetland needs to be enhanced. We experimented through a multi-disciplinary

research and community participation, an innovative, integrated agriculture/fish polyculture system – called fingerponds. These are flood recession, self-stocked aquaculture ponds constructed at the lake fringes or within the river floodplains. The results indicated that under normal annual flooding regime, the ponds can be adequately stocked by natural ($\geq$3 fish/m^2). Water supply depended on natural processes and in a good year the functional period of the ponds is about 5–6 months. A Fingerpond of about 200 m^2 can provide an additional per capita fish supply of 3.4 kg. This can be increased if pond management is further improved. Through such initiatives, wetland provisioning services and habitat function can be enhanced. The environmental effects of such systems is minimal. The main challenge of such systems is the uncertainty created by dependence on flooding for water supply and aquaculture. These systems have a high potential for adaptability and can be used for maintaining the lake fisheries. Ponds at the fringe zones can be used to host the broodstock/reproductive habitats and fingerlings can be left to migrate freely into the littoral zones and finally to the open waters. The approach requires community participation perhaps collaboration with the Beach Management Units (BMUs). Adoption of such system needs flexibility and should be as adaptive as possible. The initial investment in construction may limit adoption. However, institutional support, particularly from the government, NGOs and other local community support groups is required. There is also need to include such sustainable approaches in wetland policy with clear guidelines for communities and decision-makers.

Key words*: wetlands, provisioning, habitat, integrated systems*

1-#2-18

Assessing Vegetation Impact on Ecosystem Water Cycles with Stable Oxygen Isotopes

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Water-availability limits carbon uptake particularly in semi-arid ecosystems, which contribute about 40% to global productivity. Evapotranspiration accounts there for up to 95% of water loss of the ecosystem. Thus functional understanding of evapotranspiration and the contributions of evaporation and transpiration from over- and understory vegetation to water cycling in semi-arid regions is key knowledge in forest management under future climate change. ET has two distinct components: soil evaporation and plant transpiration, which may to be further separated in contributions of different plant functional types. These component fluxes are not necessarily controlled by the same mechanisms. In addition, climate change is expected to cause substantial changes in water availability due to increasing air temperature and changed rainfall patterns. Separating net fluxes into their components leads to functional understanding regarding the development of ecosystem water and carbon fluxes. Water isotopes trace water through the compartments of an ecosystem from soil and the vegetation to the atmosphere. They are used to partition evapotranspiration ET into its components evaporation E and transpiration T. Particularly, oxygen isotope signatures are valuable tracers for water movements within the ecosystem because of the distinct isotopic compositions of water in the soil and vegetation.

Evaporation from the soil modifies the isotopic composition of source water. The evaporation model proposed by Craig and Gordon is widely used in ecological and modeling studies to determine the oxygen isotopic composition of soil evaporation. It has been used to achieve better understanding of the dynamics of hydrological processes, and to partition ecosystem water fluxes into their two components: soil evaporation and plant transpiration. To effectively use isotope partitioning, care must be taken to thoroughly characterize the isotopic composition of evaporation and transpiration. Analysis of the water dynamics of a semi-arid woodland showed that herbaceous understorey transpiration was always larger than soil evaporation. Both fluxes were nearly negligible in summer, leaving transpiration to contribute by more than 90% to ET. The herbaceous understorey can have positive effects for ecosystem functioning: 1. Legumes of the herbaceous layer can add nitrogen to the ecosystem that gets also used by the trees. 2. The understorey layer helps infiltration of precipitation. However, during years of severe drought the oak woodland uses more water through evapotranspiration than is introduced into the ecosystem by precipitation. The resulting depletion of deep/groundwater reservoirs could prove fatal for the resilience of this ecosystem, as cork-oak trees rely on their access to water in deep soil layers.

Key words*: evapotranspiration, vegetation, legumes, groundwater reservoirs*

1-#2-19

Soil Water Monitoring in Savannah Ecosystems

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Storage, availability and dynamics of water in soils are key factors and key processes for ecosystem stability, resilience and crop production. Especially in semiarid regions hydrological systems are highly sensitive to climate change trends in combination with extreme events. This may result in increased surface runoff and soil loss by water erosion due to extreme rainfall events. Decreased storage of plant available water and droughts and thus reduction of crop production may be expected by reduced infiltration of rainfall water into the soil and water bypassing the soil matrix via preferential flow paths. Ecosystem behavior on climatic changes is in general not known in advance but is essential for developing efficient management strategies. Against this background, soil hydrological monitoring appears indispensable for planning and controling of environmental measures.

In this contribution we present some recent developments of hydrological monitoring devices and designs for ground measurements and analyses. This includes new sensors for water availability under dry conditions, cheap logger systems for hydraulic measurements of soil moisture, open boundary lysimeters for high precision measurements of water balances, and runoff collectors with simple flow divider systems for runoff and erosion measurements. Special attention is put on the role of spatial variability at profile, field and landscape

scales. Here, quick and cheap measurements are required. In addition to already available remote sensing techniques, visual and near infrared spectroscopy with portable devices could provide efficent strategies for high resolution measurements on different scales in the near future. These measurements could subsequently be used for scenario analyses with process based management models like the "Soil Water Assesment Tool" SWAT.

Key words*: soil water, environmental measures, lysimeters*

1-#2-20

Surface-groundwater Interactions in Ombeyi Watershed Floodplain Wetlands

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Wetlands situated in flood plains can be characterised by significant temporal and spatial variations in the pattern and magnitude of water inflows and outflows. The Ombeyi watershed in Kano flood plains, Nyando Basin, hosts a number of wetlands that are characterised by competing water uses, especially between expanding irrigated agriculture and availability of other wetland products. Water within the wetlands may comprise varying quantities of water derived from rainfall, surface water and

groundwater sources. The seasonal contribution of each source to the wetland water is a function of season of the year, geology, land-use/cover, rainfall and upstream water-use activities. These influence the extent to which the wetlands function. Water samples from rainfall, streams, wetlands and shallow wells were collected at weekly intervals for a period of six weeks between April and June 2014 in the Ombeyi watershed. Measurement of stable isotopes oxygen-18 (18O) and Detrium (2H) on these samples was carried out in July at UNESCO-IHE. Rainfall and stream discharge for the period were also measured. To further understand the relationship between surface and groundwater, an Electrical Resistivity Tomography (ERT) mapping was done in June along four transects that coincided with the location of the shallow wells the water levels of which were being monitored. The study showed that a combination of permeable sediments, discontinuous clay layers and fault scarps allow for surface water to infiltrate deeper into groundwater aquifers. Isotope characteristics of water in rivers after the wetlands are different from that of water from rainfall, upstream rivers and shallow wells perhaps due to enrichment.

Key words: *electrical resistivity tomography, isotope, surface water, groundwater*

1-#2-21

What matters? Unraveling the Complexity of slow and fast Variables to determine Sustainability of Agro-ecosystems in northern Tajikistan

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Human development of global drylands can affect regional sustainability of ecosystem goods and services, particularly in rural dryland communities that depend on local agro-ecosystem to maintain livelihoods. In Tajikistan, agricultural land conditions are a major concern since only 8% of the country's land is arable and agriculture contributes significantly to its economy (30-40% of the country's GDP). However, an estimated 97% of farmed lands in Tajikistan have been adversely affected by poor irrigation services and salinization. Various social, economic, and ecological factors contribute to the sustainability of Tajikistan's agro-ecosystem. Some examples may include land tenure laws, market prices of cash crops, and seasonal stream flow patterns. Generally, how do these social, economic, and ecological variables behave together as a system? More importantly, how can one understand their integrated dynamics, especially when they are often measured differently and studied in isolation from one another? First, the key variables that drive Tajikistan's agro-ecosystem are identified. Second, their behaviors are characterized as either "slow-" or "fast-occurring" variables. Quantitative and qualitative data from an integrated assessment of the agriculture sector of northern Tajikistan

(2010-2011) are used to identify and characterize these key variables. Third, a conceptual model of the variables' behaviors, integrated dynamics, thresholds, and system-wide effects are highlighted. This diagnostic process is derived from three theoretical frameworks: (1) the Social-Ecological Systems (SES) framework, (2) the Drylands Development Paradigm (DDP), and (3) the telecoupling framework. Preliminary results suggest that Soviet-era agricultural institutions and practices (slow variables) continue to be employed in Tajikistan and contribute to water scarcity, soil salinization, erosion, land degradation, and loss of biodiversity (also slow variables). Subsequently, increased water scarcity and environmental stresses contribute to larger-scale abandonment of agriculture in favor of alternative economic opportunities, which are often dependent on the economic stability of distant labor markets (fast variables).

Key words: *social-ecological systems, slow and fast variables, integrated assessment, Tajikistan*

1-#2-22

Development of Forest Fire Forecasting and Monitoring Information System in Vietnam

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The risk for forest fire in Vietnam is extremely high. There are more than 112 thousand hectare of forests, which have been lost due to fire (approximately to 0.82% of current total forest area in the country). Thus, a big problem currently faced in Vietnam is related to the following questions: (1) how can forest fire danger levels be accurately forecasted? and (2) what is a fast, convenient and efficient way to communicate information concerning forest fire potential occurrence to the forest office, forest owners and to local stakeholders? This study has developed a system (FFSOLUTION2014) using the integration of many data sources such as meteorological information, forest resources, remote sensing, GIS, and reports from local people to establish automatically news and maps of Forest Fire Danger Warning Index (FFDWI) for every hour of a day., which can also be modified interactively when input data change. The characteristics of FFSOLUTION2014 are: (i) forecasting and monitoring accurately, faster and in real-time; (ii) integration directly with hotspot of MARD; (iii) receiving and sending data through SMS, email and web services; (iv) synthesizing inputs from multiple remote users in real time and from any device to

increase accuracy, and (v) ease of use. With the advantages of FFSOLUTION2014, the study shows that our research has led to an effective solution for forest fire forecasting by using web-based GIS and RS, and it can be deployed at many different scales such as in national parks, for specific watershed areas, and at provincial or national levels.

Key words: f*orest, fire, FFSOLUTION2014, Web GIS, Vietnam*

1-#2-23

The Locality of Knowledge Production: Power Differentials in expert and practical Knowledge in the Lake Victoria Basin

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Instead of conceptualization expert/scientific knowledge and local knowledge based on dichotomies like modern – traditional, universal – particular, abstract – real, differentiated – holistic, scientific – cosmological, practical – theoretical, global – local, indigenous – alien etc. which have a particular epistemological background, I take local knowledge first of all as produced knowledge just like other forms of knowledge. I follow the perspective of Actor Network Theory (Latour), in which it is maintained that knowledge is generated in networks. As much as these differ, the knowledge produced differs. From a phenomenological perspective, Mary Douglas shows in her analysis of institutions how local knowledge is integrated and part of local institutions. Local knowledge is institutionalized as

"thought style", by which people are identified with collectives and distinguished from other such collectives. Consequently, any analysis of local knowledge cannot limit itself to certain aspects of it, but has to be as well an analysis of those institutions defining the culture.

The Lake Victorian Basin Authority as an (formal) institution produces/uses expert/scientific knowledge – following to some extent an instrumental reason (Adorno) – that differs from local collectives who create (informal) institutions/networks and own forms of practical knowledge („sense pratique", Bourdieu). I maintain that there is no agency outside of society and space that might be able to define truth and objective validity of knowledge. Such a definition is political processes and therefore processes dependent on power. Even more, not the power of some actors, but the power vested in relations and practices. For knowledge this implies that whether it is defined as local or as universal, whether seen as valid and valuable or as useless results from power relations between agencies. As much as power is a relation, knowledge is relational.

These power differentials have to be highlighted in that specific idiographic context in the Victoria Lake Basin Region of Kenya to find a pathway for a collective share/integration of knowledge between the science/expert sphere and the local-regional communities as „experts" of their own live-worlds in the shifting context of land-use, ecology and development.

Key words*: local knowledge, production of knowledge, expert and practical knowledge, political processes, Lake Victoria Basin*

1-#2-24

Options to Monitor Microfungal Diversity in Western Kenya

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Fungi are distributed world-wide, occur in all ecosystems and exhibit hyperdiversity at most locations. However, fungal diversity is still poorly studied and only a small proportion of existing species (ca. 5%) is known to science. Fungi exhibit various functional traits which are of high relevance to ecosystem function (e.g. degradation of carbon, or mutualistic and/or antagonistic interactions), and therefore provide a wide range of ecosystem services. Examples of functionally highly relevant groups are soil fungi, water fungi, and lichenized fungi (= lichens). Soil fungi either are important mycorrhiza-forming and support of plant C-assimilation or they act as saprotrophs/ destruents decomposing all kinds of biological matters. A co-operative project could concern agricultural soil monitoring. In various studies using anonymous analysis (ARISA) and non-anonymous analysis (microarray, NGS) (metagenomics) we were able to demonstrate fungal community vertical shifts along soil horizons (due to plant litter decompositions stages) and horizontal/seasonal shifts (due to different land management

regimes). Water fungi are of highest interest to science, mainly saline or alkaline water with regard to their specific genetic long- and short-term adaptations to these extreme environments. Rift Valley soda lake 'Lake Nakuru' would be a highly interesting study site for detecting new fungal species and describing their physiological behaviour by applying up-to-date molecular biological analysis techniques. Fresh water fungi belonging to the Oomycota are severe pests in fish farming. Aside from analysing DNA-extracts from soil and water, fungi may also be isolated and cultivated for various scopes as for analysing their phenotypic traits including the secondary metabolism. Obtained reference isolates may be deposited in institutional strain collections like DSMZ, CBS etc. Obtained occurrence and DNA-barcoding data may be submitted to data repositories in Africa or Europe for onward transfer to GBIF. Co-operating projects with Kenyan colleagues should result in joint publications in high-ranked journals. Lichenised fungi or lichens are often neglected organisms, but cover most of tree bark and rock surfaces mostly in mountainous and alpine regions. Mt. Elgon it known to be an El Dorado for lichens. However, a scientific monitoring of lichen diversity has never been achieved there. As lichens also form microhabitats for numerous so-called 'endolichenic' fungi, the study of lichens in the Mt Elgon area and comparable natural sites, would be a worthwhile contribution to the knowledge of fungal diversity of Western Kenya.

Key words*: lichenized fungi, extreme environment, DNA-barcoding, endolichenic*

1-#2-25

Stable Isotope Natural Abundance Data as a Tool to Elucidate the Complex Nutrition Pathways of Orchids

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With more than 20.000 species, orchids belong to the largest and most widespread plant family on earth. Simultaneously many orchid species are rare and facing extinction due to anthropogenic land use activities. Thus, orchids play an important role in attempts on biodiversity, species and nature conservation. Our knowledge on the requirements of orchids for their survival, however, still has major deficits. All orchids start into their live with very tiny seeds that require nutritional support by mycorrhizal fungi for germination. This kind of nutrition is called **initial mycoheterotrophy**. Later on the majority of orchids develops green leaves and is considered as autotrophic, but still remains mycorrhizal. However, more than 200 orchid species have entirely lost the ability to photosynthesize and therefore are dependent on fungal nutrient supply throughout their life cycle. Their nutrition is known as **full mycoheterotrophy**. In addition, some green orchids recently have been identified as gaining carbon and nitrogen by autotrophic means and simultaneously by feeding on the fungal source. The nutrition of this plant group is called **partial mycoheterotrophy**. Full and partial mycoheterotrophy provides the opportunity for orchids to thrive in the deepest

shade of forest grounds. The fungus-plant interaction in carbon and nutrient exchange becomes even more complicated by the fact that different fungal groups are involved in the mycorrhiza of these heterotrophs. Partners of fully or partially mycoheterotrophic orchids can be wood- or litter-decay fungi or fungi that simultaneously form ectomycorrhizas with trees.

This presentation reports on carbon, nitrogen and hydrogen stable isotope natural abundance as a tool distinguishing between the different groups of mycoheterotrophic orchids and, more important, to identify partially mycoheterotrophic orchids among the huge diversity of green orchid species. Our previous investigations were mostly focussed on orchids from temperate regions. However, the majority of orchid species grows in the tropics. Thus, more research on nutritional demands of tropical orchids is urgently required in order to improve management recommendations for tropical orchid forest habitats.

Key words*: stable isotope, mycorrhizal fungi, mycoheterotrophy, orchids*

1-#2-26

The Value of Kenyan Aquatic Biodiversity and Implications of Climate Change on the Future Biodiversity

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Freshwater ecosystems cover less than one percent of Earth's surface, but are home to 35 percent of all vertebrate species. Multiple components of climate change are anticipated to affect all the levels of aquatic biodiversity ranging from organism to biome levels. At the most basic levels of biodiversity, climate change is able to decrease genetic diversity of populations due to directional selection and rapid migration, which in turn affect ecosystem functioning and resilience. Because of climate changes, species may no longer be adapted to the set of environmental conditions in a given region and could therefore fall outside its climatic niche. A change in the environmental conditions will alter both the abundance and composition of biodiversity. In this paper, the benefits and services of aquatic biodiversity contributing to poverty alleviation, employment, foreign exchange, nutrition, health and ecosystem services are first examined. The different possible effects of climate change that can operate at individual, population, species, community, ecosystem and biome level are also discussed. Finally, several conservation measures and challenges for future research are highlighted. Overall, the review shows that the values of components of biodiversity and their contributions to economies

at local, national and global levels need to be determined. There is need to determine the impact of climate change on aquatic ecosystems and diversity of organisms or species. In order to effectively stem the loss of biodiversity, our country should prioritize development of a national biodiversity conservation strategy.

Key words: *aquatic biodiversity, biodiversity loss, climate change, Kenya*

1-#2-27

Structural and functional Responses of Macroinvertebrate Assemblages to Changes in Water and Habitat Quality in the upper Reaches of the Nzoia River Basin, Kenya

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Degradation of aquatic ecosystems in the Lake Victoria basin (LVB) and the rest of East Africa has elicited concern because of its bearing on social and economic development. Rapid population growth, nutrient enrichment, agricultural intensification and habitat loss have increased pressure on the integrity of water resources. The structure (composition and abundance) and functional (functional feeding groups, FFGs) organization of macroinvertebrates are increasingly being used as biological indicators to identify multiple stressors in aquatic ecosystems. However, most of these studies are temperate

with poor representation from tropical regions and this hampers efforts for monitoring global trends in water quality. The objective of this study was to evaluate the structural and functional organization of benthic macroinvertebrates in relation to water quality and habitat diversity in an upland tropical river in the Kenyan Rift Valley. Nine study stations were chosen to correspond to different land-uses in the catchment. Instream substrate characteristics were assessed and water quality physico-chemical variables measured at each station. Surber samples of benthic macroinvertebrate were collected from pools, riffles and runs during the dry and rainy season in 2006. Significant spatio-temporal variation was observed in relative abundance, with *Diptera* dominating the study area. *Ephemeroptera, Plecoptera* and *Trichoptera* dominated the headwater stations, whereas *Coleoptera, Oligochaeta* and *Chironomidae* dominated further downstream. Significant relationships were recorded between physico-chemical water quality variables and the occurrence of specific taxa. There were differences in the distribution of macroinvertebrate FFGs in the study stations. Gatherers and filterers were the first and second dominant groups during the two seasons. Variability was observed among stations with shredders and scrapers occurring prominently in upstream stations with had elaborate canopy cover. The results from this study indicated that the greatest influence on the structural and functional organization of benthic macroinvertebrates was at the local scales (channel unit and microhabitat) suggesting that monitoring programs should also pay attention to minimizing near-stream human impacts as opposed to current focus on land use change at the catchment scale.

Key words: *benthic macroinvertebrates, bioindicators, tropical stream, water quality*

1-#2-28

Impacts of Human Disturbance on Macroinvertebrate Assemblages within Chep Koilel River Swamp, upper Nzoia River Basin

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The study investigated the impacts of human activities on macroinvertebrate assemblages along Chep Koilel River swamp. A total of six sampling stations were objectively chosen along the swamp to correspond to various human activities and sources of pollution. Sampling for benthic macroinvertebrates, littoral aquatic insects and water quality parameters was done for six months covering both rainy and dry seasons. Selected water quality parameters were measured in-situ while the macroinvertebrates were sampled using 500μm mesh size scoop net at all the sampling stations. The macroinvertebrates sampled were sorted live and identified to genera level using appropriate keys and analyzed for taxon diversity, abundance and evenness. Composition and distribution results were used for bioassessment of ecological integrity of the swamp. Results showed significant ($p < 0.05$) spatial variation in macroinvertebrate attributes and water quality parameters. Stations with high human disturbance recorded low diversity compared to those with low disturbance. It is thus concluded that human disturbance impacts negatively on macroinvertebrates within Chepkoilel River swamp.

Key words: *macroinvertebrates, swamp, community structure, human activities*

1-#2-29

Delineating Lake Victoria Fishes: A Key to Managing the Fishery

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Three species of Nile perch; *Lates macrophalmus* and *Lates niloticus* (from Lake Albert) and Lates longispinis and *Lates niloticus* (from Lake Turkana) were introduction into Lake Victoria in the late 1950s and early 1960s. The Nile perch has established as a major commercial fishery and promoted auxiliary activities for example boat building, ice making and transport. Its impact on the social economics of the fishing communities cannot be ignored. Changes in the Lake Victoria ecosystem have been attributed to agricultural run-off, deforestation, eutrophication and over fishing. However, the contribution of Nile perch introduction to these changes is important especially the disappearance of over 300 endemic haplochromines. The main reason for re-introducing Nile perch in Lake Victoria was to prey on the endemic Haplochromis, which was of little commercial importance. The fisheries of Lake Victoria make a significant contribution to the riparian countries of Kenya, Uganda and Tanzania. In Kenya alone 92% of fish production valued at over Kes.7 billion is from Lake Victoria. The Kenyan portion of Lake Victoria is a narrow and shallow gulf comprising only 6% (4,100Km^2) of the entire lake (68,000km^2). The major rivers draining into this fishery on the Kenyan side are Nzoia, Yala, Migori, Nyando, Kibos, Sondu Miriu and Kisat. The fishery

is multi-species with the catch dominated by; Nile perch, *Lates niloticus* (60%), *Rastrineobola argentea* (30%) and *Tilapiines* (5.5%). *Clarias gariepinus*, *Bagrus dokmak*, *Haplochromis spp.* and *Protopterus* appear in small quantities. It is probable that whole populations may be 'lost' before they are studied and identified. However, meaningful conservation and management can only be carried out within the framework of known species and an understanding of the relationship between and within different populations and species.

Key words: *delineate, fish species, conservation, management*

1-#2-30

Phylogenetic Study of the 'endangered' Ripon Barbel, *Barbus altanialis* (Boulenger, 1900) (Cyprinidae) in Lake Victoria Catchment based on Mitochondrial DNA Sequences

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A phylogenetic study of the endangered cyprinid *Barbus altianalis,* a species known to be potamodramous in the Lake Victoria basin, was carried out based on 850 bp of the D-Loop and 658 bp of the COI mitochondrial DNA genes, respectively. Samples were drawn from four Kenyan *Barbus altianalis* river populations and from sequences from Ugandan Lake Victoria basin retrieved from GenBank. 63 mitochondrial DNA d-loop haplotypes were found from 196 samples from rivers Nzoia, Yala, Nyando and Sondu – Miriu, the four main rivers draining the Lake Victoria catchment and 36 sequences from genebank. Population connectivity patterns of the studied area inferred from analysis of molecular variance show that the variation seen in the haplotypes is highly contributed by the substructure within populations. Phylogenetic trees from the two markers display two distinct Clades. Clade I having samples from Nzoia and Uganda while Clade II had samples from the four Kenyan rivers population. River Nzoia and Ugandan populations probably represent phylogenetically different populations or sub-species of *Barbus altianalis*.

Key words: phylogenetics, *Barbus altianalis*, Lake Victoria, mitochondrion

1-#1-31

Striga Pandemic in Western Kenya: A Limiting Biological Constraint to Food Production

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Parasitic weeds belonging to the genus of *Striga* are among the world's most tenacious, prolific and destructive agricultural pests. The obligate parasite, *Striga hermonthica*, is identified as the most dangerous with dramatic effects on cereal crops in western Kenya. The parasite may cause yield losses in cereals ranging from 15% under favorable conditions to 100% where several stress factors are involved, thereby affecting the livelihood of resource-poor farmers. The average yield loss due to *Striga* is 1.15, 1.10 and 0.99 tons per hectare for maize, sorghum and millet, respectively. However, research conducted in western Kenya showed potential levels of tolerance to *S. hermonthica* among the rice cultivars. One of the greatest traits of the parasite is its ability to withstand a wide range of climatic conditions as well as to be quickly adapting to different hosts and environments. This makes it even more difficult to develop universally resistant host crops, and effort towards obtaining resistant cultivars may need to take the view that *Striga* species are diverse. More detailed analysis of genetic diversity in *S.*

hermonthica population is required for understanding the parasite well for effective management. Future *Striga* programs should not be conducted by individual institutions, but should rather be conducted in an integrated approach that combines research talents of various institutions. This will facilitate collaborative research and achieve qualitative interaction between stakeholders, which can easily produce reliable technologies that are practical and available to farmers.

Key words: *Striga weed, tolerance, rice, yield*

1-#1-32

Development of Cowpea (*Vigna unguiculata*) varieties resistant to *Striga gesnerioides* and *Alectra vogelii*

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Cowpea (*Vigna unguiculata*) is an annual legume which plays an important role in the nutrition of people in Nzoia River Basin in Lake Victoria. The legume is highly nutritious with a high content of protein ranging between 20-38%. In addition, it has low levels of metabolites and other toxins. Despite this importance, cowpea is highly susceptible to attack by parasitic weeds including both *Striga gesnerioides* and *Alectra vogelii*. These

parasitic weeds affect the quality of land and food security as the density of their seeds increase in the soil and are spread to new areas. Five races of *striga* are known to affect cowpea. It is therefore of great importance to develop cowpea varieties to meet a range of specific demands by farmers like combined resistance to *Striga gesnerioides* and *Alectra vogelii* while maintaining preferred grain type and vegetable leaf quality. To achieve this, it will be relevant to determine the genetic variability of *Striga* infecting cowpeas. Crossing of cowpea varieties that are high yielding and those resistant to *Striga gesnerioides* and *Alectra vogelii* will lead to the development of new resistant varieties. Utilization of markers in the selection of resistant varieties will shorten the period of time required for the development of resistant varieties.

Key words: *cowpea, Striga gesnerioides, Alectra vogelii, resistance*

1-#1-33

Horticultural Biodiversity for Sustainable Diets, Long Term Health and Economic Development

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Seventy percent (70%) of contributors to health status of a person is due to health behaviours and the environment. There is a significant and strong correlation between diet and health status of an individual. Sixty (60%) per cent of global calories come from only three crops, wheat, rice and maize. Food security

in Kenya and other African countries is largely measured by strategic maize reserves and horticultural biodiversity remain unexploited leading to inadequate consumption of fruits and vegetables and increased consumption of fatty and sugary foods. This has led to alarming increase of obesity and associated degenerative diseases yet Africa is endowed with Horticultural biodiversity that need to be exploited to solve the double burden of malnutrition. This paper highlights the strategies that can be employed in repositioning Horticultural biodiversity for improving sustainable foods and diets for long term health and development in Africa. There are numerous proven advantages of Horticultural biodiversity that gives it a competitive advantage with regard to nutrition, health benefits and improved quality of life. Major constraints of Horticultural biodiversity include negative attitudes, poor information sharing, lack of quality seed and poor policy framework. Strategic repositioning of Horticultural biodiversity will contribute significantly to sustainable diets for long term health and economic development in Africa.

Key words: *Horticultural; biodiversity; sustained diets; health economic development.*

1-#1-34

Determinants and Extent of Diversification in Smallholder Rice Farms in the Face of Deteriorating Climatic Conditions: Case Study of Bunyala Rice Farmers in Bunyala District, Busia County

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Agriculture is the backbone of Kenyan economy and is the mainstay for the livelihood of a large portion of the population. Kenya's agricultural production is mainly dependent on rain-fed cultivation with maize, wheat and rice as the principle staple food crops. IPCC (2001) has forecasted that with the likely long-term changes in the rainfall patterns and shifting temperature zones, climate change is expected to affect agricultural production and consequently food security and economic development. In order to improve food security and build resilience in smallholder farms, there is need to establish functional relationships among various agricultural sectors. This study analyses the determinants of rice production and the factors influencing the extent of diversification by smallholder farmers of rice in Budalangi, Bunyala District, Busia County within the lower Nzoia river basin.

The cross sectional study used primary data obtained through household surveys conducted on the smallholder rice farmers in Budalangi, employing both purposive and random sampling techniques and secondary data. Results indicate that land

ownership, various input factors (good soils, quality fertilizer and, enhanced technology), credit flow/insurance and access to markets as well as the interplay between local institutional capacity and arrangements, determine the extent of rice farming diversification and climate change resilience. The findings have important implication for policies that are designed to enhance profitable rice farming. In particular, the results suggest the need for the government to consider policies enhancing an integrated value chain. The research concludes that a food secure community is a resilient community and this can only be achieved through partnership with institutions in a multi-sectoral environment.

Key Words: *smallholder farmers, diversification, resilience, livelihoods*

1-#1-35

Evaluation of Upland Rice Response to Interseasonal Variations in Water Availability: Regulation of Carbon Gain and Water Use in Relation to Yields

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Rice is the second largest cereal crop planted in the world, is strongly linked with global climate change due to methane emissions, and provides the staple food for more than 2 billion

people. There is a huge need with increases in population to maintain or improve rice production and to develop crops locally that are resistant to negative influences of climate change and extreme events. New cultivars must be evaluated with respect to resilience and made available to small shareholders. Rice crop production is tightly linked to the seasonal course of water use and carbon gain which vary interseasonally with climate. Diagnosis over the course of growth seasons of the biophysical drivers that control efficient carbon gain and water use in rice together with characterization of plant response from the level of cell structure up to ecosystem scale can provide insight with respect to the sensitivities and utility of cultivars proposed for use by local farms. The adaptive properties of upland rice cultivars may be evaluated in response to natural climate variation, but also in manipulation experiments where especially water availability is modified. The research described illustrates the type of phenomena that we will examine in experiments with upland rice grown at the Botanical Garden of Maseno University.

Upland rice was studied under rainfed conditions and with temperate climate in Gwangju, South Korea, where more than 60% of precipitation fell during the monsoon season (May to October). Nevertheless, extended dry periods occurred during the milk filling stage in July and in August, which resulted in decreased soil water availability. The rice plants exhibited a diurnal response in rolling of the leaves when midday water potentials decreased below – 1 MPa. After strong monsoon rains, the reversion to full canopy leaf exposure was essentially immediate. During the dry periods, leaf conductance, carbon

gain, total water use and water use efficiency decreased, and leaf rolling contributed to a midday depression in gas exchange. We hypothesize that the sensitivity of this response varies with root system development of specific cultivars, leading to differences in the impact on crop yields. The planned experiments will evaluate this hypothesis for upland rice cultivars selected for planting under tropical climate conditions near Kisumu. The seasonal responses in observed leaf morphology and function will be included into a process-based model of carbon gain and yield in order to assess potential influences of climate variation and climate change.

Key words: *Rice, water stress, carbon use, water use, yield*

1-#1-36

Effects of Ridge-furrow and Plastic-mulching Tillage on Maize Production and Water-saving at Melkassa in Ethiopia

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Two field experiments were conducted at Melkassa Agricultural Research Center during dry and rainy seasons in 2012-2013, respectively. (i) In dry season, (a) three levels of drip irrigation, namely low 357, middle 435 and high 515 mm, combined with three film-mulching treatments, i.e. without film-mulch as control, and with black plastic mulch and clear film-mulch under ridge-furrow were designed to test effects of film-mulching and irrigation on water using efficiency and seed yield of maize. (b) Three furrow irrigation levels of water (namely low 484, middle 674 and high 865 mm, respectively) combined with two mulch treatments [namely without mulch (CK) and clear plastic mulch (CM)] under ridge and furrow tillage systems among three replications and four days irrigation interval was used. (ii) In rainy season, four kinds of mulching treatments [namely without mulch (CK), straw(teff :wheat 3:1) mulch (SM), clear plastic mulch (CM) and black film mulch (BM)] combined with two farming methods (ridge and furrow farming and flat farming) among three replications were applied. The results showed that film mulching techniques can effectively maintain soil moisture content, increase soil temperature, accelerate crop growth and increase maize biomass and grain yield. Where the soil water content at depth 0-70 cm in CM and BM were higher than in SM and CK, especially the difference was more significant when irrigation was stopped in dry season and the circumstances of little rainfall in rainy season, but there was no significant difference of soil water content between CM

and BM, SM and CK. On the other hand, the film mulching technology can effectively shorten the growth period of maize 5-11 days than CK and SM, but no difference between SM and CK. Furthermore, the highest grain yield (8523 kg ha^{-1}) and WUE (15.0 kg ha^{-1} mm^{-1}) were recorded in RCM and CM-LF plots, respectively. Compared to the control, the maximum incremental values of corn yields and WUE or RUE in three experiments were recorded in BM-HD (69.9%), CM-LF (75%) and RCM (47.5%). However, there were no significant differences in corn yield and WUE with the BM and CM, SM and CK treatments. The net income was the highest with RCM (1665.28 USD ha^{-1}) and the highest net income difference from the control treatment was (597 USD ha^{-1}) with CM-MF. The ridge and furrow with film mulching system could effectively increase crop production and be beneficial to agricultural sustainability in semiarid area of Ethiopia.

Key words: *film-mulching, furrow irrigation, soil water, net income*

1-#1-37

Ecological factors influencing spatial distribution of large grazing herbivores in Ruma National Park of Homabay county, Kenya

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Understanding ecological factors influencing large grazing herbivores densities and distribution in terrestrial ecosystems is a fundamental goal of ecology. Previous studies have provided

evidence that ecological factors variably influence large herbivores density and distribution in savannah ecosystems. Research focusing on the influence of ecological factors on large grazing herbivores densities and distribution had received little attention in Ruma National Park which is among the fragmented savannah ecosystems. Therefore, the objectives of this study were to: assess the influence of grass biomass on large grazing herbivores distribution; determine the effect of grass species on the large grazing herbivores distribution; establish the effect of landscape and water sources on large grazing herbivores distribution; and determine the influence of mean monthly rainfall on distribution of large grazing herbivores in Ruma National Park. This study adopted a descriptive research design. It was carried out in the whole park with large grazing herbivores, eight plots with 32 subplots, six mean monthly rainfall data in the study. The study area was stratified into the escarpment, riverine forest and the wooded grassland plains. Biomass plots were identified using a GPS, transect navigated using a compass, grass clipped with secateurs and, weighed using Aston Meyers balance, and recorded onto field datasheets. Quantitative data was analyzed using correlation, least squares linear regression and multiple regressions. Results were presented in tables, graphs, correlation regression scatters, multiple regression tables, photographs, spatial maps, and observational information was expressed in writing. Biomass ranged between 474 g/sqm to 1034g/sqm in the park. All the ecological factors were found to influence the spatial distribution of the large grazing herbivores in Ruma National Park. There was linear correlation on grazers by grass biomass and grass species contributes at 19.4% but the

biomass had the highest influence 74.3 Seq. SS whereas species abundance had 52.9 Seq. SS, and rainfall at 12%. The F ratio in the analysis of variance was 0.60 and the significant at P = 0.05 provided evidence of a linear relationship. This study has provided baseline information on ecological factors influencing large grazing herbivores distribution in protected terrestrial savannah ecosystems of Ruma National Park.

Key words: *biomass, species abundance, herbivores, rainfall, multiple regressions*

1-#1-38

Nutrient Load and Heavy Metals in the Water along Rivers Amala and Nyangores Tributaries of Mara River in Kenya for Assessment of recent Increase in anthropogenic Activities

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Mau Forest in the upper reaches of Mara River basin has recently undergone increased forest destruction followed by human settlement and agricultural activities. These anthropogenic activities may be contributing nutrients and heavy metal loads, ultimately polluting the river water and eventually Lake Victoria water, consequently damaging the aquatic systems of both the river and the lake. Nutrients and heavy metal levels in the water

of tributaries of River Mara, Kenya were evaluated in the dry and wet season to establish the influence of the anthropogenic activities on their levels. Springs in the forest that had not been disturbed, were used as controls. Water samples were analyzed for pH, temperature, conductivity, nutrients and selected heavy metals. The range of pH was 5.44-7.48 and conductivity 20-99 μS/cm which were within the environmentally acceptable limits. The range of the levels (μg/l) of nutrients were:- 80-443 **(**NO_3^--N), 21.7-82.7 (NH_4^+-N), 11.9-65.0 (soluble reactive phosphorous), 51-490 (total phosphorous and heavy metals (μg/l) :- 6.56-37.55 (Cu), 0.26-4.97 (Cd), 13.91-213.19 (Zn), 0.35-3.14 (Cr), 0.19-5.53 (Mn), 1.90-9.62 (Pb) and 0.21-4.50 (Se). These levels were also within the WHO acceptable limits for animal and human use demonstrating that anthropogenic activities had not reached unacceptable limits. The nutrients and heavy metals loads were different and higher ($p \leq 0.05$) than at the control, implying that the anthropogenic activities were influencing the water quality. Heavy metals and nutrient loads were higher in the wet season than in the dry season, possibly due to increased leaching and surface run offs. In both seasons, with exception of total phosphorous, nutrients and heavy metals levels obtained were within the WHO limits for domestic water use. If increase in the anthropogenic activities is unchecked, the levels may soon reach unacceptable limits. It is important to control the anthropogenic activities, as with time, the activities could impact water quality of Mara River, and that of Lake Victoria.

Key words: *Water quality, nutrient load, heavy metals, anthropogenic activities, Mara River Basin, Kenya*

1-#1-39

Influence of Anthropogenic Activities on Seasonal Variations of Nutrients in Spring Water along Amala and Nyangores Tributaries of the Mara River Basin

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Replacing natural forests with human settlements and agricultural activities has several environmental impacts including potential of contaminating aquatic ecosystems, including spring water. Springs are sources of major rivers. For example, Amala and Nyangores tributaries in the Mau Complex are the main sources of River Mara, a river transcending Kenya and Tanzania. In the Mau Complex, land use practices have changed with time, but the impact of the activities on the quality of the spring waters have not been determined. The objective of the study was therefore to determine the effect of land use practices on the water quality of springs within the Mau forest catchment. Seasonal and site variations in pH, temperature, total nitrogen, ammonium-nitrogen, nitrites, total phosphates and soluble reactive phosphates in waters from springs that flow into and are source of Amala and Nyangores tributaries were determined. Water samples were collected from eight (8) sites - from both tributaries' springs - during the long dry and long wet seasons. Water pH ranged from 6.4 to 6.6 and temperature range was 13.00 – 15.79 ^{o}C (Nyangores) and 15.21 – 17.70 ^{o}C (Amala) in wet and dry seasons. Soluble reactive phosphate (SRP) varied ($p \leq 0.05$) in springs, ranging from 42.01 - 22.00

ppb during the dry season and 64.11 - 19.55 ppb in wet season. Total phosphate levels in the water samples varied significantly ($p \leq 0.05$), ranging from 52.01 - 362.00 ppb). Different springs had varying ($p \leq 0.05$) amounts of nutrients in water. These could, in the long run, cause adverse water quality problems to streams and rivers downstream. The concentrations in SRP, TP, ammonium, nitrates and nitrites, however, fell within the World Health Organization guideline limits for domestic water. Land use practices in the complex did not significantly affect the quality of spring waters. However, periodical monitoring of the springs is recommended to ensure land use activities do not cause deterioration of the spring waters for domestic and agricultural uses.

Key words: *anthropogenic activities, spring water, nutrients*

1-#1-40

Assessment of Water Quality using Multivariate Techniques in River Sosiani; upper Catchment of Nzoia River

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Variation in water quality along a riverine ecosystem is affected by multiple factors (climate, geomorphology, hydrology and anthropogenic activates) downstream. Multivariate techniques

can infer intrinsic characteristics of complex data by generating correlation, similarity, dissimilarity and covariance vector matrix to ascertain their relationships. We evaluated effect of anthropogenic activities by analyzing selected physico-chemical water quality parameters (WQP) as indicators of pollution in River Sosiani at 6 stations (ST), with ST 2, ST 3 and ST 5 assessed before and after anthropogenic activities, from August 2012 to February 2013 (Aug-Oct≡Wet, Nov-Feb≡Dry). Temperature, pH, TDS and Conductivity were measured in situ while TP, TON, BOD and DO measured in vitro using standard methods. The measurements were significantly different at the stations ($p = 0.00$). Except for DO and pH, the other variables were increasing in concentration downstream. Cluster analysis grouped stations with municipal discharge (ST 5 and ST 6), to be the most distant in relation to the measured variables in both seasons. Multidimensional scaling had four categories of stations with similar WQP; before, after and wet and dry seasons. Principal component analysis with component 1 at 60.5% variance and component 2 at 26.1% variance evaluated TON and TP as key pollutants in both wet and dry season, with BOD levels high at ST 5 and St 6. Varifactor 2 at 35.3 % and 27.1% variance in wet and dry season respectively had strong negative factor loading of BOD (Wet; -0.878, Dry; -0.915) and also of TP (Wet; -0.839, Dry; -0.709). Varifactor 3 at 18.4% and 21.7 % variance in wet and dry season also had a strong negative factor loading of TON (Wet; -0.822, Dry; -0.861). Multiple pollution effects, changing environment and intrinsic characteristics of aquatic ecosystems generate complex data which are better assessed with multivariate techniques.

Key words*: riverine ecosystem, water quality assessment, multivariate techniques, anthropogenic activities*

1-#1-41

Luffa-Aqua Purifier as A Source of Domestic and Industrial Water

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Luffa-Aqua purifier (LAP) is simple equipment made of a spongy material that can be used to desalinate sea water. The sponge is obtained from a mature dried sponge gourd, *Luffa cylindrica* L., a *Cucurbitaceae* that is widely distributed within the tropical areas. The device has the potential for use in sea water purification. When smeared with cellulose acetate, the sponge forms a thin matrix that effectively dries up within 6 hours in an oven set at temperatures 110 ^{o}C. The spongy material allows water molecules to percolate through whereas foreign materials including mineral salts are trapped. The equipment is integrated with positive and negative electrodes supplied by a 300 mA generated by a solar panel to aid electrolysis. The percolate is further passed through an ultraviolet ray for sterilization of pathogenic microbial communities. LAP has the potential of purifying saline and contaminated water that can be used in both domestic and laboratory set-ups.

Key words: *cellulose acetate, Cucurbitaceae, purification, sponge gourd*

1-#1-42

Suitable Combination of selected locally available Materials for domestic Water Purification

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Water is a finite and life sustaining resource which covers about 70% of the physical environment of the planet Earth. A wide range of human and natural processes affect the biological, chemical and physical characteristics of water and thus affect water quality. Consequently, consumption of contaminated water puts lives and livelihoods at risk because water has no substitute. It is, therefore, expected that before consumption, water should meet the set quality standards of potable water. The modern water treatment technology is limited, very expensive and unavailable in rural areas leading to increased prevalence of mortality rates caused by waterborne diseases. Currently, research is being conducted to look for other desirable water purification processes that may be employed in providing potable water for the rural population. Various techniques have been developed among them, the use of locally available materials which have shown efficiency in purification of water when separately used; however their activity when factorially combined is not known. It is presumed that different contaminants will be adsorbed onto their surfaces as they have different adsorptive capacities for various contaminants hence producing safe water. The objective of this study was to determine a suitable

combination of selected locally available materials for domestic water purification. Water samples were collected from fresh and salty boreholes in triplicates. They were then passed through columns containing separate and various combinations of specific amounts of filtrate of distilled water-soaked powdered *Moringa Oleifera* seeds and crushed activated clay, activated charcoal and natural zeolites. Selected water quality parameters (temperature, pH, total dissolved solids, electrical conductivity, dissolved oxygen, total solids and *Escherichia Coli*) were analysed before and after the purification process using standard methods for each parameter and a comparison was then made with the set water quality standards by the World Health Organization (WHO). The results showed that one combination gave the best water quality parameters that are acceptable by the WHO standards for potable water. This would ensure accessibility of potable water to the rural community.

Key words: *water treatment, locally available materials, World Health Organization*

1-#1-43

A comparison of Adsorption Equilibrium, Kinetics and Thermodynamics of Aqueous Phase Clomazone between Faujasite X and a Natural Zeolite from Kenya

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In this study, a well-known synthetic faujasite X (FAU-X) zeolite and a recently discovered natural zeolite material from Kenya (NZ-K) were compared for their efficiency in removal of clomazone, a herbicide and water contaminant, from aqueous solution. The adsorption kinetics, isotherms and thermodynamics parameters were investigated. Equilibrium sorption data was describable by both the Langmuir and Freundlich models. The adsorption kinetics obeyed the pseudo-second-order kinetic law while pore diffusion was not the sole operating rate determining step. The derived thermodynamic parameters, namely ΔG and ΔH, indicated the adsorption process was feasible, spontaneous and exothermic for the natural zeolite and non-spontaneous for the synthetic zeolite *via* a physical and chemical process, respectively. The natural zeolite proved to be a suitable low cost adsorbent for clomazone removal with removal efficiency above 70%, five-fold more efficient than faujasite X.

Key words: *adsorption, natural zeolite, faujasite X, clomazone*

1-#1-44

Prediction of Gold Speciation in the Environs of Kakamega Mines using Sulphates Concentrations as Species for WATCH Computer Program in Water Quality Management

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Gold mining is now amongst serious environmental degradation propellants., This is attributed to high concentration of sulphates in the effluents. Acidic water is generated from the gold mine working, waste rock piles and tailing. In Kakamega, the former Rosterman gold mines, currently there's informal illegal mining characterized by rampant disposal of acid mine drainage before treatment. This is a direct threat to drinking water, agriculture, vegetation, wildlife and waterways. Chemical analytical results for pH, temperature, conductivity, gaseous species and sulphates concentrations in systematically sampled hand-dug wells water from Kakamega were adopted as WATCH program inputs. The concentrations, activity coefficients and activities of aqueous species at hand-dug well reservoir conditions were determined by iterative process that involved simultaneous solution of mass balance and mass action equations in the WATCH computer software. A model of gold ion – sulphate ion interactions formed

a basis of the output that gives concentrations of analytes at the hand-dug wells reservoirs conditions, activity coefficients of aqueous species which could be used to compute activities and activity ratios for the process of gold speciation. The computed activity ratios stand out as accurate rapid predictors for rates of acid water states in these hand-dug wells that will go a long way in saving on the lengthy water analysis procedures meanwhile enhancing water quality management updates for the Lake Victoria basin region.

Keywords: *gold mining, water quality, speciation, WATCH*

1-#2-45

Technologies, People and the Environment

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Technologies have become crucial in the ways people connect to, interact with, change, destroy and restore environments. My work is interested in the interplay between technologies, environments and societies. In this context I've so far focused on two thematic areas: human and nonhuman health, and (renewable) energy landscapes. My work in health is interested in the social ecologies of disease, I'm particularly fascinated by the question how we might live together with organisms that are harmful to human health. Earlier work on malaria control in Ghana was concerned with the relations between mosquito-parasite-human interactions, health politics and the social

ecology of malaria, in particular the conditions and possibilities of coexistence between humans and other-than-humans. Currently, I'm involved in a collaborative research project on the translation of new health technologies in Uganda and Rwanda, where the aim is to analyse how therapeutic settings change when travelling technologies are being translated to particular sites.

My developing work on shifting energy landscapes in sub-Saharan Africa centres on two conceptual and empirical interests: (i) the relationship between recycling and energy production in Africa; and secondly (ii) 'burning' as a concept and in how burning practices may have changed and shifted over the last decades. Burning or combustion has accompanied humans throughout history: fire held our ancestors warm, fertilized soils, enabled the cooking of food, and was elementary to tool making and use. Although often less visibly so, combustion and burning are still key to today's production of electricity, heating, (auto.) mobility and goods. However, in times of climate change and growing awareness of the finite nature of fossil fuel reserves, humanity's reliance on fossilized energy sources has come under increased scrutiny. In attempts to move beyond our dependency on fossil fuels and to slow down climate change, much hope is invested in burning *different* materials than before, as well as in burning materials *differently*. I am (together with my colleague Dr. Julien McHardy, Amsterdam) curious about 'burning', its uses, practices and meanings in society, and we aim to look closely at some of the multifarious practices through which combustion is incorporated in and animates the 'social-energetic metabolism' (Mitchell) of contemporary life on the African continent. How

is 'burning' in the process of becoming reconfigured in Africa: which kinds of burning (and by extension carbon emissions) have in the past qualified as wanted or dangerous? How is this changing today?

Key words: *technologies, mosquito-parasite-human interactions, (auto) mobility*

1-#2-46

Impacts of selective Logging on Regeneration, Population Structure and Dynamics of a Canopy Tree *(Olea capensis*) in Kakamega Forest

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Olea capensis is one of the canopy dominants in the Kakamega forest that shows no regeneration inside the forest. Like canopy dominants in other tropical forests, adults are widely spaced and seedlings and saplings, where present, are usually hundreds of metres away from the parent plants. This study assessed the impacts of logging on the population structure and dynamics of Elgon teak (*Olea capensis*). The objective was to ascertain and determine the regeneration status of this tree species in view of its commercial value. A comparison was made between logged and unlogged sections at three sites in the forest. This study also examined strategies of regeneration of this important species to determine its recruitment patterns.

Most seedlings/saplings occurred considerable distances from the parent trees. Experimental manipulations of seeds revealed that forest rodents and fungi accounted for over 90 per cent of seed mortality around the parent trees. Observation on dispersers revealed that ecotone birds were responsible for seed dispersal into new areas that provided a safe haven for the seeds to germinate and establish. Further examination of seed predation in these areas showed insignificant levels of predation. There was also a relationship between location of seed deposit and presence of termite mound growing trees, suggesting a coincidental interplay between feeding behaviour of the dispersers and dispersal of *Olea capensis* seeds. Pairwise comparisons of the differences in the population structure among three sites, and the differences in the mean tree size revealed significant differences in all three study sites. Results also revealed a variation in stem density that was dependent on the block of forest under study. Results of the spatial contagion revealed that *Olea capensis* had a varied clumped distribution in all the study sites. Clumping was highest in the Kisere forest. These results point to logging as the major factor that explains the differences in population structure and stem density in different parts of Kakamega forest. And while intermittent recruitment may explain clumped distribution, logging appears to explain the variation in the degree of clumping. Findings of this study point to the importance of understanding the biology of tree species of concern for successful regeneration efforts. In particular, knowledge of seed dispersers and predators is crucial.

Key words: *regeneration, spatial dynamics, population structure, Kakamega Forest*

1-#2-47

Land and Water Resource Planning and Management Options in Floodplain Wetlands: A Case Study of Ombeyi Watershed; Nyando Basin

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Land resources are integral components of watershed ecosystems. The wide-ranging functions and services of watersheds and land resources are, however seriously compromised when these production factors are scarce. Furthermore, watershed management strategies are often challenged by the presence of poor people who typically depend on the natural resources base for their livelihoods. Such is the case in Ombeyi Watershed where land under rice irrigation has recently expanded into wetlands. This decrease in area under wetlands is likely to result in their reduced functionality. An optimal goal is to implement a management strategy that can achieve the desired environmental integrity while simultaneously improving livelihoods and alleviating poverty.

A study aimed at identifying the hydrological equilibrium between expansion of area under rice and restoration of wetlands was conducted in Ombeyi Watershed. Historical time series for the Great Oroba and Little Oroba rivers, weather data (1970-2010), Digital Elevation Model (DEM), soil database, and land use/land cover database were obtained from various credible sources. Outcomes from several land use scenarios were compared. Through a stakeholder analysis framework, issues at stake regarding wetland use and management were identified and used to derive existing and potential trade-offs between the various uses of the wetlands and their ecological functions. The community was further engaged in a one day workshop to discuss activities that could ensure the sustainable use of wetlands.

The study showed that the increasing area under rice cultivation affected the residual stream flow to up to 70% in dry years. This impact could be reduced if the farmers adopted an optimized seasonal calendar. The presence of permeable sediments, discontinuous clay layers and fault scarps in the flood plain suggest that the alterations on the use of surface water, especially, affects groundwater recharge. Three main trade-offs were identified: between crop production and natural production of fibres, between crop cultivation and hydrological regulation, and that related to the depletion of soil organic matter associated with the artificial drainage of wetland plots and unsustainable agricultural practices.

Keywords: *irrigation, stakeholders, trade-off, wetlands*

1-#2-48

Comparing daily Precipitation Indices on the Chinese Loess Plateau

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Greenhouse-gas-induced climate warming is expected to intensify daily precipitation variability, i.e. lower precipitation frequency, longer dry periods, and larger individual precipitation events. In this case study of the Loess Plateau, we attempt to compare 10 daily precipitation indices: WD (number of wet days), PI (simple daily intensity, total precipitation/WD), C90 (the 90th percentile), R90N (number of events with precipitation greater than long-term 90th percentile), R90T (percentage of total precipitation from events above 90th percentile), R5GD(greatest 5-day total precipitation), WS (max number of consecutive wet days), DS (max number of consecutive dry days), CV (coefficient of variation) and GCI (Gini concentration index). Using a cluster analysis (R-Type Factor Analysis), we identified three categories: (1) intensity of precipitation events, including PI, R90T and R5GD, (2) number of precipitation events, including WD and WS, and (3) dispersion of precipitation events, including CV, GCI and DS. The other two indices, C90 and R90N, can be grouped into either category 1 (at sites with lower precipitation regime) or 2 (at sites with higher precipitation regime). The major sites show positive trends in category 3 of dispersion, i.e. more variability of daily precipitation on the Loess Plateau during 1957-2014. In

contrast, the major sites show negative trends in category 1 and 2 of number and intensity of precipitation events in the same period. We proposed three different indices for each category: PI in category 1, WD in category 2 and CV in category 3. These indices are able to provide important information regarding to different aspects of daily precipitation variability on the Chinese Loess Plateau.

Key words: *precipitation indices, 90th percentile, Chinese Loess Plateau*

1-#2-49

Why the Sum is less than the Parts: Some Recent and Ongoing Research on Nzoia River Basin

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Nzoia is the largest river basin in the Kenya side of the Lake Victoria catchment. Its importance derives not only as a source of water and economic good for the millions of people living within its area, but also due to the fact that it acts as a conduit of pollutants into Lake Victoria. The Department of Civil and Structural Engineering at Moi University has been investigating various aspects of the Nzoia basin since 2007 and a number of reports have been produced: 1. Water Quality Modelling using QUAL2E-UNCAS Programme. A case study

of Sosiani River (2007); 2. Optimal Location of Raingauges in a River Catchment. A case study of the Nzoia River basin in western Kenya (2009); 3. Quasi Two-Dimensional River Flood Modelling for the Budalangi Flood Plains (2011); 4. Flood Mitigation Modelling in the River Nzoia Basin through Storage Reservoirs (2013); and 5. Application of MIKE 11 Simulation Model for Water Quality Management in River Nzoia (2014); 6. Combined Hydrological–Hydrodynamic Modelling and Forecasting of Hydrological Extremes for Nzoia River Basin, Kenya (ongoing). A number of journal publications have also been made. While undertaking these studies, lack of quality data constituted a major challenge. As a result, it was decided to improve instrumentation in Sergoit, an upland sub-catchment of the Nzoia basin. This is ongoing.

This paper presents an outline of these studies and their findings. It is argued that the results, and those of others, are in a format that is not tailored for general use; are scattered and not readily accessible for application in water resources management, and that consequently, the individual works surpass their combined effect. It recommends cooperation for improved data collection, and partnerships for consolidation and synthesis of knowledge for the benefit of users and the general public.

Key words: *resource management, data, partnership*

1-#2-50

Potential of Lubricating Oil (MGALO) and Organic Bio-fertilizer Production from Marine Green Algae (Patent Number, KE/UM/2012/00295)

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Green seaweed *Euchuma rhodophyta, Ulva lactuca* and *Enteromorpha flexuosa* harvested from the Indian Ocean (Kenya) were characterized as feedstock for the production of lubricating oil and bio-fertilizer. *Euchuma rhodophyta* had the highest oil yields of 10.5% (g/g) followed by *Ulva lactuca* with 6.3% (g/g) and *Enteromorpha flexuosa* with 3% (g/g) from 100g of algal biomass respectively. The average kinematic viscosity from all the three algae was 32 cst at 40^{o}C suggesting a potential industrial application of the oils as lubricating base stock. Oil from the three marine algae had similar densities of 0.9132, 0.9136 and 0.9151 kg/L at 20^{o}C though the oils were denser than the stipulated range of Shell Tellus Lubricating oils ranging between 0.8850kg/L-0.870kg/L. After oil extraction, the biomass was further converted into bio-fertilizer containing 10% potassium

which is absent from many commercial fertilizers and rich in nitrogen (10%) and phosphorus (8%). We conclude that the three marine algae are potential source of bio-energy and bio-fertilizer and that industrial processing of the algae will be of significant economic and environmental advantage.

Key words*: algae, bio-fertilizer, lubricating oil, marine.*

Appendices

Maseno University – Kenya

ISO 9001 – 2008 Certified Institution

Maseno University is a university based in Maseno, near Kisumu, in Kenya and was founded in 1991. Maseno University is a modern institution of higher learning set up to advance teaching, learning, research and development that responds to the emerging socio-economic as well as technological and innovation needs of Kenya and the Eastern African Region. According to the Vice-Chancellor, Prof. Dominic W. Makawiti, Maseno University has embarked on a mission to develop and deliver academic programmes that not only respond to the needs of industry but also prepare workers for the knowledge economy, in line with the Vision 2030. The programmes offered by Maseno University (referred to as 'With IT' programmes) ensure that all graduates of Maseno are adequately exposed to a knowledge-base that enables them to live, learn and work in a multi-disciplinary setting where ICT is as much a resource for learning and working, as it is a discipline in its own right.

Vision

The University of Excellence in discovery and dissemination of knowledge.

Mission

To discover, harness, apply, disseminate and preserve knowledge for good of humanity.

Objectives

1. To implement an effective quality management system based on ISO 9001:2008 by establishing procedures to enhance access to quality university education and support undertaking of research and development.
2. To strengthen linkages for community services, extension and outreach by offering timely service through reaching out to the community using well thought our research and outreach programmes.
3. To maintain efficient and effective communication between members of staff and university customers to improve performance of internal administrative and institutional support structures.
4. To increase the income base to fund programmes and expand the physical infrastructure of the university to facilitate provision of the highest quality service or product at committed cost and on time.
5. To continuously monitor and review performance of university structures and systems to ensure continual improvement of our services to our customers.

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Moi University - Kenya

ISO 9001 – 2008 Certified Institution

Moi University is located in Eldoret, Kenya and was established in 1984. The University currently operates four (4) campuses, namely: Main Campus, Town Campus, Eldoret West Campus and Odera Akang'o Campus. The Town campus hosts the College of Health Sciences (Medical complex), School of Aerospace Sciences (Rivatex) and School of Law (Annex) while the Eldoret West Campus is home to our Privately Sponsored programmes. Moi University has two (2) constituent colleges, namely Garissa and Rongo that also offer unique undergraduate and postgraduate programmes, and a total of five (5) Satellite Campuses in Nairobi, Kitale, Alupe, Kericho, and Coast (Mombasa). Moi University is committed to providing quality education and services that meet the needs of its customers and stakeholders through quality and relevant teaching, research and community service and outreach. The University is committed to a quality work and learning environment that is grounded in intellectual and academic freedom, teamwork, quest for excellence, professionalism, discipline and continuous improvement of its products (programmes/activities) and services so as to achieve client/customer satisfaction.

Vision

To be the university of choice in nurturing innovation and talent in science, technology and development.

Mission

To preserve, create, and disseminate knowledge, conserve and develop scientific, technological and cultural heritage through

quality teaching and research; to create conducive work and learning environment; and to work with stakeholders for the betterment of society.

Core Values

1. Promotion and defence of intellectual and academic freedom, scholarship and relentless search for truth.
2. Fostering teamwork, innovation, networking, tolerance, and a culture of peace.
3. Embracing excellence, transparency and accountability.
4. Practising professionalism, meritocracy, equality, integrity and social justice.
5. Maintaining self-respect, discipline, responsibility, institutional loyalty, national patriotism and international competitiveness.
6. Continual improvement of services in order to remain competitive and relevant.

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Lake Basin Development Authority - Kenya

ISO 9001 – 2008 Certified Institution

The Lake Basin Development Authority (LBDA) was established by an act of parliament (Cap 442) on August 31, 1979 as a quasi-government regional development Agency. The aim was to catalyze coordinated and sustainable socio-economic integrated basin based development in the Kenyan portion of the Lake Victoria Basin. LBDA operates under the Directorate of Regional Development in the State Department for water of the Ministry of Environment, Water and Natural Resources. Under the establishing Act, the organization is empowered to plan, co-ordinate, implement, monitor & evaluate integrated sustainable development projects and programs. This includes the promotion of integrated sustainable management and conservation of natural resources for the welfare of the communities of the Lake Victoria Basin.

Vision

To be an authority in integrated socio-economic development in the Region

Mission

To foster integrated socio-economic programs through optimum utilization of resources using appropriate technology and innovations for improved livelihoods of the communities within the Kenyan portion of the Lake Victoria Basin.

Objectives for Plan Period 2012-2017

Formulate and implement sustainable integrated basin-based development programmes, Enhance sustainability in operations, Increase market share of LBDA's products and services, Enhance institutional and human capacity for improved performance. LBDA

undertakes its activities in the Basin through partnerships and mobilization of resources and assets, both internally and externally, in pursuit of the broad aim of improving livelihoods through sustainable development in the region.

The Authority has lined up several major projects and programmes for implementation. These include major Multipurpose Dams such as Magwagwa, Nandi, Webuye and Kuja. The projects all together will produce and supply into the national grid some 218 Mw of hydro-electric power, turn 41,058 ha of land into greeneries of productive croplands through irrigation development; besides domestic water supply, tourism, fisheries and catchment conservation in the water towers of the basin. Currently the Authority is developing a 25,000 m2 Mall, which will provide not only offices but also commercial shopping spaces to stimulate business and development in the region. The LBDA Mall is scheduled to be ready for occupation by August 2015. In addition to a number of Development Studies, several Strategic Capacity Building Projects, Technology transfer projects, as well as Integrated Climate Change Adaptation and Mitigation Projects are also currently being implemented by the Authority. All the above activities are expected to provide numerous employment opportunities and socio economic progress for the people of the Region.

LBDA is therefore seeking for partnerships to energize implementation of these programmes and project activities.

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